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TERNA Wind Energy Programme

Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

23 Country Analyses

Eschborn, September 2007

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New Edition of the TERNA Country Survey

Since the first edition of the TERNA country survey appeared in 1999, there has been a distinct heightening of public and political awareness of the consequences of climate change and of energy provision as a key factor in sustainable development. In Germany and other industrialised countries, a political tailwind, effective promotion mechanisms and rising energy prices have created the conditions for a dynamic market in which renewable forms of energy are exhibiting high growth rates within the energy mix. In 2006, global new investment in renewables amounted to US$ 70.9 billion – an increase of 43 % over 2005.

Strong economic development in many emerging countries has triggered rapidly rising demand for energy and competition on the international oil market. Against the background of the rising cost of fossil fuels, supply risks and damage to the environment, the significance of renewable energy as a means of generating electricity is growing – also in developing and emerging countries: according to analyses conducted by the Renewable Energy Policy Network for the 21st Century (REN21), 39 countries have set expansion targets for renewable energy sources and introduced promotion mechanisms, nine of which are developing or emerging countries. Of total new investment in renewable energy around the world, US$ 15 billion was invested in developing and emerging countries. Nevertheless, the majority of countries still have a long road ahead of them before they overcome existing barriers to the successful introduction of renewable forms of energy.

The German and European market acts as the driving force for the wind energy industry and provides an indispensable background of experience. However, growth in the industry is also increasingly apparent in developing and emerging countries. It is the successes in countries such as India, China and Brazil which encourage commitment beyond the borders of industrialised nations. In those three countries there is a growing proportion of local content in the systems and equipment they produce – and not only for supply to their own domestic markets.

A number of other countries though, too, are erecting their first wind farms, thereby establishing the basis for gaining experience to be utilised in future markets.

To help interested players gain access to the new markets, this survey provides detailed descriptions of the framework conditions for electricity markets and renewable energy in 23 developing and emerging countries.

Latin America	Africa/Middle East	Asia
Argentina	Egypt	Bangladesh
Brazil	Ethiopia	China
Caribbean States	Jordan	India
Chile	Morocco	Indonesia
Colombia	Namibia	Pakistan
Costa Rica	South Africa	Philippines
Dominican Republic	Tunisia	Viet Nam
Mexico		
Nicaragua		

This latest country survey and the previous editions are available on our homepage: www.gtz.de/wind. For the first time, the publication is also available on CD-ROM. For information on how to obtain this, again, go to the homepage.

Our grateful thanks go to a large number of GTZ staff members and other experts in the field for their help in putting this information together.

Eschborn, September 2007

Legal Information

1. The data used in this study is based on both publicly accessible sources of information (publications, specialist articles, internet sites, conference papers etc.) and non-public papers (for example internal expert reports from promoting institutions), as well as personal interviews with experts (for example officials at energy ministries in the investigated countries and project staff at promoting institutions). Although all information has been checked as far as possible, errors cannot be ruled out. Neither the GTZ nor the authors can therefore provide any guarantee of the accuracy of the data included in this study; no liability can be accepted for any loss or damage resulting from use of the data included in the study.

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The TERNA Wind Energy Programme

There is great potential for generating electricity from renewable energy sources in many developing and emerging countries. Obstacles to the exploitation of such sources include a lack of knowledge of framework conditions in the energy industry and insufficient transparency with regard to the prior experience and interests of national actors.

The purpose of the TERNA (Technical Expertise for Renewable Energy Application) wind energy programme, implemented by GTZ on behalf of the Federal German Ministry for Economic Cooperation and Development (BMZ), is to assist partners in developing and emerging countries in planning and developing wind power projects. Since 1988 the TERNA programme has pursued the twin goals of laying the foundations for sound investment decisions while at the same time enabling partners to assess wind energy potentials, plan wind energy projects and improve energy-policy frameworks for renewable forms of energy.

The TERNA wind energy programme's partners are institutions in developing and emerging countries that are interested in commercial exploitation of wind power. These include, for example, ministries or government institutions which have the mandate to develop BOT/BOO projects, state-owned or private energy supply companies (utilities) and private enterprises (independent power producers).

TERNA offers its partners expertise and experience. In order to initiate wind power projects, favourable sites must be identified and their wind energy potential ascertained. To do this, wind measurements are normally taken over a period of at least twelve months and wind reports are drawn up. If promising wind speeds are found, the next step is to conduct project studies investigating the technical design and economic feasibility. TERNA also provides advice to partners on matters of finance, thus closing the gap between potential investors and offers of funding from national and international donors.

If required, CDM baseline studies can be prepared and advice can be offered to potential operators on setting up an efficient operator structure. In order to ensure as much transfer of know-how as possible, efforts are made to ensure cooperation between international and local experts, for example when preparing the studies.

In successful cases, TERNA initiates investment-ready wind farm projects by this method. TERNA itself is not involved in financing. In addition to the activities that are tied to specific locations, TERNA advises its partners on how to establish suitable framework conditions for the promotion of renewable energy sources.

Up until 2007, TERNA has been active in over ten countries around the world.

Further information on GTZ's TERNA wind energy programme, the application procedure etc. is available at www.gtz.de/wind or directly from:

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1 Argentina

1.1 Electricity market

Installed capacity

At the end of 2005, Argentina had power generating capacities totalling 25,674 MW, including 15,598 MW in the form of thermal power stations (fuelled mostly with natural gas), 9,920 MW as hydroelectric facilities[1] and 1,018 MW from nuclear power plants. Excluding major hydropower stations with more than 15 MW, renewable energy sources accounted for a sum total of around 210 MW. Nearly 10,000 MW of the total generating capacity has been newly commissioned since 1992, when the electricity market was liberalised. In recent years, an increasing share of new capacity has been provided in the form of gas-fuelled power plants and new hydroelectric facilities.

Due to deficient maintenance, however, only about 18,000 MW of power generating capacity is actually available. In 2006 the peak load was 17,400 MW, so the system has very little reserve capacity. Supply shortages in the country's main grid, Sistema Argentino de Interconexión (SADI), are partially alleviated via import supply agreements.

Power generation

Approximately 96,650 GWh of electricity were generated in 2005. A breakdown according to primary sources of energy is reflected in the following table:

	Thermal		Hydro		Nuclear		Total
	GWh	%	GWh	%	GWh	%	GWh
2001	38,929	46.9	36,949	44.5	7,059	8.5	82,987
2002	34,945	45.5	35,797	46.7	5,821	7.6	76,637
2003	42,306	50.6	33,737	40.3	7,566	9.1	83,688
2004	52,993	58.1	30,445	33.3	7,869	8.6	91,380
2005	54,845	57.4	34,192	35.4	6,873	7.1	96,650

Tab 1: Power generation according to primary energy source; 2001-2005; GWh[2]

Exports and imports of electricity in 2005 amounted to 4,140 GWh and 8,017 GWh, respectively.

Power transmission

Technically speaking, the power supply system comprises two interconnected grids: SADI which operates in the north and in the Argentine heartland, and within which the generation companies serving the Mercado Eléctrico Mayorista (MEM) electricity market are organised; and Sistema Interconectado Patagónico (SIP) in Patagonia, which handles electricity generated by the members of Mercado Eléctrico Mayorista Sistema Patagónico (MEMSP). Both grids are managed by CAMMESA.[3] In late 2005, the two grids were interconnected by a 500 kV high-tension line running between Choele Choel in Rio Negro province and the more southerly situated Puerto Madryn in Chubut province. Never-theless, both grids, SADI and SIP, continue to operate independently of each other. The transmission network comprises 500 kV, 220 kV and 132 kV lines,[4] and the installed capacity is distributed among the various networks as shown in the following table:

1 Including 974 MW from pumped-storage plants.
2 Source: Secretaria de Energía, 2001, 2002, 2003, 2004, 2005; generation figures specific to transmission and distribution networks.
3 Compañía Administradora del Mercado Mayorista Electrico Sociedad Anónima (CAMMESA), see section entitled "Regulatory authorities".
4 The Cammesa home page offers detailed maps of all the various supply networks: www.cammesa.com/inicio.nsf/marcomemnet. Status: November 22, 2006.

	MEM	MEMSP	On-grid plants	Off-grid plants
	MW			
2001	22,884	801	734	969
2002	23,148	765	619	966
2003	23,272	763	655	988
2004	23,295	801	734	969
2005	23,245	800	660	970

Tab 2: Installed capacity according to supply network; 2001-2005; MW[5]

	Households		Commerce		Industry		Other		Total
	TWh	%	TWh	%	TWh	%	TWh	%	TWh
2001	21.5	30.8	12.7	18.2	27.5	39.5	8.0	11.5	69.7
2002	20.6	30.6	12.3	18.2	26.8	39.8	7.6	11.4	67.3
2003	20.9	29.0	12.1	16.9	29.9	41.4	9.3	12.7	72.2
2004	21.7	28.5	14.1	18.5	31.8	41.6	8.5	11.4	76.3
2005	23.6	29.1	15.7	19.4	32.9	40.6	8.9	11.0	81.1

Tab 3: Power consumption according to user group; 2001-2005; TWh,%[6]

A new link, now under construction, between Comodoro Rivadavia in Chubut and Pico Truncado in Santa Cruz is being installed to integrate the windy regions in southern Patagonia. The vital connection between Puerto Madryn and Pico Truncado is scheduled for completion by the end of 2007. Some 2,000 additional kilometres of supply lines are to be installed in other parts of the country within the next two years.

Argentina had an electrification level of 95 percent in 2006.

Power consumption

As a result of the last recession, demand for power was down 2% in 2002. Since then, however, it recovered three years in a row, showing a 6% increase in 2005. CAMMESA is expecting continued growth of 6% to 8% per year for 2006 to 2008, depending on economic developments.

The most recent report from the Energy Secretariat on future developments in the electricity sector, entitled 'Prospectiva 2002', was published in 2003. It predicted that total consumption would reach 128 TWh by 2012. Accordingly, as much as 1,800 MW of new capacity needs to be added every year of this decade.

Recent years have seen efforts to compensate for the prior absence of investment in the country's supply networks. For example, the government presented two successive national power transmission plans in 2003 and 2004. Due to the fact that, despite growing demand, no new power plants have been constructed in recent years, the risk of power shortages has risen. Part of the cost of grid improvement is covered by a national electricity fund. The money in the fund comes from a surcharge on wholesale power purchases. Loans are also granted by the Inter-American Development Bank (Banko Interamericano de Desarrollo – BID).[7]

Plan Energía Plus

The Plan Energía Plus is the government's attempt to counter a consumption trend characterised by the fact that more than half of demand comes from major commercial and industrial consumers. In effect since 8 November 2006,[8] the programme is attempting to prevent any further increase in the consumption of individual customers who are already drawing more than 300 kW each.

5 Source: Secretaria de Energía, 2001, 2002, 2003, 2004, 2005.
6 Source: Secretaria de Energía, 2001, 2002, 2003, 2004, 2005.
7 BID has earmarked a 580 million peso line of credit for the NEA-NOA connecting line; the loan would cover roughly 80% of the initial cost of investment.
8 See Resolución SE No. 1281/2006.

The financial incentive is that any increase in consumption beyond that of the 2005 reference level is being made significantly more expensive. However, since the actual penalties for excess consumption have not yet been set, the marginal costs of the power plant with the most expensive production is serving as the basis of calculation for the time being. The main idea is to make major consumers think about saving energy and/or about generating their own electricity to cover additional demand.

Electricity prices

Due to the large number of market participants[9] and favourable primary energy delivery costs for power producers, the average price of electricity dropped more than 50 % during the first six years after 1992. Since 1999, however, prices have been increasing again. While the average electricity market price in MEM was 7.1 euro/MWh (28.9 arg $/MWh) in 2002, it rose to 13.2 euro/MWh (53.8 arg $/MWh) by 2004. The prices for electricity from the various distribution networks are detailed on the homepage of the regulatory agency ENRE.[10] Most differences in price are due to transmission bottlenecks.

The rise in electricity tariffs in recent years has been mainly attributable to drops in the availability of hydroelectric power and partial substitution of tendentially cheap natural gas with other types of fuel in response to domestic demand exceeding the national gas production rate. In reaction to the economic crisis and attendant devaluation of the Argentine peso, an upper limit on spot-market prices was introduced in 2002. Due to regulated prices and despite increases in the price of electricity, many producers were barely able to recover their production costs, let alone return a profit.

1.2 Market Actors

The Argentine electricity market is characterised by a large number of market actors at the various levels of generation, transmission and distribution.

Private actors

At the end of 2005 there were a total of 41 power-generating companies, 14 autoproducers, 66 distribution companies, 8 supraregional transmission companies and 2,614 major consumers in the two interconnected grids. In the generating sector, three companies have the biggest market shares: Endesa Costanera, Central Puerto and Yacyreta. Of the 66 distribution companies, the two largest, EDENOR and EDESUR, delivered about 43 % of all electricity consumed in 2005. A concession for power transmission via high-tension lines was awarded to Transener SA in 1990 for a contract duration of 95 years. The low voltage grids are operated by six supraregional enterprises.

In addition to the power producers integrated within the SADI and SIP grids, there are also a number of local-level utilities with tie-ins to the interconnected network, but which do not participate in the central load-distribution arrangement. Yet another group is that of the independent power producers, who either feed in to isolated grids or produce for their own consumption.

Due to the large number of actors at all different levels, the Argentine electricity market is characterised by high competitive pressure. All power producers have, as a matter of principle, free and equal access to the grid. Electricity from the public power grid is traded by way of bilateral agreements between producers and distributors and/or major consumers, as well as by way of seasonal subscriber agreements and a short-term spot market with hourly price quotes operating under the supervision of CAMMESA. Some 78 percent of all electricity passing through MEM in 2004 was traded on the spot market.

9 See section entitled "Market actors".
10 See www.enre.gov.ar.

Public-sector actors

Few Argentine electricity generating facilities are still owned by the state. That category includes the two nuclear power plants Atucha I and Embalse and both binational large-scale hydroelectric plants, Yacyreta and Salto Grande. Altogether, the public-sector generation system accounts for approximately 14 percent of the country's total installed generating capacity.

In 2004, in reaction to the recent years' energy crisis, the government established a national energy enterprise called ENARSA (Energia Argentina Sociedad Anónima) in order to establish a regulative state-owned element in an energy market that was almost completely privatised. In addition to securing the government's influence on the oligopolic oil and gas markets, the company was geared to ensuring the availability of basic supplies. The company's potential activities relate primarily to the oil market and secondarily to the gas and electricity markets. Its radius of action encompasses all links of the value-added chain. At the moment, the company's main concern is to develop the oil fields situated off the coast of Argentina. According to its statutes, the state is supposed to hold 53% and the provinces 12%. The remaining 35% were sold to private investors via the stock market.

Other Actors

Regulatory authorities

Independent national- and provincial-level agencies are tasked with regulative responsibility for the natural monopolies of transmission and distribution (national level: ENRE = Ente Nacional Regulador de la Electricidad; regional level: EPRE = Ente Provincial Regulador de la Electricidad). ENRE mediates in the event of conflict between utilities, ensures that federal laws and regulations are implemented, and watches over the conclusion of concession contracts. In addition, ENRE sets the standards for power distribution and the maximum prices of transmission and distribution, and supervises both the generating companies and CAMMESA.

CAMMESA (Compañía Administradora del Mercado Mayorista Electrico Sociedad Anónima) was established as a private, non-commercial company responsible for administrating that part of Argentina's electricity whole sale market that is not covered by bilateral agreements. The power producers' association (AGEERA), the major consumers' association (AGUERRA)[11], the power distributors' association (ADEERA), the association of high-tension transmission network operators (ATERRA) and the Energy Secretariat each hold a 20 percent interest in CAMMESA. CAMMESA's main tasks are to regulate supply and demand (load distribution) according to the principle of least (short-term) marginal costs,[12] determine transmission costs and other non-variables, and ensure sufficient reserve capacities.

1.3 Legal Framework

Liberalisation

Argentina's centralised, government-owned and -operated electricity sector was split up into the separate areas of generation, transmission and distribution and incrementally privatised by way of law no. 24,065 of 16 January 1992 ("Electricity Act") and the associated implementing regulation (Decreto 1398/92 of 6 August 1992). Decree 1853 from 1993 did away with the last remaining impediments for foreign investors. With but few exceptions, Argentine companies can now be wholly owned by foreigners, and the companies' profit and capital can be freely exported.

Evolution of electricity market policy

As a result of the economic crisis in 2001 and 2002 and with the resultant energy crisis in the years to follow, regulative elements have now been strengthened in connection with Argentina's energy policy.

11 Major consumers are those who purchase at least 2,000 MWh/a.

12 The minimum marginal cost principle was replaced, with medium-term effect, by the variable production cost principle. Source: CMA, 2006.

Devaluation of the Argentine peso immediately led to more expensive fuel and higher operating costs. In July 2004, in response to a lack of private investment in Argentina's power generation system despite increasing demand for electricity, a fund was established to enable expansion of the power supply volume. The funding consists of a percentage share of the revenues of power-sector enterprises.[13] New thermal power stations with ratings of 1080 MW and 540 MW, paid for in part with money from that fund, are scheduled to go on line in the latter half of 2007 or in early 2008. The companies that have paid into the fund automatically become pro-rata co-owners of the new power plants.

On 24 August 2006, the Government of Argentina announced a plan to expand the use of nuclear energy through new investments totalling 3.5 billion pesos. The Atucha II power station is to be completed, but also a fourth reactor is to be built and the uranium enrichment programme resumed.

1.4 Policy Promoting Renewable Energy Sources

The government intends to increase to eight percent the share of renewable energies in overall primary energy consumption, although the target year 2013 that was named at the 2004 World Conference on Renewable Energies is proving to be too short a goal. Consequently, the December 2006 law governing the promotion of power generation from renewable energy resources now aims to raise the share of renewable energies to eight percent of the national electricity mix by the end of 2016.

Promotion at the national level

While in the early 1990s the government confined itself to engaging in preparatory activities for the conduct of wind potential studies and/or relevant research, law no. 25,019 of November 1998 was adopted in order to regulate both wind and solar energy. The decision on whether or not to enact such a law was a matter of contention for quite some time, because there was a generally preponderant belief that all support for the energy sector should cease. Thus, it was with a substantial delay that the law's implementing provisions were initiated in December 1999.[14]

The law underscores the nation's interest in the generation of power from wind and solar energy and introduces for the first time national-level assistance to the amount of 0.23 euro cent/kWh (0.01 arg $/kWh) for wind energy. This subsidy is to be paid in addition to revenues from the sale of energy for the next 15 years. The law also prescribes tax incentives in the form of stretched-out remittance of value-added tax.

At the policy-making level it has become generally accepted that the national law on the promotion of renewable energies does not offer sufficient incentives and therefore needs to be expanded. Following some failed legislative initiatives by several different senators in recent years, congress passed a law on the promotion of power generation from renewable energy sources on 6 December 2006. This law envisages broad-scale promotion of renewable energy sources within the scope of a bonus model. The payments are to be rendered by way of a trust-administrated renewable energy fund. In addition to photovoltaics worth 22 euro cent/kWh (0.9 arg $/kWh) and wind energy worth 0.37 euro cent/kWh (0.015 arg $/kWh), the eligible sources of energy also include geothermal energy, tidal energy, biomass, biogas and small-scale hydropower with ratings up to 30 MW, all of which are to receive 0.37 euro cent/kWh (0.015 arg $/kWh).[15] The period of entitlement is 15 years. The law underscores the political intention to create jobs by promoting the use of renewable energy sources and to increase the national and regional net outputs by using domestic products.

13 Between 2004 and 2006, 65 percent of corporate profits must be paid over to the fund.
14 See Decreto P.E.N. N° 1.597/99.
15 Due, however, to the fact that the remuneration rates are still relatively meagre, it is feared that this law, too, will fail to achieve the rapid development of renewable energy resources.

Promotion at the regional level

As of this writing, the southern province of Chubut[16] (Patagonia) and the province of Buenos Aires[17] were promoting alternative energies at the regional level by paying, respectively, 0.12 and 0.25 euro cent/kWh (0.005/0.01 arg $/kWh) per generated kilowatt hour of electricity. In Chubut, payment of the bonus depends on how much, in percent, of the equipment is of local origin. As of January 2001, the minimum percentage was 30 %, but that was raised to 60 % in January of 2003 and, ultimately, to 80 % in 2005. As of January 2007, the entire equipment pool must stem from local production.

In August of 2005 Santa Cruz Province adopted the currently most comprehensive law on the promotion of renewable energy sources. Both conventional thermal power generation and power generation from renewable energy sources are eligible for promotion. The law is characterised by broad-scale promotion of various renewable energy technologies, including wind, solar and tidal energy, hydropower (up to plant ratings of 15 MW), biomass and other technologies that are eligible for promotion and not classified as polluting. Here, too, the remuneration depends on how much of the equipment is locally produced. It varies between 0.25 and 0.75 euro cent/kWh (0.01 and 0.03 arg $/kWh).[18] Various tax incentives are also granted. The aid money stems from a regional energy fund.[19]

No other special provisions are in effect for electricity from renewable energy sources. However, some communities with power supply cooperatives are offering land and infrastructure on very easy terms for wind energy projects. The building laws are handled much less strictly than in Germany.

Clean Development Mechanism

Argentina ratified the Kyoto Protocol on 28 September 2001. The Clean Development Mechanism Office OAMDL (Oficina Argentina del Mecanismo para un Desarrollo Limpio), which reports to the Secretariat for the Environment and Sustainable Development, is serving as the country's Designated National Authority (DNA) for the Clean Development Mechanism. Decree No. 1070 of September 2005 established a national fund (Fondo Argentino del Carbono – FAC) for the purpose of facilitating the implementation of CDM projects.

Six projects have been registered to date with UNFCCC. An initial project for extracting landfill gas in Villa Dominico, Buenos Aires, was accepted in September 2005. That project aims to utilise existing biogas for local generation of electricity. The output, however, is not intended to be fed into the power grid. Four other landfill-gas projects were registered in 2006.[20] The only wind power project to date – a 10 MW system in Comodoro Rivadavia in Chubut Province – was approved in December 2005. Its power output is to be injected into the Patagonian grid by the cooperative SCPLCR (Sociedad Cooperativa Popular Limitada de Comodoro Rivadavia). Three additional projects have also been registered. The CO_2 equivalent prevention effect of all registered projects together amounts to approximately 1.8 million tonnes per annum.

16 See Law No 4389/1998 and decree No 235/1998.
17 See Law No 12603/2001.
18 If all equipment is produced outside the Province of Santa Cruz, only 50 % of the full remuneration is granted. If, however, all plant components are of regional origin, 100 % remuneration can be claimed. Proportional increments are granted for different percentages of regional production.
19 See Legislación Provincial No. 2796/2005 (Santa Cruz), Art. 7.
20 The landfill gas project in Olavarría, led by the World Bank; the Norte III project, led by Argentine enterprise Aria.Biz; and the British-Canadian project in González Catán and Ensenada all target the recovery of landfill gas from waste material, and all three projects are being implemented in Buenos Aires Province.

1.5 Status of Renewable Energy Sources

In Argentina, renewable energy producers are concentrating mainly on hydroelectric power from major plants. However, small hydropower plants are also gaining importance, though on a much smaller scale. While developments in the wind energy conversion sector have been rather sluggish in recent years, the government's current plans have earmarked that branch in particular for an upswing. Argentina possesses multiple underutilised potentials for generating heat and electricity from hydro and wind power but also from solar, biomass and geothermal sources.

Hydropower

Most hydroelectric power in Argentina comes from major dams. Depending on precipitation levels, those plants can cover between 35 % and 45 % of the country's electricity requirements. In 2005, small hydropower facilities (up to 15 MW) accounted for a total installed capacity of around 180 MW. Approximately 60 plants, including some 20 micro- and mini-hydropower plants,[21] produced 675 GWh of electricity. Five miniature plants were installed for experimental purposes in the northern province of Jujuy in connection with the government's PERMER project for renewable energies in the rural electricity market. At present, 2 % of the overall hydroelectric yield comes from mini- and micro-hydropower plants with ratings of 15 MW or less. The Energy Secretariat has identified an additional 120 suitable sites for small-scale hydropower plants with an estimated total capacity of around 276 MW.[22] According to an as yet unpublished study, the real potential stands even higher, at approx. 400 MW. Future development of those sites is to be implemented in part via CDM projects.

Wind energy

Argentina has a very large wind energy potential, but most of the best-suited locations are situated in the southern part of the country (Patagonia), which is only sparsely populated and far away from densely populated areas and industrial centres. Grid expansion, i.e. the interconnection between the SEDI and SIP grids, in combination with extension of the 500 kV line into the southern reaches of Patagonia, will improve the framework conditions for the exploitation of wind energy. Primarily, however, the grids are being expanded to accommodate the further development of hydropower in Patagonia. At present, the planned grid capacity appears insufficient to enable full exploitation of Patagonia's full wind energy potential.

According to information provided by the Energy Secretariat, wind energy conversion systems produced 75,381 MWh of electricity in 2005. At the end of 2006, the installed capacity totalled 28 MW. All systems are in the hands of local authorities and cooperatives.

While Argentina played a leading role in the exploitation of wind energy in South America during the 1990s, only little additional capacity has been installed in recent years. In 2002, there was some 26 MW of installed capacity, and no new wind power installations were erected in 2003 because of the economic crisis. The following year, the General Acha plant was expanded by another 900 kW system, and in 2005 two additional 600 kW systems produced by the German company ENERCON were installed in Pico Truncado, Santa Cruz. Also in Pico Truncado, a pilot project launched in February 2005 involves partial powering of a hydrogen production facility with wind-generated electricity. No new wind generators were commissioned in 2006. The licensing procedures for wind farms have not been standardised, so the regulations differ from region to region.

21 For the sake of better differentiation, the Energy Secretariat has introduced the categories micro-hydropower (5-50 kW), mini-hydropower (50-500 kW) and small-hydropower (500-15,000 kW).

22 The Energy Secretariat has published on its own home page a list of planned and implemented small-scale hydropower projects; see http://energia3.mecon.gov.ar/contenidos/verpagina.php?idpagina=949; Status: 28 November 2006.

Location	Province	Operator	Qty. WECSs*	Installed capacity [MW]	Ø wind velocity[m/s]	Date of commissioning
Rio Mayo	Chubut	DGSP Pcia. Chubut	4	0.12	–	2/90, presently inoperative
C. Rivadavia	Chubut	PECORSA SCPL	2	0.50	9.4	3/94
Cutral Co	Neuquén	COPELCO	1	0.40	7.2	10/94
Pehuen Co	B.A.	Coop. Punta. Alta	1	0.40	7.3	2/95
Pico Truncado	Santa Cruz	E. Pcial. S. Pub.	10	1.00	–	dismantled
Rada Tilly	Chubut	COAGUA (Coop. de Servicios R.T.)	1	0.40	10.2	3/96
Tandil	B.A.	CRETAL	2	0.80	7.2	5/96
C. Rivadavia	Chubut	SCPL de C. Riv.	8	6.00	9.4	9/97
Darregueira	B.A.	Coop. Darregueira	1	0.75	7.3	9/97
M. Buratovich	B.A.	Coop. M. Buratovich	2	1.20	7.4	10/97
Punta Alta	B.A.	Coop. Punta Alta	3	1.80	7.8	2/95 and 12/98
Claromeco	B.A.	Coop. Claromeco	1	0.75	7.3	12/98
Pico Truncado	Santa Cruz	Municipalidad de P.T.	2	1.20	10.3	2/2001
C. Rivadavia	Chubut	SCPL de C.Riv.	16	10.56	9.4	10/2001
General Acha	La Pampa	COSEGA	2	1.80	7.2	12/2002 and 2/2004
Pico Truncado	Santa Cruz	Municipalidad de P.T.	2	1.20	10.3	5/2005
Total				27.76		

* WECSs = wind energy conversion systems

Tab 4: Wind energy conversion systems in Argentina; MW, m/s; November 2006[23]

All wind energy conversion systems installed to date were produced by European companies. The (erstwhile) Danish company NEG Micon[24] holds a market share of 44 %, followed by Spanish turbine manufacturer Gamesa (40 %), the Danish enterprise AN Bonus (now Siemens, 11 %) and the German producer ENERCON (5 %).

However, two Argentine enterprises most recently tested some new prototypes. The state-owned enterprise INVAP is designing systems of its own with modest ratings (500, 1,000 and 1,500 watts) and is cooperating with Spain's wind turbine manufacturer Ecotécnia to build wind generators with electric outputs situated between 225 kW and 750 kW. As early as the year 2000, Industrias Metalúrgicas Pescarmona S.A. (IMPSA) initiated a research project termed IMPSA Wind for the purpose of building a large-scale wind power installation with an output of 1 MW. NRG Patagonia is also developing large wind power plants designed specifically for the kind of constant high-speed winds that are encountered in Patagonia. The model system NRG 1500 is supposed to have a rating of 1.5 MW.

23 Source: Asociación Argentina de Energía Eólica (AAEE), Greenpeace Argentina, 2005.
24 Since acquired by its Danish competitor Vestas.

Planned wind power projects

Demand for domestically produced systems is to be stimulated in part by a National Strategic Plan for Wind Energy that was initiated in 2005 and makes provision for the installation of some 300 MW of capacity within the next three years. The plan is based on an agreement between the Ministry of Planning, Public Investment and Services, the Regional Centre for Wind Energy (Centro Regional de Energia Eólica – CREE) in Chubut province, and the stated-owned and -managed energy enterprise ENARSA. Eighty percent of the wind-power equipment is to be produced in Argentina. However, commitments by private investors are still a long time coming.

Nevertheless, planning at the provincial level is being vigorously pursued, and in July of 2005 Chubut province entered into an agreement for developing the "Vientos de la Patagonia I" project. The first wind farm, with a rating of 50-60 MW, is planned for installation near the City of Comodoro Rivadavia. It was scheduled to join the grid in mid-2006. A similar agreement concerning the "Vientos de la Patagonia II" project with the government of Santa Cruz as project partner is under consideration. Pico Truncado is slated to become the site of a 60 MW wind farm in this case. Other projects are to follow in the provinces of Buenos Aires (100 MW), Neuquén, Rio Negro, La Rioja, Cordoba and San Juan. Considering the only marginally better remuneration provided for by the national law dating from December 2006, it remains to be seen whether those projects actually can be implemented.

In addition, it was announced in November 2005 that the national government and the province of La Rioja are planning a joint venture in the form of a wind farm in the northern part of the province. The equipment is supposed to be domestically produced and supplied by IMPSA. The 70 planned wind turbines with a total rating of approximately 60 MW will require investment of the order of 60 million pesos. The provincial government has signed an agreement, according to which it pledges to provide part of the requisite infrastructure, including a tie-in to the transmission network. Implementation of the project, however, has not yet begun.

In November 2006, the utility company EMGASUD presented a plan for the construction of a thermal power plant with a rating in excess of 400 MW and the installation of a 100 MW wind farm in Chubut province. Both projects were supposed to be launched in February 2007. The total cost comes to 1,240 million pesos. The wind farm, composed of individual 2 MW wind turbines, is supposed to enter service in August of 2008.

Here, too, it remains to be seen whether the planned projects will ever be implemented, because recent years have seen the pronouncement of numerous major wind power projects that in fact came to nothing. It is hoped that the World Wind Energy Conference to be hosted by Argentina in October 2007 will generate new impetus for wind energy.

Wind atlases

Wind atlases are available for two windy provinces in the southern part of the country (Chubut and La Pampa). Compilation of a comprehensive wind atlas for the entire country constitutes an essential component of the national wind energy plan. With a view to improving the planning of wind power projects, the Regional Centre for Wind Energy (CREE)[25] in Chubut province was called upon in March of 2005 to compile the atlas. On 3 August 2006 the President of Argentina presented the resultant interactive national wind map, with the help of which the competent ministry is able to pinpoint the windiest prospective sites. This instrument is to be further refined during the second phase of the project. The interactive map is not yet generally available, but it most likely will be published sometime in 2007.

25 The CREE home page (www.eeolica.com.ar) provides access to the wind atlases for the Chubut and La Pampa regions. Status: 27 November 2006.

Biomass

Primarily in central rural areas there is substantial biomass potential (e.g. organic residue from the sugar and alcohol industry) for use in the local generation of electricity. The Plan Energía Plus programme offers incentives to cover more demand for electricity in agriculture by way of autonomous generation, with any surplus electricity being injected into the power grid. The incentive to do so stems from the fact that any consumption surpassing that of the reference year 2005 will be considerably more expensive. The Energy Secretariat is presently investigating further-ranging uses.

Solar energy

Solartec S.A. has been producing photovoltaic modules in the City of La Rioja since 1986. The components are purchased from the Japanese company Kyocera. The factory turns out about one megawatt worth of modules annually. The company claims to command a market share of about 80 percent.[26] Most solar energy systems in Argentina were installed in connection with the National Renewable Energy for Rural Markets project (PERMER). In all, Argentina has an estimated total installed capacity of 6.5 MW_p in the form of photovoltaic systems. The Energy Secretariat even assumes 9 MW to be more accurate. Some 1.3 MW_p was installed via the PERMER programme. The estimates are based on import data and figures provided by the installation contractors.

In 1987 the national solarmetric network, which has been in place since 1979 as the aggregation of all solar measuring stations, monitored the insolation rates at 118 different locations. Ten years later, NSN mapped the mean insolation levels in all of Argentina.[27]

Geothermal energy

Argentina is believed to have ample geothermal potential. As early as the 1970s, a national commission on geothermal studies was set up to evaluate the potential. To date, 42 potential utility zones have been identified and classified, nearly all of them in the western Andes region.[28] The first pilot project dedicated to power generation was commissioned in 1988: the Copahue facility in Neuquén province has a capacity of 670 kW and is connected to the local network of on-grid power plants. For maintenance reasons, however, the facility has been out of operation since 1998. The high cost of development and the remoteness of suitable locations with respect to ultimate consumers are main impediments to the geothermal generation of electricity.

1.6 Rural Electrification

While 5% of Argentina's overall population has no access to electricity, that fraction stands at about 30% in rural areas. Consequently, the national and provincial governments have set up a special fund to pay for electrification promotion programmes. Since untoward transmission factors often preclude a tie-in to the public power grid, there is strong interest in stand-alone solutions involving renewable sources of energy for remote regions. As a rule, only modest capacities are required, so small power generating units are most in demand.

Electrification programme

PAEPRA

In 1995 the Argentine Government (Secretaría de Energía) created the rural electrification programme PAEPRA (Programa de Abastecimiento Eléctrico a la Población Rural de Argentina). The programme grants subsidies to private concessionaires who guarantee via competitive tendering to provide electricity to rural areas for the lowest amount of subsidies, even if off-grid options have to be implemented.

26 Source: J. E. Salgado, Solartec S.A.
27 See Grossi Gallegos 1998. The maps are available at the following Internet address: www.salvador.edu.ar/csoc/idicso/docs/arep_a3_Abr06.pdf; Status: November 20, 2006. Scientific discourse is currently focused on how to find better methods of producing insolation maps for Argentina, cf. Righini et al., 2005.
28 Source: http://www.salvador.edu.ar/csoc/idicso/docs/arep_a4_feb06.pdf; status: 20 November 2006. The article includes a map of the regions that have been evaluated to date.

The concession contracts have a 15-year tenure and can be extended twice thereafter by way of a new tendering process. The electricity tariffs are set at two-year intervals at levels that ensure sufficient profit for the suppliers.

The first two provinces in which the rural electricity market was concessioned according to that model were Jujuy (contractor: EJSEDSA) and Salta (contractor: ESEDSA, a subsidiary of Spanish utility company Unión Fenosa) in the north-western part of the country. Most electrification is effected on the basis of isolated networks or off-grid approaches relying on fossil fuels (diesel generators) and/or renewable sources of energy. Beginning in March 1998 EJSEDSA provided roughly half of its customers with diesel generators, roughly one quarter with micro-hydropower facilities, and the rest with photovoltaic systems. By the end of 1999 more than 40 % of the by then over 3,000 customers had electricity from individual or collective photovoltaic power plants.

PERMER

In 1999, PAEPRA was expanded to include as a new component a programme geared specifically to the use of renewable energy sources for rural electrification purposes (Proyecto de Energías Renovables en Mercados Rurales – PERMER). The project aims to broaden the private-sector market for alternative power supply systems and to make the supply of power in rural regions sustainable. PERMER is intended to concentrate on scattered settlements, houses and facilities.[29]

The six-year project, which runs until mid-2007, involves an estimated total cost of US$ 120.5 million which will be financed by the World Bank (US$ 30 million loan), the GEF (US$ 10 million grant), the Argentine Electricity Investment Development Fund FEDEI (Fondo Especial de Desarrollo Eléctrico del Interior; US$ 26.5 million subsidy), the concessionaires (US$ 44 million) and the customers themselves (US$ 10 million). The consumers have to carry the cost of installation and then render a monthly flat rate that suffices to cover, over the 15-year tenure of the concession, approximately 40 percent of the initial cost plus expenditures for maintenance and batteries. Supplementary subsidies provided to reduce the monthly financial burden for the poorest members of the population gradually decrease in the course of the concession.

It was planned at the beginning of the project to provide electricity to a total of 1.8 million people in 314,000 households and 6,000 institutions and facilities, such as schools, medical centres and police stations. By September of 2006, however, only 2,235 households and 556 public institutions, including schools, were receiving electricity thanks either to expansion of the public grid or to isolated, off-grid solutions.[30] At present, 3,440 photovoltaic systems have been installed on private buildings and 690 on public buildings in the provinces of Catamarca, Río Negro, Jujuy, Santiago del Estero, Salta and Tucumán.[31]

Exchange rate (9 March 2007):
1 Argentine peso (ARS) = 0.25 euro (EUR)
1 US dollar = 0.76 EUR

29 Nearly all 23 Argentine provinces have agreed to participate in the project. For a pertinent list, go to: energia.mecon.gov.ar/permer/conveniotabla.html; status: 20 November 2006.

30 Regarding the present status of the PERMER project, please refer to energia.mecon.gov.ar/permer/Estado.html; Status: 1 December, 2006.

31 The project's progress in the various provinces can be tracked at energia.mecon.gov.ar/permer/avance.html; Status: 20 November, 2006.

1.7 Information Sources

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  Fuentes renovables de energía en América Latina y el Caribe: Dos años después de la conferencia en Bonn, Septiembre de 2006, Santiago de Chile

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- Proyecto de Energías renovables en Mercados rurales (PERMER) – project description, undated (go to http://energia.mecon.gov.ar/permer/PERMER.html)

- **Righini, R., H., Grossi Gallegos & C. Raichijk:**
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  Informes del sector eléctrico para los años 2000 hasta 2004, Noviembre 2001-2005

- **Secretaria de Energía, (2003a):**
  Prospectiva 2002, Mayo 2003

- **Secretaria de Energía (2004a):**
  Energías Renovables 2004 – Energía Geotérmica.

1.8 Contact Addresses

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2 Brazil

2.1 Electricity Market

Installed capacity

At the end of 2005, total domestic generating capacity was almost 93.2 GW, and by the end of 2006 it had reached approximately 96.3 GW. In addition, at the end of 2005 there were contractual agreements to import 7.7 GW from Argentina and Paraguay. Almost 6.9 GW of this is used purely for on-site provision. More than 50% of generating capacity is located in the three federal states of Minas Gerais, São Paulo and Paraná.

	2001	2002	2003	2004	2005
Hydropower/ wind	62,523	65,311	67,793	68,999	70,858
Thermal power stations	11,725	15,140	16,705	19,727	20,293
Nuclear power	2,007	2,007	2,007	2,007	2,007
Total	76,255	82,458	86,505	90,733	93,158
of which self-generating	5,138	1,651	6,218	6,625	6,858

Tab 1: Power generating capacities; Brazil; 2001-2005; MW

The total capacity licensed by the regulatory authority in the public supply sector and at independent power producers and self-generators, in other words also including projects at the planning and construction stage, was about 100.9 GW at the end of 2006.

Type	Licensed capacity (ANEEL)		Capacity in service	
	Number of plants	MW	MW	%
Large hydropower	156	73,349	71,885	74.66
Small hydropower	476	1,702	1,671	1.73
Thermal power stations	946	23,570	20,490	21.28
Nuclear power	2	2,007	2,007	2.08
Wind energy	15	239	237	0.25
Photovoltaics	1	20	20	0.02
Total	**1,596**	**100,867**	**96,310**	**100.00**

Tab 2: Power generating capacities; Brazil; licensed capacity and capacity in service, end of 2006; MW; %

By far the majority of all generating facilities feed into the wide-area interconnected grid, SIN. In the isolated supply networks in the north and north-east, at the end of 2005 fifteen public utility companies operated generating facilities with a capacity of 2,533 MW in thermal plants und 636 MW in hydropower.

In recent years investment in new power stations and hence growth in generating capacity has in some cases fallen well below expectations and requirements on account of inadequate regulatory conditions[1] and a lack of price signals. Stricter environmental constraints applying to the construction of dams have greatly restricted growth in the hydropower sector or caused considerable delays. The medium-term security of power supply has also been put under strain as a result of the crisis in the Bolivian gas sector.

Since 2004, therefore, the difference between capacity demand and supply has begun to widen, at an ever faster rate. Between 2005 and 2006 alone the power reserve fell from 12% to 6%; it is likely to continue to decline in 2007, to the extent that supply shortages have to be expected.

1 These have now been changed in a positive direction, beginning in 2005.

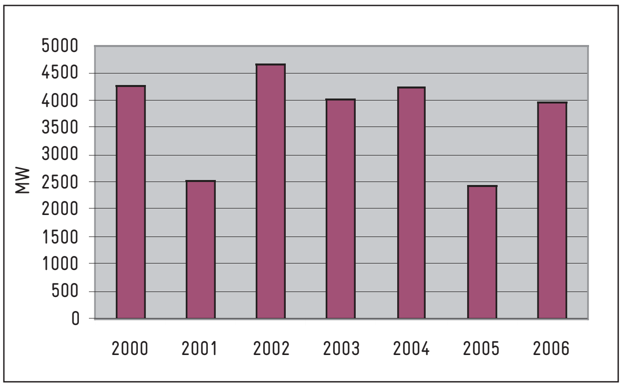

Fig. 1: **Annual addition of new generating capacity 2000-2006; Brazil; MW[2]**

	2001	2002	2003	2004	2005
Natural gas	6,907	9,097	9,073	14,681	13,898
Coal	7,352	5,080	5,251	6,344	6,107
Diesel	4,010	4,697	5,640	6,868	6,630
Heavy oil	6,070	4,492	1,625	1,390	1,613
Nuclear	14,279	13,836	13,358	11,611	9,855
Hydropower	262,655	274,338	294,274	308,584	325,053
Wind	35	61	61	61	93
Total	301,318	311,601	329,282	349,539	363,248

Tab 3: **Public electricity supply – generation; Brazil; 2001-2005; GWh**

Power generation

In 2005 electricity generation totalled 442.3 TWh (an increase of 4% over 2004). Production by public utilities amounted to 363.2 TWh (3.9% above the previous year's level). Self-generators accounted for 39.8 TWh and (net) electricity imports totalled 39.0 TWh. The technical and non-technical losses in power supply amounted to 66.8 TWh (15.1%).

Domestic electricity generation (public supply only) is based largely on hydroelectric power, which accounts for almost 90%. The rest is provided almost exclusively by thermal power stations fired by coal, gas and oil, and by two nuclear reactors (Tab.3). However, in view of the trend towards nationalisation in the Bolivian gas industry, on which Brazil is heavily dependent, it is rather uncertain at present whether the proportion of thermal power stations operating on the basis of fossil fuels will continue to increase in the coming years.

In relation to total power generation (including self-generators and imports), in 2005 over 77% was based on (domestic) hydropower, while all other energy sources were each still well under 5%, as shown in the chart below.

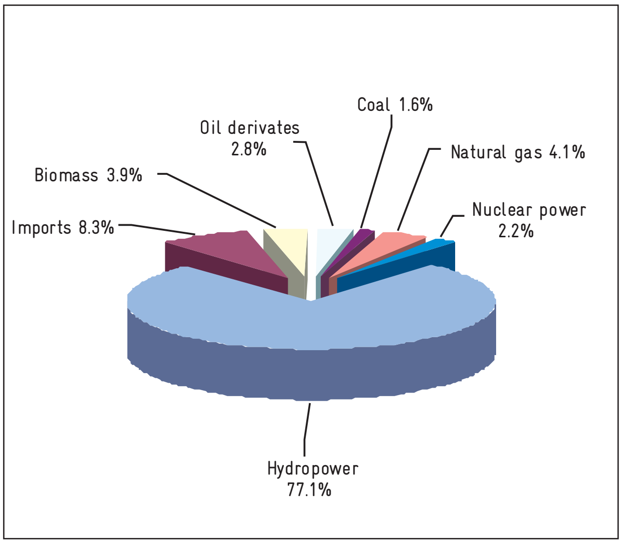

Fig. 2: **Share of total electricity generation from different energy sources; %; Brazil; 2005**

2 No allowance is made here for simultaneous decommissioning of power generating capacity.

Self-generators

Due to links with the agricultural and industrial sectors, the energy resource base for self-generators is much more widely spread and in particular makes use of organic residues. For a number of years, though, the main energy source has been small-scale hydropower. The number of self-generators has more than trebled in absolute terms over the past ten years, and on occasion during this period has undergone sudden, sharp increases.

	2001	2002	2003	2004	2005
Natural gas	3,014	3,309	4,037	4,583	4,914
Coal	242	247	185	236	245
Wood	585	677	626	660	618
Sugar cane bagasse	4,655	5,360	6,795	6,967	7,661
Black liquor[3]	3,111	3,515	3,881	4,220	4,482
Other waste products	3,925	4,184	4,157	4,501	5,513
Diesel	2,063	933	640	672	968
Heavy oil	1,966	1,715	1,470	1,518	1,400
Coke	624	693	464	454	450
Hydropower	5,211	11,754	11,342	12,213	12,404
Others	1,794	1,683	1,460	1,892	1,127
Total	**27,190**	**34,070**	**35,057**	**37,913**	**39,782**

Tab 4: Self-generated power; Brazil; 2001-2005; GWh

Electricity imports

Brazil is a net importer of electricity, and purchases power mainly from Paraguay[4] and Argentina. There are also low-capacity links to Venezuela and Uruguay, which feed electricity into regional grids.

Power transmission

At the end of 2005 the transmission grid extended for 72,000 km, consisting of transmission lines at voltage levels from 230 to 750 kV. All of the major generating and consumer centres are linked to each other via this national interconnected grid. However, in recent years there have been bottlenecks in supply as a result of the low transmission capacities between the north and northeast on the one hand and the south of the country on the other. These bottlenecks are now being eliminated step by step by the construction of new transmission lines.

Since 1998 a total of 28,263 km of transmission lines have been approved by the regulator ANEEL, of which 23,132 km have been built so far (February 2007). Almost 3,200 km of new lines entered service in 2006 alone. New routes with lengths of 2,644 and 2,330 km are envisaged for 2007 and 2008 respectively.

Electricity consumption

Following years of growth, electricity supply fell and consequently consumption dropped drastically in 2001 by comparison with the previous year due to a shortage of water resources. The consumption level of 2000 was not reached again until 2003.

Total electricity consumption in 2005 amounted to 373.5 TWh. Concession-holding distribution companies and electricity traders (public-sector supply) supplied around 346 TWh of this. However, due to a further expansion of self-generation, consumption growth in industry supplied from the public grid remained limited. Part of the growth in the supply of electricity by public suppliers is also attributable to new consumers being connected as a result of grid expansion in rural areas and general demographic trends.

3 Black liquor is a liquid residue from the paper and pulp industry containing organic residues and chemicals. It is concentrated so that it can be burned and generate steam, but it can also be used to produce biogas.
4 From the Itaipú hydroelectric power station jointly operated with Paraguay; each country has 50% ownership.

	Electricity consumption
Sector	(TWh)
Households	82.3
Commerce	52.9
Industry	161.1
Other customers	49.8
Total	**346.1**

Tab 5: Electricity consumption by sector – public supply; Brazil; 2005; TWh

Between 2000 and 2002 electricity consumption dropped sharply from 84 to 73 TWh, especially in the household sector, as a result of the drastic economy measures, and has not yet been able to reach its former level, even in 2005 when it rose to 82.3 TWh. Average monthly consumption in households fell from 173 kWh in 2000 to 142 kWh in 2005, and was therefore actually lower than in 1994. This also means that households' share of total electricity consumption has fallen in the meantime to 22.2% (2005). The decline in specific consumption has been especially notable in the southeastern/central eastern parts of the country and the northeast.[5] Interestingly, average household consumption has risen only insignificantly even after the end of the electricity crisis.

Considered geographically, electricity consumption is concentrated above all in the Southeast Region of the country with its industrial conurbations, but also in the Centre-West (Southeast/Centre-West interconnected grid); altogether these two regions account for about two thirds of national electricity demand.[6]

Since the beginning of the 1970s the growth in electricity consumption has regularly been well above the rates of growth in GNP. Even economic crises failed to curb this trend to any significant extent in the past. Only the electricity crisis of 2001 and the simultaneous occurrence of Argentina's economic problems broke this trend.[7] Despite these dips, forecasts for the 10-year period 2005-2015 in the expansion plan reference scenario assume an average growth in consumption of 5.2% per year. Total consumption in 2015 is therefore anticipated to be about 618 TWh (including self-generation). Long-term forecasts even predict that electricity consumption will rise to over 990 TWh by the year 2030, to which public supply would have to contribute almost 900 TWh.

Electricity consumption by self-generators amounted to 27.4 TWh in 2005 (including commercial users), 17.6 TWh of which was used by large-scale consumers alone.

Electricity prices

In mid-2006 electricity prices averaged € 90/MWh (R$ 251/MWh), varying between € 82/MWh (R$ 228/MWh) in the South Region and € 95/MWh (R$ 263/MWh) in the North. Average prices for the domestic sector were € 106/MWh (R$ 295/MWh), while in the industrial sector they were € 75/MWh (R$ 208/ MWh).[8] At the beginning of 2007 the tariffs for households ranged between 8.6 euro cents (R$ 0.24) and 15 euro cents/kWh (R$ 0.42/kWh).

5 The decline in average consumption among households in the northeast, however, can also be put down to rural regions with low electricity sales being connected to the grid for the first time.
6 In 2005 only 7.2 TWh was consumed in the isolated networks that mostly supply the settlement centres in the north of the country (Amazon region, with Manaus as the largest consumer unit) and are under the control of concessionaires. The situation in smaller communities that commonly generate electricity themselves with diesel generators is generally described as precarious in view of the outmoded plant technology.
7 Energy efficiency programmes have lowered electricity consumption by about 20% and peak load by 5 GW.
8 These prices are net without taxes and charges.

Expansion planning

Following two auctions for the supply of electricity from producers to distribution companies on the basis of new regulations dating from March 2004, it is apparent that no significant new capacity will come on stream until the end of the decade. According to the present expansion plan for 2006-2015, and given the rises in demand assumed in the plan, power generating capacity would have to increase by up to 40 GW within this decade. To achieve that, annual investment amounting to roughly US$ 6 billion is required. Interestingly, to provide the short-term growth in supply great hope is placed in the construction of new biomass-fired thermal power plants on the basis of bagasse, or improving the performance of existing ones – a realistic option, among other things in view of the considerable expansion in sugar-cane cropping envisaged in the coming years.

For the period up to 2030, long-term forecasts predict an increase in installed generating capacity for public supply to 223 GW (including imports). Accordingly, there would have to be a net addition of about 100 GW of new capacity in the period 2015-2030.[9] Some two thirds of the increase would depend on the expansion of hydropower, which would also include a number of large-scale plants. Moreover, this scenario also assumes there will be a revival of nuclear power and a considerable expansion of thermal power stations on the basis of fossil fuels, as a result of which CO_2 emissions from the energy sector would rise significantly.

2.2 Market Actors

Brazil's electricity market has been undergoing a process of great change for some years now. After the completion of restructuring, the original state-monopoly supply sector is set to give way to a largely privatised, liberalised and competition-oriented service sector. However, following the sale of many distribution companies, privatisation has largely come to a standstill in recent years and expressly excludes the generating sector, which is still centrally controlled by the state.

Structure of the public electricity sector

The (public) Brazilian electricity sector is essentially divided up into the state holding Eletrobrás with the bi-national hydropower station Itaipú (operated jointly with Paraguay), an operating company for the nuclear power stations, three large electricity producers as subsidiaries,[10] many independent and individual state electricity suppliers, a relatively large number of distribution companies at regional – in other words mainly federal state – level, and a series of supply companies focused on the larger municipalities.[11] Only some of the regional and municipal suppliers have their own generating capacities. They generally purchase their electricity from the central electricity producers.

At the end of 2005 Eletrobrás owned 69 % of all transmission lines in the interconnected grid and 40 % of Brazilian generating capacity. The latter was shared between 29 hydroelectric plants, 15 thermal power stations and two nuclear power stations with a total capacity of 37,056 MW. In 2005 the generating facilities belonging to Eletrobrás produced a total of 219 TWh of electricity.

9 This forecast is based on calculations made by the government and makes relatively little allowance for the exploitation of potential efficiency gains. An alternative scenario has been put forward by Greenpeace Brazil, see www.greenpeace.org.br.
10 Furnas, CHESF and Eletronorte.
11 However the three largest of these municipal and regional suppliers contribute almost 40% to Brazil's electricity resources.

Generating sector

The generating sector is dominated above all by government-run enterprises. At the beginning of 2007 a total of 1,264 power producers were registered (companies with permits to generate electricity), including 91 public suppliers, 530 producers generating solely for their own use, 71 self-generators which also supply excess electricity to the public grid, 570 independent power producers and 71 electricity traders with their own generating facilities. These figures do however also include a number of companies which have yet to begin electricity generation.

The role of Eletrobrás is still significant, despite curtailment of its scope of tasks following the unbundling of part of the generation and distribution sector. It acts as a holding company for the important enterprises that remain, and in the meantime also performs important tasks as a financing institution for the electricity sector.

Other Actors

National Power System Operator - ONS

The National Power System Operator (Operador Nacional do Sistema Elétrico - ONS), established in 1999, ensures non-discriminatory access by market participants to the national interconnected grid (Sistema Interligado Nacional – SIN) and coordination between supply and demand. The generators, distributors, traders, bulk consumers and representatives of the other consumer groups hold shares in this private sector company.

Regulatory authority ANEEL

The new independent regulatory authority ANEEL (Agência Nacional de Energia Elétrica) was established at the end of 1997.[12] Its tasks are mainly to draw up proposals for the issuing of concessions for electricity generation and distribution, to set tariffs for end customers and to issue permits for access to the grid.

Ministry of Mines and Energy – MME

The Energy Ministry (Ministério de Minas e Energia) is responsible for the energy sector at the government level, and was considerably strengthened by the sector reform of 2004. The Ministry is now once again directly responsible for the granting of concession licenses at the proposal of ANEEL. It plays a central role in planning for the electricity sector and coordinates supply and demand within the framework of the regulated electricity market according to the model presented by EPE (see below). The MME is directly responsible for the PROINFA programme to promote the generation of electricity from renewable energy and for rural electrification, even if day-to-day operations are dealt with by Eletrobrás.

Energy Research Company - EPE

Empresa de Pesquisa Energética (EPE – Energy Research Company) was called into being with Law 10.847 of 15 March 2004 and the restructuring of the electricity market.[13] EPE is a wholly state-owned enterprise that is directly answerable to the Ministry of Mines and Energy; it started its work at the beginning of 2005. EPE has taken over some of the tasks that were previously entrusted to Eletrobrás, for example drawing up expansion plans for electricity generation and transmission, but it is engaged in drawing up the national energy balance, determining the potential of various energy sources, conducting studies into the optimum use of hydropower resources and gathering data in the energy sector.

National Energy Policy Council – CNPE

The CNPE (Conselho Nacional de Politica Energética) is an advisory body that has the role of supporting the President in all matters relating to energy policy. It can generally make representations about anything to do with energy, among other things by adopting guidelines, which also includes the involvement and promotion of renewable forms of energy and, for example, the provision of energy to rural regions. In connection with the sector reform the CNPE was given the task of examining all plans for high-priority supply projects presented by MME in the course of the auctions being run for the regulated electricity market.

12 On the basis of Law 9.427 of 1996. The structure and tasks of ANEEL are described comprehensively in Regulation 2.335 of 6 October 1997. Some readjustments were made in Law 10.848 of 15 March 2004.

13 Implementation by Decree 5.184 of 16 August 2004.

Electric Power Commercialisation Chamber - CCEE

The Electric Power Commercialisation Chamber (CCEE – Câmera de Comercialização de Energia Elétrica) is the successor to the Electric Power Wholesale Market (MAE)[14] and was set up as a private, not-for-profit civil organisation according to Law 10.848 of 15.03.2004 and Decree 5.177 of 23.08.2004. It is answerable to the regulatory authority ANEEL and is responsible for electricity trading within the national interconnected system, SIN. Its most important duties are to prepare and run the trading auctions for the regulated part of the electricity market that were introduced under the sector reform, and to arrange the contractual agreement for the supply of electricity with the generating companies. CCEE's operational procedures and organisational structure were laid down by ANEEL Resolution 109/2004, which also defines the terms of electricity trading.

Power Sector Monitoring Committee – CMSE

The Power Sector Monitoring Committee (CMSE – Comitê de Monitoramento de Setor Elétrico) was created within the MME in response to earlier power crises. Its primary purpose is to ensure that demand and supply in the power sector are in a state of balance in the short term (up to five years) as a result of planned and economically efficient development of generation, transmission and distribution. If supply shortages are foreseeable, the Committee can for example decide to introduce particular price incentives in order to bring additional generating units into the market.

2.3 Legal Framework

Privatisation

The national privatisation programme (Programa Nacional de Desestatização, Law No. 8.031) was launched in 1990. This also provided for the privatisation of areas of electricity generation and distribution for which Eletrobrás had been responsible. The basis for a fundamental reform was established with the Concession Laws 8987/95 and 9074/95 in 1995, which also aimed to set up new regulatory bodies. A first step was taken with the privatisation of the distribution company Escelsa in 1995, and this was followed by many other sales, primarily to foreign investors. However, within the restructuring of the power sector, Eletrobrás and the electricity suppliers that it controlled, i.e. Furnas, CHESF, Eletronorte and CGTEE (Companhia de Geração Térmica de Energia Elétrica),[15] along with the transmission grid operator Eletrosul, were excluded by law from privatisation.[16]

Limitation of market dominance

ANEEL Resolution 278 of 19 July 2000 stated that no electricity generating company or any of the companies controlling it may hold more than 20 % of the total capacity of the national grid or more than 25 % of the southern interconnected grid and 35 % of the northern interconnected grid. The same applies to electricity distribution companies. At the beginning of 2007 Eletrobrás held considerably more than a third of total capacity: its subsidiary CHESF had almost 11 % (10,615 MW), Eletronorte more than 8 % (8,046 MW), Furnas towards 11 % (10,515 MW), the hydroelectric power station Itaipú just over 7 % (7,000 MW) and the subsidiary Eletronuclear about 2 % (2,007 MW) of total installed generating capacity.

A further cornerstone for a competition-oriented power market was created with Law 9648/98 and Decree 2655/1998, setting up the National Power System Operator (Operador Nacional do Sistema Elétrico – ONS), which started work on 1 March 1999.[17]

14 Mercado Atacadista de Energia Elétrica.
15 CGTEE operates three thermal power stations and has belonged to Eletrobrás since July 2000.
16 Law 10.848 of 15.3.2004, Art. 31.
17 See section headed "Other Actors".

Auctions for long-term supply contracts

Following the enactment of Law 10.848 of 15 March 2004 and Decree 5.163 of 30 July 2004, the reform of the Brazilian power sector entered a new phase. The liberal wholesale market that had originally been established was replaced by a new model that provides for greater state regulation. An obligation was introduced for distribution companies that as of 2005 they had to enter into relatively long-term purchase contracts with power producers for 100 % of their demand on the basis of competitive auctions. This is associated with an obligation for all power distribution companies with sales exceeding 500 GWh/a to divest themselves of all holdings in generation facilities and transmission lines, to rule out in-house business and to enable the greatest possible degree of competition. As a general rule all power producers can participate in the various auctions, in other words also new, independent power producers and self-generators who can supply any excess electricity.

These auctions are held at regular intervals, broken down according to power provision from older plants (whose supply contracts have expired) or 'new' plants (commissioned after 1 January 2000 and without a supply contract before 16 March 2004), further differentiated by type of generation, and an upper price limit is assigned for certain types of supply. For example, the price limit for electricity from large-scale hydropower at the first auction (old plants) in December 2005 was € 42/MWh (R$ 116/MWh), while for thermal power stations the limit price was set 15 % higher. At the first auction for 'new plants' in June 2006, the upper limits were set at € 50/MWh (R$ 140/MWh) for thermal power stations and € 45/MWh (R$ 125/MWh) for hydropower plants. In this case the agreed purchase prices for hydropower averaged out at € 46/MWh (R$ 127/MWh), while for thermal power stations they were € 47.5/MWh (R$ 132/MWh).

For existing plants the minimum contract term is set at five years, whereas for 'new plants' the minimum is 15 years (thermal power stations) and can extend to as much as 30 years (hydropower plants).

All of the offers are placed in a joint pool, which balances supply and demand on the basis of forecasts from the distribution companies and establishes an average price so that the purchase prices are standardised across the country for all distribution companies. A second auction for conventional large-scale power plants was held in 2006. An auction is planned for May 2007 that for the first time is intended solely for companies supplying electricity from small-scale hydropower, biomass and wind energy.

In addition to the regulated market between power generators and distributors described above, there is also a market with freely negotiated contracts and non-regulated prices. Selected bulk consumers (those taking more than 3 MW of power) and traders can obtain their electricity on this market. Consumers dominated by the central government, federal states or municipal authorities are always obliged to go through a public tendering process before concluding power purchase contracts.

Concessions for distributing electricity

Concessions are awarded to distribution companies on the basis of public auctions. Distributors have a prior right to supply consumers in their own supply territory, although large-scale consumers purchasing more than 3 MW of power can also enter into contracts with suppliers directly on the 'free' (non-regulated) power market.

Independent power producers and self-generators

Regulation 2003 of 10 September 1996 granted independent power producers and self-generators the right to operate. Independent power producers and self-generators have free access to the interconnected grid and to the electricity grids of the distributors by paying the transmission charges.[18] ANEEL drew up a comprehensive set of rules on calculating the charges in 1998, according to which the transmission price is formed for each individual case depending on the applicable parameters (transport distance, voltage level, amount of electricity etc.).

Independent power producers can sell their electricity to:

- the regulated electricity market within the framework of the auctions described above
- traders and consumers who can select their electricity generator freely on the basis of the minimum power requirements described above
- consumers who also purchase heat at the same time (in other words in cogeneration)
- consumer communities by agreement with the local electricity supply company
- any consumer who proves that he has not been supplied by the local electricity supply company 180 days after signing an electricity supply agreement

With special permits, self-generators can exchange electricity between themselves or sell surplus electricity on the regulated or non-regulated electricity market. There is no legal obligation or preferential arrangement to accept and pay for electricity that is supplied to the interconnected grid from renewable energy sources, for example.[19] In view of the very high peak load tariffs, many self-generator plants are run primarily to avoid these peaks and are not operated for base-load supply, so it is frequently not cost-effective to cover heat requirements at the same time.

2.4 Policy Promoting Renewable Energy Sources

The PROINFA programme (Programa de Incentivo às Fontes Alternativas de Energia Elétrica or Programme of Incentives for Alternative Electricity Sources) was created with Law 10.438 of 26 April 2002.[20] In two phases, the programme envisages the purchase of electricity on preferential terms from plant operators that use renewable energy sources and supply the electricity generated to the interconnected grid. The focus is expressly directed at greater market participation by independent producers who are not governed by concessionaires in the public supply sector.

PROINFA – Stage I up to end of 2008

Originally it was planned that, in the first phase up to the end of 2008, 1,100 MW each of wind power plants, small hydroelectric power systems and biomass power stations were to commence operation and supply electricity to the interconnected grid at defined price rates that have been agreed with Eletrobrás for a period of 20 years.

The rates of remuneration defined by the Ministry of Energy must comply with certain minimum rates based on the average electricity tariffs for final consumers (Tarifa Média Nacional de Fornecimiento ão Consumidor Final – TMNF): at least 90 % for wind energy, at least 70 % for small-scale hydroelectric power, and at least 50 % for biomass. The prices are limited by maximum ceiling values resulting from the uniform spread of the additional costs among all electricity consumers. Consumers with very low consumption (up to 80 kWh/month) will be exempted from all additional costs.

One particular requirement is the regulation that 60 % of the added value of the plants must be created within Brazil. Components for the remaining amount, i.e. no more than 40 %, can be imported tax-free, although only if there is no Brazilian manufacturer and the parts are so specialised that they can only be used for the purpose of power generation within the framework of PROINFA. Otherwise an import tax of 14 % is payable.

18 It is however a problem for smaller units feeding electricity into the grid that access to the distribution level is not regulated yet.
19 One exception to this is the supply of electricity from renewables as contractually agreed within the framework of PROINFA.
20 Partially amended by Law 10.762 of 11.11.2003. For implementation see Decree 5.025 of 30.3.2004.

Remuneration rates and selection of projects

At the end of March 2004 the price tariffs were published for plants that were due to enter service in the course of 2006.[21] At the time it was planned to adjust the tariffs in line with general price trends up to the conclusion of the contract.

According to information from the end of 2005, the agreed rates of remuneration for wind-generated electricity (depending on location) are US$ 86.3 to 97.8/MWh, US$ 56.0/MWh for small hydropower, US$ 44.9/MWh for electricity from bagasse and US$ 48.5/MWh for electricity from wood.

Limits were introduced for projects that can be implemented under PROINFA in each federal state (220 MW each for wind energy and biomass,[22] 165 MW for hydropower). While independent autonomous producers enjoyed priority for small-scale hydropower and biomass, autonomous producers and non-autonomous producers were to be treated equally for wind energy (max. 550 MW each).

After two public calls for tenders, by January 2006 contracts had been entered into for a total of 144 projects. The quota for biomass was not met, reaching only 685 MW, as the operators considered the remuneration offered to be too low and the contract period (20 years) to be too long. As a consequence it was possible to increase the shares intended for small hydropower and wind. The projects with contracts from Eletrobrás can provide a total of some 12,000 GWh per year valued at approximately R$ 1.8 billion, of which over 1,800 GWh is from plants rated at below 15 MW and 10,200 GWh from plants rated at over 15 MW. It is already foreseeable, however, that no more than 139 projects are likely to be implemented. It is also open to question whether it will be possible to keep to the timetable up to the end of 2008 for all of these projects.[23]

	Installed in March 2005	New with PROINFA			Installed end of 2008 (forecast)
	MW	No. of plants	MW	Invest-ment [R$]	MW
Small hydropower	2,200	63	1,191	3.6	3,391
Wind energy	28	54	1,423	5.5	1,451
Biomass	3,070	27	685	1.0	3,725
Total	5,298	144	3,299	10.1	8,567

Tab 6: Electricity-generating plants operating on the basis of renewables; anticipated trend within the framework of PROINFA

In addition the Brazilian Development Bank BNDES has made funds available for low-interest loans amounting to a total of R$ 5.5 billion for PROINFA projects based on hydropower and wind energy for up to twelve years; the loans can be used to cover up to 80 % of the investment costs. To obtain approval, however, 60 % of the value added for the plants (not for the project as a whole) must be created in Brazil. By the end of October 2006 BNDES had released funds of the order of R$ 3.6 billion.

PROINFA – Stage II

In the second phase, envisaged to start after the target of 3,300 MW is reached, further projects are to be implemented in order to ensure that renewable energies (not including large-scale hydropower) account for a share of 10 % of annual electricity demand within a period of twenty years. At least 15 % of the annual growth in electricity generation is supposed to originate from these sources. The purchase prices, also guaranteed for 20 years by Eletrobrás, are to be geared to the generation costs at new hydropower plants with an output of more than 30 MW and new natural gas power stations. At present it does appear questionable, though, whether this phase will be implemented in the intended manner:

21 Ministerio de Minas e Energia, Portaría No. 45 of 30.3.2004.23
22 These limits can however be adjusted and exceeded if this quota is not exhausted in individual federal states.
23 The original deadline by which the PROINFA projects were supposed to have been completed at the latest, the end of 2006, has already been put back twice.

after the sector reform of 2004 increasing emphasis is being placed on free-market competition, which does not exclude the field of renewable energies. Moreover, in view of the current prices for electricity supplied from large hydropower plants it is likely that certain forms of renewable energy (e.g. wind energy) will find it difficult to be competitive.

Power purchase contracts on the basis of competitive tendering

In May 2007 the first auction was held which was intended which is intended solely for suppliers with what are referred to as 'new' plants and electricity generated from renewable energy sources. In the run-up to the declaration of interest 143 offers were registered by power producers, which could provide a total output of 4,570 MW. Almost all of the biomass plants (41 of 42) use bagasse as their primary energy source. The prospects for the numerous offers for wind energy, however, are thought to be poor, as the upper price limit was set at € 50/MWh (R $ 140/MWh), placing it well below the remuneration rates agreed in the context of PROINFA.

ANEEL Resolutions

ANEEL Resolution 245 of 11 August 1999 expanded a fund for the use of fossil energies in isolated grids (Conta Consumo de Combustíveis Fósseis – CCC), originally set up to cushion the high cost burdens in off-grid regions, to finance renewable energies provided that these replace mineral oil products in isolated grids in the north.

Law 10.438 of 26 April 2002 (Art. 17) and ANEEL Resolution 219 of 23 April 2003 specified that the transmission and distribution tariffs may not exceed 50 % of the prices normally allotted if hydropower, biomass or wind energy is used in power units rated between 1 and 30 MW. This ruling was extended by Law 10.762 of 11 November 2003 to hydropower plants up to 1 MW and generally for wind energy and biomass plants up to 30 MW.

Energia Produtiva

In September 2003, with support from USAID, the international development institute Winrock launched the 'Energia Produtiva' (2003-2007) programme involving eight Brazilian institutions that belong to the RENOVE[24] network, which has existed since June 2000. The goal of the programme is to use renewable energy sources in the north and northeast of the country to develop or expand productive activities.

Clean Development Mechanism

Brazil ratified the Framework Convention on Climate Change in February 1994 and the Kyoto Protocol in August 2002. An initial national climate change report was not submitted until November 2004, several years later than planned. Since July 1999 an interministerial commission coordinated by the Ministry of Science and Technology (Comissão Interministerial de Mudança Global do Clima) has been responsible for climate change mitigation and hence for CDM projects too. This commission has also been given the status of the Designated National Authority (DNA) for Brazil. The private sector and NGOs participate via the Brazilian forum on climate change (Fórum Brasileiro de Mudanças Climáticas). The Ministry of the Environment also plays a major role in selecting CDM projects.

By the beginning of 2007 a total of 205 CDM projects had been submitted to the CIMGC, of which 111 had received approval by that time. Forty-six projects deal with the use of various forms of renewable energy for power generation, and a further 67 with the use of bagasse in combined heat and power plants. Eighteen projects envisage the extraction and utilisation of landfill gas. Among all the energy projects approved as CDM measures at the national level, 2,164 MW had already been implemented by the beginning of 2007, of which 938 MW was on the basis of bagasse, 474 MW small hydropower and 290 MW large hydropower (over 30 MW).

24 Rede Nacional das Organizações da Sociedade Civil para as Energias Renováveis, www.renove.org.br.

Of the altogether 561 projects registered by the CDM Executive Board in March 2007, 94 originated from Brazil, putting Brazil in second place in the global ranking behind India. Eighty-five of these projects can be said to be in the renewable energy sector. Of these, there are 16 projects on small hydropower, four projects on the exploitation of wind energy, 10 projects in the field of landfill gas use, 20 projects on the use of biogas in the agricultural sector, 25 schemes related to the use of bagasse, 9 projects on the use of wood residues, wood shavings and green timber, and one project on energy recovery from rice husks.

2.5 Status of Renewable Energy Sources

The use of renewable energy sources traditionally plays an important role in electricity generation and in the provision of energy supplies to rural areas of Brazil. Recently efforts to develop renewable energy sources (especially sun, wind and biomass) have increased substantially, both in the research and development sector and in application-oriented implementation. In the urban and industrialised centres, however, there has so far been little sign of applications to make use of the abundant renewable resources.

Hydropower

The hypothetically available hydropower potential is quoted as being 260 GW, and is concentrated mainly in the North Region (Amazon territory, approx. 40 %) and in the south and southeast of Brazil. A little more than a quarter of this potential (71 GW) is currently utilised, with hydropower contributing more than 40 % to primary energy resources and almost 90 % to electricity generation. A further seven large hydroelectric plants with a total capacity of 1.7 GW were under construction at the end of 2006.

More than half the expansion of electricity generation will be based on hydropower in the coming years. An additional 90 GW is considered to be secured, although given investment costs of up to US$ 4,100/kW and average generating costs of as much as US$ 60/MWh it is currently possible to utilise only about 61.3 GW cost-effectively. Beyond the hydropower plants already in operation, however, in practice it is only possible to develop a relatively small proportion of the total energy volume since intervention in nature to build large reservoirs appears unjustifiable in many cases, especially in the flat north of the country. In the south and southeast, on the other hand, over 50 % of the available capacity is already being used.

Long-term forecasts estimate the installed generating capacity from hydropower for 2015 will be almost 100 GW, which would mean that an average of 3,100 MW would have to come on stream in each of the coming years. Expansion is expected to reach 156.3 GW by 2030.

Small-scale hydropower

Hydropower plants rated at between 1 and 30 MW are defined as small-scale hydropower plants, and provided that the associated reservoir is not larger than 3 km^2 and they are operated by independent power producers or self-generators, they only need a simple permit under electricity law, which is granted to the first suitable applicant.[25] In exceptional cases public auctions may also be held. Concessions are granted for a period that allows refinancing of the investment, but at most for 35 years.

Small-scale hydropower plants are currently concentrated above all in the mountainous regions of the south and south-east of the country.

Despite the investment incentives and the large number of permits issued under electricity law (3.380 MW from 1998 to the end of 2005), there has been only very limited building of additional capacity in recent years. The figure given for 2005 was an installed capacity of 578 MW.

25 ANEEL Resolution 394 of 4 December 1998 and 395/1999. According to ANEEL Resolution 652 of 9 December 2003 larger reservoirs are also authorised in specially defined cases.

However, it is to be expected that at least 1,000 MW of new capacity will be built within the scope of Stage I of PROINFA by the end of 2008. Up to the end of 2006, nine plants with a total of 162.3 MW had commenced operation, out of the contractually agreed 63 projects.

Altogether the potential for small-scale hydropower plants is put at between 7 and 14 GW. It is estimated that 700 MW alone can be developed by expanding and improving existing plants and reactivating dormant power stations. Long-term forecasts predict expansion to 2,770 MW by 2020 and to 7,770 MW by 2030.

Promotion of small hydropower plants

Various incentives have been used to stimulate the construction of new small hydropower plants in recent years:

- At most 50 % of the normal tariffs have to be paid for electricity transmission and distribution, with a discount of as much as 100 % being granted for small hydropower plants that went into operation before the end of 2003.
- Exemption from compensation payments for flooded areas and from tax payments for water use.
- Consumers with a demand of 500 kW or more (or 50 kW for isolated supply) can freely negotiate agreements, and up to 49 % of the electricity they take is allowed to come from other sources.

Wind energy

Despite good to very good wind energy conditions, the use of wind to generate electricity is still in its infancy in Brazil. At the end of 2006 the total installed capacity, shared between relatively few locations, was just over 236 MW. If all the schemes contractually agreed within the PROINFA programme are seen through to a conclusion, the installed capacity is expected to be 1,450 MW by the end of 2008.

The technically feasible generating potential is estimated at more than 140 GW, and the amount of electricity that can be produced from wind energy is put at 272 TWh a year. Not least the coastal areas in the North and Northeast Regions, where mean wind speeds of 8 m/s and more prevail at a height of 50 m, are ideally suited to the exploitation of wind energy.

As already explained above, all wind generating plants and wind farms up to 30 MW have to pay only 50 % of the usual tariffs for transmission and distribution.

Wind measurements

Thanks to international programmes and other assistance, most of the wind-rich areas are well surveyed and documented. Wind measurements were carried out at three coastal locations in the state of Ceará as long ago as 1990/91 within the framework of GTZ's TERNA programme in conjunction with the regional electricity supply company COELCE.[26] They revealed excellent wind potential at a highly constant level. The Brazilian Wind Energy Centre published a first wind atlas for the Northeast Region in 1998.

At state level there are wind atlases available for Ceará, Paraná and Bahia. The first version of a pan-Brazilian wind atlas by the Solar and Wind Energy Reference Centre CRESESB (Centro de Referência para Energia Solar e Eólica Sérgio Brito) at the Electrical Energy Research Centre (CEPEL) was completed in 2002. This atlas is based on measurements taken by various supply companies and other actors in the field.

Brazil has important know-how resources in the form of the Brazilian Wind Energy Centre in Recife, which has a test facility, and CRESESB in Rio de Janeiro. Academic institutions in other federal states are also looking at wind energy more closely and are contributing to training specialists. In the past, training measures for Brazilian energy and finance experts have been held repeatedly with German assistance (InWEnt and German Wind Energy Institute - DEWI).

26 See www.seinfra.ce.gov.br.

Status of wind use

Thanks to the plants installed within the framework of PROINFA in 2006, wind power capacity registered considerable growth. By the end of the year 208 MW went on stream, shared between five locations, most of them in the southernmost state, Rio Grande do Sul (Tab. 7). All of the plants were supplied by the Enercon subsidiary Wobben Windpower.

In the meantime the Osório and Água Doce wind farms have also been registered as CDM projects, as well as another small wind farm (Horizonte) in Santa Catarina rated at 4.8 MW which was finished in 2003, and three installations with a total of 1.8 MW in Macau in the state of Rio Grande do Norte which have also been in operation since 2003 and which supply power for oil-well pumps belonging to the state-owned enterprise Petrobrás.

Location	Federal State	Capacity	Turbines	Start of operation	Operator
Água Doce	Santa Catarina	9.0 MW	15 x 600 kW	2005/2006	CENAEEL
Rio do Fogo	Rio Grande do Norte	49.6 MW	62 x 800 kW	July 2006	Iberdrola / Enerbrasil
Osório	Rio Grande do Sul	50.0 MW	25 x 2,000 kW	June 2006	Elecnor / Enerfin / Ventos do Sul
Sangradouro	Rio Grande do Sul	50.0 MW	25 x 2,000 kW	Sept. 2006	Elecnor / Enerfin / Ventos do Sul
Índios	Rio Grande do Sul	50.0 MW	25 x 2,000 kW	Nov. 2006	Elecnor / Enerfin / Ventos do Sul

Tab 7: Wind power stations installed in 2006 under the PROINFA programme

Altogether there are 54 PROINFA projects in the wind sector which have power purchase contracts with Eletrobrás. They are distributed across various federal states as follows:

- Santa Catarina – 11
- Ceará – 14
- Pernambuco – 5
- Paraíba – 13
- Rio Grande do Sul – 5
- Rio Grande do Norte – 3
- Rio de Janeiro – 2
- Piauí – 1.

Interestingly, in some equally windy states in the northeast such as Alagoas, Bahia and Sergipe there are no wind projects at all that were considered for selection in the context of PROINFA.

One factor that is proving problematical as far as swift implementation is concerned is the requirement that 60 % of the value added in all schemes must be from Brazilian sources. Until now it has only been possible to meet this condition with systems from the only turbine manufacturer based in Brazil, Wobben Windpower; there have been distinct signs of a bottleneck as a result.

From the second half of 2007 it is likely that the German company Fuhrländer will also begin manufacturing wind generators in Brazil.

Current long-term forecasts do not envisage any expansion of wind energy beyond the planned first phase of PROINFA by 2015. Given the current cost situation, expansion in the subsequent period through to 2030 is not expected to exceed 3,300 MW, the equivalent of only 220 MW per year.

Biomass

Brazil has wide-ranging biomass resources at its disposal that already account for almost a quarter of primary energy consumption and contribute about 2 % to electricity generation. However, often these resources are not exploited sustainably at present; for instance charcoal is burned without there being any specific reforestation measures in place.

It is also the case for all biomass plants up to 30 MW that only 50 % of the tariffs for transmission and distribution have to be paid.

Use of biomass

So far the main instances where biomass is used for generating electricity are in industrial self-generation. Mostly this involves the use of bagasse from sugar production and (associated) alcohol production[27] as well as the use of residual substances in the timber and paper industries. About three quarters of the electricity-generating biomass plants with a total capacity of over 3,000 MW (March 2005) are combined heat and power plants. In almost all of these the fuel used is bagasse; only a limited amount of excess power is available for supply to the interconnected system, and only on a seasonal basis (six to seven months per year).

In relation to the use of biomass for electricity generation and the supply of surplus power to the public grid, the PROINFA programme has proved to be of only limited help as the envisaged remuneration arrangements were seen as being largely inadequate.

Up to the end of 2006, fifteen plants with a total of 414 MW had commenced operation, out of the contractually agreed 22 projects (with a total planned capacity of 685 MW). Greater hope is now being placed in the pending competitive tendering procedures for new generating capacity in connection with pro rata financing through the sale of emissions certificates under the CDM.

Power generation from the use of bagasse

In 2005 there was a total of 106.5 million tonnes of bagasse available for energy-generation purposes. In the plants operating in the sugar industry, this was used to generate about 7,660 GWh of electricity. In 2006 a total of 248 sugar factories possessed licences as self-generators, which for the most part were also authorised to operate as independent power producers (supplying surplus electricity to the public grid).

All in all the Ministry of Mines and Energy quantifies the potential for power generation from the use of bagasse at around 8,000 MW, of which according to another source 3,220 MW or about 14,000 GWh would be available during the harvest period for supplying electricity to the public grid. An increase to 35,000 GWh and the ability to supply electricity throughout the year appears to be possible if crop residues from agriculture were to be utilised in addition to bagasse in plants with high-pressure steam generators.[28]

Moreover, as a result of expansion of the ethanol programme there is expected to be a large increase in the cultivation of sugar cane. Compared with approximately 425 million t in the 2006/07 harvest period, there is expected to be a yield of almost 630 million t of sugar cane in 2012/13, which would then be processed in a probable 325 factories.

Other biomass resources

At the end of 2002 ANEEL published an inventory of the biomass potential that can be additionally developed for electricity generation at short notice in agriculture and forestry in the various parts of the country.

27 With electricity generation of more than 4,000 GWh a year.

28 Other estimates quote a possible electrical capacity of CHP stations on a sugar-cane basis of 6,000 MW for the state of São Paulo alone. For the whole of Brazil the prospect is held out that the energy potential could even be more than 21,000 MW, provided that high-efficiency techniques are used by 2010.

	North	North-east	Centre-West	South-east	South
	MW				
Oilseed crops	Pará: 157	45	No data	No data	No data
Rice husks	33	34	68	13	190
Forestry[29]	13	52	3	121	127
Coconut shells	6	36	–	5	–
Cashew nut shells	–	13	–	–	–

Tab 8: Biomass potentials exploitable at short notice for electricity generation, by region; Brazil; MW[30]

In view of the resources that are already being utilised or are currently being developed, however, the identified potentials are more likely to be a conservative estimate.

In recent publications the Ministry of Energy quantifies the technical generating potential in rice growing and the paper and pulp industry at 1,300 MW. For the southern states of Santa Catarina, Paraná and Rio Grande do Sul alone, the technical power generation potential that can be utilised at short notice from the exploitation of timber residues, rice husks and parts of the sugar cane plant is estimated at several hundred megawatts. The first electricity-generating plant designed to utilise rice husks began operation in 1996.[31] All in all four new plants using rice husks and wood chips are due to be built in 2007 in the state of Rio Grande do Sul by the German company CCC Machinery GmbH, producing a total of 61.5 MW.

At the same time the development of further biomass resources is being discussed and partly already being implemented on a small scale. Attention is focused here not only on organic constituents of domestic waste, but also on residues of other agricultural products, for example cocoa and coffee husks, and on oleaginous fruits that could play an important role in the form of pure vegetable oil or as biodiesel above all in the rural electrification of the north and northeast, as fuel for internal combustion engines.

As in other countries, the use of landfill gas is also proving to be an important resource. Several schemes are presently being implemented in the context of CDM certificate trading. There are also some initial pilot projects trialling the use of sewage gases from wastewater purification.

One current long-term forecast assumes an installed biomass capacity (not including bagasse) of 56 MW in 2005. By 2015 this is expected to be expanded to 1,621 MW, and to 6,571 MW by 2030.

Solar energy

The Federal University of Pernambuco presented a first solar atlas for Brazil in 2001 on the basis of results from 350 measuring stations. A considerably improved version was produced as part of the UNEP-SWERA project and published in 2006.[32] Thanks to its position close to the equator, Brazil has good to very good solar conditions in all parts of the country. Average daily irradiation ranges between 4.5 kWh/m^2 on the coast of the state of Paraná and 6.3 kWh/m^2 in the interior of the country in the northeast (the sertão area). There is a regional solar radiation atlas for the state of Santa Catarina which was prepared in partnership between the regional energy supply company and the Federal University.

Photovoltaic use

In recent years solar energy has been used to generate electricity mainly within the framework of the federal PRODEEM programme, under which communal facilities in the health sector but also some production facilities were equipped with PV systems with a total output of about 5.8 MW. Initial experience with a grid-coupled plant was gained in the grounds of the Federal University of Santa Catarina. No mention is made of solar-generated electricity in the energy development plan up to 2030.

29 Only timber residues from forestry.
30 Source: ANEEL, 2002
31 At São Gabriel in the state of Rio Grande do Sul.
32 See swera.unep.net.

Altogether the potential for photovoltaic facilities within the context of basic rural electrification is estimated at about 100 MW. In the past, solar home systems for the provision of elementary off-grid power to private households have mainly been distributed in the course of bilateral development projects. However, due to insufficient market density and a lack of maintenance, the failure rate of PV systems has been very high. It is hoped that such faults will be avoided in future by direct involvement of the distribution companies in the electrification measures within the framework of the new programme 'Luz para Todos'. The firm Heliodinâmica is the sole national manufacturer of solar cells and modules, but its production volume is only very low to date.

Solar thermal electricity generation

Since 1996 Brazil has been participating in the international SolarPACES project (Solar Power and Chemical Energy Systems) through the research establishment CEPEL (Centro de Pesquisas de Energia Elétrica). No specific consideration has been given to building solar-thermal power stations.

Solar thermal water heating

It is common practice in Brazil to heat water for showers with simple and in acquisition very inexpensive electric continuous-flow heaters, unless people do without such a convenience for reasons of cost or because of a lack of running water. In some southern cities, including Rio de Janeiro, gas-fired continuous flow water heaters are also in widespread use. The supply of electricity to these devices gives rise to extreme peak loads in the morning and evening, especially in the major consumer centres. Despite the availability of solar power all year round and a number of collector manufacturers, and the fact that technical quality assurance requirements are certainly comparable to international standards, solar water heating can still not be described as having been widely introduced.

Solar thermal heating has so far not been able to gain a significant market volume, whether in urban environments with multi-storey buildings or in single-family houses. Nevertheless, there is constantly growing demand for thermosiphon systems for individual households and for larger installations, for example for hospitals. Power supply companies in particular are attempting to open up a wider field of application with appropriate promotion in poor areas. As it is often the case that no payment is made for electricity use in these residential areas, initial efforts are being made to build and install relatively simple systems with the involvement of the inhabitants. The power supply companies cover the costs from a budget that they have to spend on energy efficiency measures anyway, as stipulated by law. Individual municipalities are also currently launching initiatives to increase the distribution of solar water heating in their areas.

Geothermal energy

Due to its geological features, Brazil does not have favourable conditions for using geothermal energy. It has not yet been explored whether there is any potential in specific localities for using geothermal energy to produce electricity.

2.6 Rural Electrification

Due to its territorial size, low population density in large parts of the country and severe poverty in rural regions, Brazil still has a not insignificant proportion of non-electrified communities and households.[33] According to the 2000 census, some 3.1 million households (corresponding to 6.5 % of the total) did not have electric lighting.[34] Thanks to the steps that have been taken in the meantime, however, the rate of electrification is now likely to have risen to over 95 %.

33 The term 'non-electrification' is to be taken literally in this connection, since usually not even diesel generators are available for elementary autonomous supply and frequently only batteries can be procured for basic needs (for example for operating radio sets). Communities are to be understood as local communities whose residents are frequently settled over a wide area but do not necessarily own land of their own. That is why in Portuguese the term used is more frequently "propriedade" ("property").

34 According to estimates in 2006 Brazil's total population numbered 186.8 million (DSW data report, Sept. 2006). Moreover in many regions the existing electricity supplies are frequently interrupted and thus only available for part of the time.

'Luz para Todos' programme

To improve electrification in rural areas the 'Luz para Todos' ('Light for All') programme was launched in November 2003.[35] According to this, all 12 million people without access to electricity are to be supplied with electricity (10 million of these in rural areas). By the end of 2008 it is intended that a total of 1.7 million non-electrified households will be given access to electricity. In the concession areas with an electrification rate of less than 96% at the start of the programme, complete coverage is to be attained by 2013, while in communities with less than 53% this is not expected until 2015.

The programme is coordinated by the Ministry of Mines and Energy, handled by Eletrobrás and put into practice by the distribution companies under its control and the privatised and federal power supply companies with the participation of regional committees. By November 2006, 4.6 million people had been supplied with electricity for the first time. The programme's activities focused on the northeast and the southeast. All in all, over US$ 3 billion had been tied in through contracts for investment and construction measures by that date.

The funds for the programme, which are estimated to total around € 2.5 billion (R$ 7 billion) through to 2008, originate at least in part (€ 1.9 billion, equivalent to 72% of the total cost) from the concession fees and fines paid by the energy supply companies and collected by ANEEL, which are given as a loan (Reserva Global de Reversão – RGR), and from the CDE (Conta de Desenvolvimento Energético), a subsidy fund into which all electricity consumers pay that is designed to develop the electricity sector in the federal states and to promote power-generation sources that have previously been uncompetitive. The rest is to be contributed by the federal states and municipalities (14%) and the power supply companies (14%). If the initial electrification rates are very low, however, up to 90% of the total investment made by the supply companies will be subsidised from national funds. Electricity consumers do not have to pay for any network expansions.

Priority is assigned to projects in communities with a connection rate of less than 85% and projects providing for the productive use of electrical energy, or to schemes implemented in state schools, health stations or for water supply.

Use of renewable energy sources

Electrification is achieved through network expansion, distributed generating systems with isolated networks or individual plants, whereby renewable energies are also used for generating electricity in addition to diesel. The programme therefore also replaces the earlier PRODEEM programme (Programa para o Desenvolvimento da Energia nos Estados e Municípios) with which communal facilities could be equipped with systems generating electricity from renewable energy. Regionally graded tariffs serve to provide economic balance, and if these are exceeded alternatives to expanding the network should be considered. The marginal costs in the northeast, for instance, are on average about € 1,870 (R$ 5,200) per consumer.[36]

It is estimated that the use of approximately 130,000 PV systems is the most economically efficient option for about 17,500 localities with small populations in the Amazon territory. A further 2,300 villages with about 110,000 buildings could usefully be equipped with a mini-grid on the basis of photovoltaics or biomass. 680 medium-sized communities could be supplied on the basis of hybrid systems, and 10 larger communities could be provided with power generation based on conventional diesel generators or hybrid systems.

By the end of 2006 the total number of approved applications for schemes using renewable energy within the Luz para Todos programme was six, all of these being solar home systems (SHS), amounting to 3,071 installations.

35 Decree 4.873 of 11 November 2003, which relates to Law 10.438 (Art. 14 and 15). The new project follows the 'Luz no Campo' programme managed by Eletrobrás with which about one million rural households and buildings were to be supplied with electricity within four years. However, due to the fact that promotion funds were only granted on a credit basis for supply companies with concessions and rural cooperatives, the programme did not lead to the desired success.

36 These average values refer to all households within a region to be supplied and merely are criteria for choosing the type of maintenance.

Currently there are also a range of pilot projects in operation throughout the Amazon territory, with small hydropower, vegetable oil, biomass gasification, PV systems, biodiesel and hybrid systems; these mainly serve the purpose of investigating the suitability of such systems for everyday use. One of the systems is an electricity-generating plant based on wood gasification in the community of Nossa Senhora das Graçcas in Manacapuru in Amazonas state (Projeto Ribeirinhas). Eletrobrás also installed 180 solar home systems in 27 settlements close to the river in Amazonas state in the period up to 2005.

Replacement of fossil fuels in isolated supply networks

Another key area which lends itself to the use of renewable forms of energy is isolated supply networks, which in the Amazon region are mainly powered by generators fuelled by diesel or heavy oil and whose additional costs of more than US$ 2 billion per year are presently borne by all consumers together. Substitution by small hydropower and biomass plants would be particularly suitable for these networks. The first projects are already in place.

GTZ projects

Since 2005, GTZ has supported rural electrification with renewable energy sources in the north and northeast of Brazil in a project scheduled to run until the end of 2008. With reference to the government electrification programme 'Luz para Todos', the cooperation between Eletrobrás and the local energy supply companies in testing and developing models for rural electrification based on renewable energies is to be strengthened in a first phase. The focus is on the problem regions in the north and northeast, which are supposed to be electrified in the period 2008 to 2015.

As part of this project three different PV systems are currently undergoing a field test, which ultimately is meant to contribute to a redefinition of the minimum standards for electricity provision to individual households as laid down by ANEEL. The background to this work is the endeavour to keep within limits the amount of loans and subsidies and the resultant electricity tariffs by ensuring that investment costs are kept down and running costs are low. In addition, advisory services were provided to the regional supply company Eletroacre in drawing up a business model for the provision of SHSs, and training was provided on the operation, installation and maintenance of the systems. In a second pilot project an electrification model using renewable energy sources is to be developed for small settlements on the basis of mini-grids.

Federal state promotion programmes

Some federal states have conducted or are still conducting their own programmes for solar electrification, partly supported by foreign donors, even if these programmes are relatively modest in comparison with the national Luz para Todos programme. In the states of Pernambuco and Ceará investment of at least 2% of annual turnover for electrifying rural areas was contractually agreed in the privatisation of the relevant regional supply companies.[37]

Exchange rate (March 2007):
1 Brazilian real (BRL) = 0.36 euro
EUR 1 = 2.81 real

37 In Pernambuco only 1% as of 2008.

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3 Chile

3.1 Electricity Market

Installed capacity

In July 2006, installed generating capacity in the public supply sector in Chile totalled 12,132 MW, roughly 7,400 MW of which was in thermal power stations and 4,730 MW in hydropower plants. Added to this is another 700 MW or so belonging to self-generators (including industrial combined heat and power stations).

	SING	SIC	Aysén	Magallanes	Total
	MW				
2001	3,440.9	6,579.2	22.9	64.5	10,107.5
2002	3,633.2	6,737.2	22.6	64.5	10,457.5
2003	3,640.7	6,996.2	33.1	65.0	10,735.0
2004	3,595.8	7,867.4	33.5	64.7	11,561.4
2005	3,595.8	8,259.8	33.5	64.7	11,953.8
July 2006	3,595.8	8,437.8	33.5	64.7	12,131.8

Tab. 1: Installed capacity by supply region; Chile; 2001-2006; MW

At the end of 2006, 3,596 MW was installed in the northern interconnected grid SING, comprising 2,112 MW in gas-fired power stations, 13 MW in hydropower, 1,206 MW in coal-fired power stations, 138 MW in diesel power stations and 128 MW in heavy-oil-fired power stations. In the SIC interconnected grid, 56.8 % of the generating capacity at the end of 2005 was in hydropower plants (4,688 MW), and the remainder in thermal power stations (3,565 MW).

Since 1994, when only about 2,000 MW was available, there has been a considerable increase in thermal capacity in particular. Over the last ten years it has mostly been new combined-cycle power plants that have been put into operation. Since 1997 they have been supplied with natural gas through pipelines from Argentina, of which there are now seven.[1]

In the more recent past however this new dependence has proved to be extremely fragile, as Argentina has scaled back its gas exports since 2004 because of a lack of production capacity and growing needs of its own.

	July 2006	
	MW	%
Hydropower	4,725.7	39.4
Storage	3,393.4	28.3
Run of river	1,332.3	11.1
Thermal	7,390.2	60.6
Natural gas	3,928.0	37.3
Coal	2,143.3	17.9
Diesel/heavy oil	1,144.1	3.9
Biomass	178.9	1.4
Wind	2.0	0.02
Total	**12,131.8**	**100.0**

Tab. 2: Installed capacity by power station type; Chile; July 2006; MW, %

Capacity expansion

In order to circumvent the Argentinean restrictions on the export of natural gas, which will presumably be tightened further, the Chilean Government has decided in the meantime to push ahead with importing liquefied gas from other countries. Work has already begun on building an LNG terminal near Quintero in Region V, which is scheduled to be completed in 2009. Consideration is also being given to installing additional diesel generators for a short time if the supply of gas is more severely restricted or interrupted. The supply situation is not expected to ease until about 2010 onwards, following the construction of new power plants that do not rely on natural gas.

1 Chile's own gas reserves are very limited and are located in the south of the country, where they are also used by local suppliers. Chile's dependence on imports in primary energy consumption grew from 54% to 72% between 1995 and 2004.

Power generation

Gross power generation in the public supply sector in 2005 amounted to roughly 51 TWh.

Due to lack of rainfall and the growing role of fossil fuels, in 1998 power generation from thermal power stations exceeded that from hydroelectric power plants for the first time. In the two subsequent years, too, the contribution from hydroelectricity remained well below the average for previous years. In 2001, 2002 and 2005, fossil fuels and hydropower accounted for approximately equal shares in the generating mix. Even though capacities stayed roughly the same, power generation based on (relatively poor quality) domestic coal and on oil staged a comeback in 2004 and 2005 because of failing precipitation and a shortage of gas supplies from Argentina.

Electricity imports

To improve security of supply, consideration is being given to stepping up electricity exchange with Argentina in the medium term. At present the only cross-border connection is with the northern interconnected system[2], which carries power from the gas-fired TermoAndes power station (643 MW) in Salta Province, which belongs to the Chilean producer AESGener. The idea of building a link to Bolivia has also been floated.

	2001		2002		2003		2004		2005	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Hydropower	21,058	51.9	22,524	53.3	21,864	48.5	20,889	43.0	25,438	50.0
Storage	12,386	30.6	13,109	31.0	12,945	28.7	12,407	25.5	16,051	31.5
Run of river	8,672	21.4	9,415	22.3	8,919	19.8	8,481	17.5	9,387	18.4
Thermal	19,479	48.1	19,744	46.7	23,191	51.5	27,700	57.0	25,482	50.0
Natural gas	12,729	31.4	12,440	29.4	15,956	35.4	17,489	36.0	14,957	29.4
Coal	5,748	14.2	6,414	15.2	6,300	14.0	8,895	18.3	8,488	16.6
Diesel/heavy oil	91	0.2	29	0.0	21	0.0	144	0.3	1,197	2.3
Biomass	911	2.2	851	2.0	915	2.0	1,173	2.4	840	1.7
Total	**40,537**	**100.0**	**42,268**	**100.0**	**45,055**	**100.0**	**48,589**	**100.0**	**50,920**	**100.0**

Tab. 3: Gross power generation in the SIC and SING grids by energy source; Chile; 2000-2005; GWh, %

2 See section headed "Power transmission and distribution".

Power transmission and distribution

The power supply system is divided into two large interconnected grid systems in the north (Sistema Interconectado del Norte Grande – SING) and the centre (Sistema Interconectado Central – SIC) of the country, each with several power producers and distributors, and two territorial or isolated grids in the south (Sistema Eléctrico de Aysén in Region XI and Sistema Eléctrico de Magallenes in Region XII), each of which are vertically integrated and are run by their own utility company.

The northern interconnected grid, SING, relies almost entirely on thermal power stations, whereas the generating capacity in the southern grid, SIC, is largely based on hydropower (61 % of total capacity). In 2005, two-thirds of the electricity supplied via the central interconnected grid originated from hydropower, and the remainder from thermal generating plants (compared with 42.5 % from the latter in 2004). Peak load in the SIC in 2005 reached 5,764 MW, which was 5.8 % higher than the previous year. In the SING grid, peak load rose considerably in 2006, to 1,676 MW. Gross power generation grew there by 4.6 % to 13,236 GWh, and electricity sales increased by 4.1 % to 12,029 GWh (of which 10,774 GWh were for non-regulated customers and 1,256 GWh for regulated customers). Roughly 50 % of the electricity generated came from power stations fuelled by coal or other solid fuels, with a further 48.4 % from gas-fired plants. The rest was shared between diesel (0.7 %), heavy oil (0.5 %) and hydropower (0.5 %).

The power supplied through SING is mainly used by mining companies, and hence primarily non-regulated customers, whereas SIC supplies mostly tariff customers (private households and other customers with a connected load of less than 500 kW). The transmission grid belonging to SIC reaches 92.3 % of the Chilean population, while only a little more than 6 % of the population live within the area covered by SING. In 2005 the generating capacity in the SIC grid grew by 5 % compared with the previous year. Of the 8,260 MW, 56.8 % was provided by hydroelectric power stations and the remainder by thermal generating plants.

Power generation in the isolated grids of Magallanes is based entirely on gas and diesel engines and gas turbines. Power in the extra-high voltage range is largely transmitted via the north-south 220-kV line, which reaches all major consumer centres. However, quite a number of areas, and particularly the coastal region, are only connected with medium and low voltage lines.

Inter-connected grid	Capacity	Peak load	Gross power generation	Electricity sales Regulated customers	Non-regulated customers	Total	Proportion of population
	MW	MW	GWh	GWh	GWh	GWh	%
SING	3,596	1,566	12,657	1,159	10,401	11,560	6.15
SIC	8,260	5,764	37,965	25,015	10,880	35,895	92.28
Aysén	34	19	108	92	0	92	0.61
Magallanes	65	41	211	156	33	190	0.96
Total	**11,955**	**8,390**	**50,941**	**26,422**	**21,313**	**47,736**	**100.00**

Tab. 4: Gross installed capacity, peak load, generation and electricity sales in the interconnected grids (public supply) in 2005; Chile; MW, GWh

Electricity consumption

Electricity consumption in 2005 amounted to almost 47,800 GWh, with the industrial and mining sectors clearly predominating. About half of electricity sales were made to the 4.7 million regulated customers through distribution companies; the remainder went to bulk consumers, who negotiate their electricity purchases directly with the generating companies. There is expected to be strong growth in the coming years, especially on the non-regulated electricity market (i.e. among bulk consumers). Consumption in the sales market covered by the SIC interconnected grid rose by 4.5 % compared with the previous year, i.e. below the long-term average of about 7 % per year.

Electricity prices

On average about 10 % is added to the generating costs to cover power transmission via the interconnected grid. Roughly 50 % of the price of electricity for tariff customers is attributable to generation and transmission.

Because of the gas crisis in 2006 and early 2007, at times the marginal prices rose as high as US$ 160/MWh. In 2006 they averaged US$ 35/MWh. The purchase prices for the distribution companies are currently set at approximately US$ 57/MWh for energy and between US$ 7 and 8 per kW/month for demand.

3.2 Market Actors

Power producers

Approximately 90 % of installed generating capacity is owned by private enterprises. Of the remaining 10 %, a large part is owned by the state copper company Codelco. Altogether there are 31 power producers, 5 transmission companies and 36 power distributors operating in Chile.

Endesa and AESGener

Chile's largest power producer, with a market share of nearly 40 %, is Endesa (Empresa Nacional de Electricidad), which belongs to the Spanish company of the same name via the Enersis holding.[3] Endesa operates almost all the hydropower stations in the country. The same holding also owns the distribution company Chilena de Electricidad (Chilectra), which operates in the region around the capital and, with some 1.35 million customers (early 2007), serves about 45 % of the entire market or almost half of the population.[4] The second-largest producer is AESGener, with a market share of nearly 30 % (including subsidiaries), which is majority-owned by the American company AES. The third-largest power producer is Colbún, with mostly Chilean capital.

Grid operators

The transmission grids that carry electricity from the producers to the distributors or directly to end customers are also privately owned. The owner of about 80 % of all transmission grids is Transelec, which was sold by the Canadian company Hydro Quebec to a consortium of private investors in August 2006.

4 For more information see www.endesa.cl.
5 For more information see www.chilectra.cl.

Load dispatch centres

Coordination within the two large transmission systems, SING and SIC, is effected by a load dispatch centre Centro de Despacho Económico de Carga – (CDEC) in each, an autonomous authority made up of representatives from all the utility companies in the respective interconnected grid system. CDEC-SING has existed since mid-1993, while CDEC-SIC was founded on 31 May 1999.

Actors in the various interconnected grid systems

In the SING interconnected grid system, which serves the northernmost administrative regions I and II, there are six power producers in operation that also run transmission lines and for the most part (90 %) supply bulk consumers, and one company dedicated solely to transmission (Transelec Norte). Also located in the SING area are high voltage routes that are not integrated into the interconnected grid and are mainly used for the mining industry.

At the end of 2005 there were ten power producers and three transmission grid operators operating in the SIC interconnected grid system, which extends from Taltal in the north to the island of Chiloé in the south. This central grid supplies more than 90 % of the country's entire population.

Intercon-nected grid	2001	2002	2003	2004	2005
SING	9,851	10,400	11,424	12,330	12,657
SIC	30,765	31,971	33,708	36,259	37,915
Aysén	77.7	86	89	97	108
Magallanes	170.4	177	185	196	211
Total	**40,865**	**42,634**	**45,406**	**48,881**	**50,891**

Tab. 5: Power generation in Chile's interconnected grids; 2001-2005; GWh

The Aysén supply grid (Sistema de Aysén) is served by the vertically integrated company EDELAYSEN.[5] The Magallanes supply grid (Sistema de Magallanes) is divided into independent subsystems for the three conurbations (Puerto Natales, Puerto Porvenir and Punta Arenas), which are each served by the vertically integrated enterprise EDELMAG.[6] A very small supply grid is also maintained on Easter Island, run by an operating company under the auspices of the national development agency CORFO.

Other Actors

The Comisión Nacional de Energía (CNE) was established as the regulatory supervisory authority, which is responsible for shaping policy in the sector and also oversees pricing in generation and distribution. It is headed by an energy minister; recently it was ruled that this is the only office that the minister should hold.[7] The Superintendencia de Electricidad y Combustibles (SEC) was also set up to supervise the technical and financial input of market players, process license applications, collate information for setting tariffs and maintain a statistical database. Disputes relating to competition are arbitrated by a monopolies commission, which in the past, however, has undertaken little against the obvious vertical reintegration on the Chilean electricity market.

The National Commission for the Environment (CONAMA) is responsible for evaluating the environmental impact assessments of projects in the electricity sector in accordance with Law 19.300 of 1994 and for issuing environmental permits.[8]

5 For more information see www.edelaysen.cl.
6 For more information see www.edelmag.cl.
7 The electricity tariffs for regulated customers are set twice each year (April/October) by CNE.
8 Projects with minor environmental impacts only need to submit a simpler environmental assessment.

Ministry of Public Works
The Ministry of Public Works (Ministerio de Obras Públicas) issues water rights in compliance with the principles set out in the water legislation of 1981. Under this legislation, limited-term usage rights are assigned to each private person or company, usually free of charge. There is no obligation to make use of these rights, however. Partly as a result of this regulation, Endesa in particular has acquired water rights in large parts of the country without any current need to use them for power generation.

3.3 Legal Framework

As far back as the early 1980s, the previously state-owned power utilities were unbundled horizontally and vertically and then privatised. The state is largely accorded a regulatory and supervisory role, which is exercised by the Comisión Nacional de Energía. There is no state planning for the power generating sector. That said, every year CNE does draw up an indicative plan (Plan indicativo de obras) for the expected expansion of power station capacity on the basis of demand analyses. This plan is an instrument used for determining prices (node price) and does not include any obligation that it should be implemented.

Free market competition
Open competition in power generation and guaranteed grid access were stipulated in electricity sector legislation adopted in 1982.[9] Generating licences are not required. In the past, however, small plants rated at less than 20 MW were not able to participate in the electricity market because only plants of a certain minimum size were represented in the CDEC. Anyone can build and own transmission lines. Grid capacities permitting, the grid operators must allow the transmission of electricity for wheeling to consumers or for sale on the spot market. Inadequate regulations determining how transmission costs are set have led to repeated disputes in the past, however.

If the grids need upgrading due to additional power transmission requirements, the cost burden and the distribution of that burden must be negotiated between users and grid operators.

Licences for power distributors
The distribution and sale of electricity to general (tariff) customers are seen as public services that are monopolistic in nature, for which a licence has to be obtained from the Ministry of Economics. In exchange, distributors are obliged to supply electricity to customers who are connected to their supply system or are located in their service area. The granting of a licence, however, does not confer exclusive supply rights for certain regions, so the service areas of the distributors can overlap in parts. Reliable electricity supply is secured through agreements between producers and distributors over terms of several years.

Free choice of supplier
Large-scale consumers with a power requirement of more than 2 MW can buy their electricity directly from the producers or distributors at freely negotiated prices.[10] Conversely, power producers can also sell their electricity to the respective load dispatch centre in the interconnected grid system (CDEC) at marginal costs fixed every hour (spot market). Producers generating power from renewables in plants rated at less than 9 MW can also sell their electricity to the distribution companies at regulated prices (precios de nudo). Large-scale producers of electricity generated by traditional means usually offer it to the distributors at the competitively tendered price or marginal cost price. Medium-sized consumers with a connected load of between 500 kW and 2 MW can choose between fixed tariffs and freely negotiated prices. There is no free choice of supplier for tariff customers.

9 The law was supplemented and updated in key passages by a ruling adopted in 1998: Reglamento de la Ley General de Servicios Eléctricos. Decreto Supremo No. 327, Ministerio de Minería, Publicado en el Diario Oficial del 10 de septiembre de 1998.

10 These unregulated customers accounted for around 55% of total electricity consumption in 2001.

Regulated electricity tariffs

Electricity sales to small consumers (< 0.5 MW) are subject to statutory maximum electricity tariffs. These regulated tariffs are based on the distributors' purchase prices, which are set twice a year, and on a 'valor agregado de distribución' (VAD) that includes the investment and operating costs of the distribution grid and is reset every four years. In addition, when the distributors' purchase price is fixed, the calculations made by the regulatory authority must be compared with current market prices. Where the calculated price is more than 10 % above or below the reference figure on the free market, adjustments must be made.

For isolated electricity systems with a power requirement of 1.5 MW or less, the law requires that maximum tariffs must be agreed between the local authority and the distribution company.

New electricity law

Between early 1998 and May 1999 a period of extreme drought brought about a wide-ranging supply crisis leading to rationing of power distribution, which was exacerbated by management shortcomings among power suppliers, inadequate legal provisions and mistakes in the supervision exercised by government authorities. As a result of this, an amendment was made to the electricity law (Ley 19.613) in 1999 which among other things granted SEC the authorisation to supervise power suppliers more closely and impose fines for the infringements of supply obligations. Quite a few passages of the law were rejected, however, as being in breach of the constitution.

After several years of discussion, another amendment to the electricity law was adopted by the senate and parliament in January 2004 (Law 19.940, Ley Corta I). It regulates the linkage between the interconnected grids and establishes responsibilities in the event of a supply failure. There is also a new regulation requiring that distributors also bear an appropriate share of the transmission costs, which previously were charged entirely to the producers.

New arrangements were applied to the use of distribution grids by power producers for direct supply to large-scale consumers. The upper limit for electricity customers without regulated tariffs was lowered to 500 kW. At the same time, buyer interests in disputes were strengthened, for example in relation to economic losses incurred as a result of interruptions to power supply, for which only inadequate compensation was granted in the past. Ley Corta I also establishes fundamental prerequisites for the integration of (non-conventional) renewable energy into the electricity market.

The second amendment to the electricity law[11], which came into force in May 2005 and was enacted in response to the supply crisis emanating from Argentinean restrictions to the export of natural gas, laid the foundations for further development of the energy sector through regulatory and economic incentives for private investors in generating facilities.

Distribution companies now have to go through public tendering processes for power supplied to meet demand on the regulated market. To that end, contracts are concluded in which prices are fixed for a lengthy period, giving producers greater investment security. This change to the law has helped to bring about a situation where in the meantime investors have expressed interest in about 60 new generating projects with a total capacity of 11,800 MW and an investment volume of US$ 12 billion.

11 Law 20.018, Ley Corta II.

3.4 Policy Promoting Renewable Energy Sources

The new electricity law (Ley Corta I) has facilitated the use of renewable forms of energy for generating electricity in plants with a capacity of less than 20 MW. In particular this was aimed at enabling local companies to gain a foothold in the electricity market. The key elements of the new provisions are as follows:

- Every owner of generating facilities operating on the basis of renewable energy can sell their electricity on the spot market at current marginal costs and surplus output at the node demand price. As a result of the new legislation, the profitability of small hydropower installations, in particular, has been considerably improved. The terms of payment for electricity from generating facilities that feed no more than 9 MW into the grid were also laid down. As an option, owners of these facilities can take advantage of a price stabilisation mechanism (remuneration at the node price).

- Grid operators at the distribution level are obliged to connect generating plants up to 9 MW to their grid.

- Complete exemption from transmission charges (at the high voltage level) applies to power fed into the grid from facilities rated up to 9 MW fuelled by non-conventional energy; a partial reduction of costs is allowed for plants rated between 9 and 20 MW. In the upper power segment, transmission costs vary between 0 and 100 %, depending on the generating capacity of the plant feeding into the grid.

The law was changed again in 2005 with Ley Corta II, when in addition an exclusive market was created for renewable electricity; the price conditions are supposed to be similar to those that form the contractual basis between power generators and distribution companies.

To put the provisions of Ley Corta I into practice, Decree DS 244 entered force at the beginning of 2006. In addition, technical standards on the connection of small power generators to the distribution grid have been drawn up in the meantime.

In April 2007, draft legislation on the promotion of renewable energy was presented to parliament which envisages that 5 % of the total electricity generated each year should originate from (non-conventional) renewable energy sources as of 2010. If the specified quota is not reached, fines will be payable. The relevant amounts of electricity can either be provided by the generating companies themselves or bought in, and evidence must be given. According to the draft, a total capacity of 250 MW based on renewable energy would have to be provided in 2010, and in 2011 this would have to rise to as much as 350 MW.

Promotion by the Chilean Economic Development Agency – CORFO

In 2005, CORFO and CNE came to an agreement to promote projects for the generation of electricity from renewable energy with a capacity of up to 20 MW on a competitive basis (Programa Todo Chile), including projects that are suitable for emissions trading under the CDM. The assistance consists of a grant towards the pre-investment costs, for example for studies (determination of potential, building plans, economic and ecological analyses) or for technical advisory services. For investments between US$ 400,000 and US$ 2 million, the assistance amounts to up to 50% of the costs, with a ceiling of max. US$ 5 million per company. If the investment exceeds US$ 2 million, the maximum assistance is US$ 50,000 per company and up to 50 % of the costs.

Following the first call for bids in July 2005, 75 projects were submitted, of which 46 were selected: 11 for generating electricity on the basis of biomass (wood and organic waste), 12 wind energy projects, 22 hydropower projects and one geothermal energy project. The support from CORFO amounts to a total of US$ 1.32 million. The hydropower projects are all concerned with the reactivation or expansion of existing installations.

A second call for bids was issued in April 2006 (final deadline for submissions was 26.6.06). According to an initial evaluation, this time 89 projects were submitted, of which 38% were wind energy projects and 24% small hydropower projects. 57 projects satisfied the selection criteria. The outcome was 40 assisted projects, comprising 16 wind energy projects, 18 small hydropower and 6 biomass/biogas projects, with a promotion volume of US$ 1.3 million. The total capacity of all 86 assisted projects is estimated at approximately 600 MW.

Because of the great success of the previous ones, a third call for bids was issued in January 2007, with a deadline of the end of April. On this occasion, too, over 80 project developers and potential investors took part.

CNE formed a Comisón Técnica Asesora in order to assess the projects. CORFO also issues low-interest loans for up to US$ 5 million each through commercial banks as part of its arrangements for the interim financing of environmental projects.

Law on geothermal energy

In January 2000 a law entered into force on the granting of concessions for the exploitation of geothermal energy sources.[12] The purpose of this legislation is to regulate and encourage domestic and foreign investment in this energy sector. Furthermore, in June 2000, on the basis of this law and of studies conducted by the national geological and mining service (Servicio Nacional de Geología y Minería – Sernageomin), a decree was issued on potential geothermal energy sources.[13]

The law on geothermal energy is currently being revised in order to give concessionaires greater incentive to invest than before and to curb speculation.

GTZ projects

In a project initially scheduled for three years, since August 2004 GTZ has supported the National Energy Commission CNE within the framework of the 'Renewable Energy in Chile' project in integrating non-conventional renewable energy into grid-connected power generation.[14] The main aim in this is to help to create suitable general political, legal and regulatory conditions and improve the investment climate for renewable energy.

As well as developing a market for schemes based on renewable energy, a principal aim is to dismantle the numerous obstacles that impede the integration of renewable energy sources into the electricity market. The project therefore supports CNE in elaborating fundamental provisions for regulating the infeed of power into the grid and in developing promotion instruments.

GTZ supports private investment by preparing analyses of potential in the fields of biomass, biogas and wind energy, including carrying out wind measurements. In order to simplify licensing procedures, the project is drawing up guides for carrying out environmental impact assessments for wind energy, biomass and small-scale hydropower projects. It also examines financing options. Furthermore, various training measures have been launched for technical and managerial personnel from the public and private sector.

Greater integration of the private sector into the preparation and implementation of individual projects is achieved through cooperation in conducting (at present) four feasibility studies for wind energy and biomass projects. This not only comes up with findings into the technical and economic chances of these projects in Chile but also strengthens knowledge transfer between German and Chilean experts.

12 Ley sobre concesiones de energía geotérmica, Ley No. 19.657, Ministerio de Minería, Publicado en el Diario Oficial del 7 de Enero de 2000.
13 Reglamento identifica fuentes probables de Energía Geotérmica, Decreto No. 142, Ministerio de Minería, Publicado en el Diario Oficial del 28de Junio de 2000.
14 In the course of negotiations between the German and Chilean governments in 2007 it was envisaged that the project would be extended by a further three years.

Financial cooperation through KfW

On the occasion of the negotiations between the German and Chilean governments in June 2005, the Chilean government presented an intervention strategy for the field of energy efficiency and renewable energy. It is founded on three pillars:

1. Promotion mechanism for investment in renewable forms of energy (primarily biomass and wind)
2. Promotion and risk coverage mechanisms for geothermal investigations
3. Refinancing line for investment in the field of energy efficiency

On this foundation, renewable energy and energy efficiency were agreed as being strategic areas of future development cooperation between Chile and Germany. To that end, so far total funding of € 53 million has been pledged in the form of grants or interest rebates.[15]

Clean Development Mechanism

Chile ratified the Kyoto Protocol in August 2002. The first pilot projects in the context of the Clean Development Mechanism have been launched or are presently being planned.

The role of Designated National Authority (DNA) is performed by the national environmental authority CONAMA (Comisión Nacional de Medio Ambiente). Decisions at the operational level are taken by an executive council headed by CONAMA, which also includes representatives of the foreign ministry, agriculture ministry and CNE.

In August 2006 CNE and CONAMA, with support from GTZ, published a CDM guide which is intended to provide help with the implementation of such projects. By April 2007 a total of 16 Chilean projects concerned with the use of renewable energy had been registered with the CDM Executive Board, among which there were four projects utilising biogas obtained from pig manure, six projects using landfill gas, four projects involving biomass (wood) and two projects using hydropower.

3.5 Status of Renewable Energy Sources

A review of the use of non-conventional forms of renewable energy in Chile was published in 1998.[16] Until then, the main focus had been on the use of solar thermal installations.

In the past, of all (localised) renewable energy sources, almost the only ones to be used for power generation were solar energy (photovoltaics) for rural electrification and small-scale hydropower (less than 20 MW). In recent years a small number of relatively large biomass plants in the wood pulp industry have been added in this field. By mid-2007 the proportion of non-conventional renewable energy (including hydropower up to 20 MW) within the total power generating capacity amounted to 2.4 %. In future, further development in the renewable energy sector will largely depend on what happens to energy prices on the electricity market, what prices can be obtained for electricity supplied to the interconnected grid, and what generating costs have to be balanced against them.

	SIC	SING	MAG	Aysén	Total	Share of total generating capacity
	MW					%
Hydropower < 20 MW	82.4	12.8	0.0	17.6	112.8	1.0
Biomass	170.9	0.0	0.0	0.0	170.9	1.4
Wind	0.0	0.0	0.0	2.0	2.0	0.02
Total	**253.3**	**12.8**	**0.0**	**19.6**	**285.7**	**2.4**

Tab. 6: Share of generating capacity provided by non-conventional renewable energy; MW, %; July 2006

By the end of 2008 six new (relatively large) schemes utilising renewable energy could be in operation, including several hydroelectric plants.

15 GTZ, too, has been implementing a project on energy efficiency in Chile since 2006.

16 Inventory for the Elaboration of the Installations of Non-Conventional Renewable Energies in Chile.

Hydropower

Chile has a number of rivers which, because of the topography of the country, run for only a short distance from their source before entering the sea, with a steep gradient over most of their course. At present only about 15 % of all the country's hydropower potential is exploited. Most facilities in operation are run-of-river power stations, often rated at well below 100 MW, although there are also some storage power stations rated at up to several hundred megawatts, which make a much larger contribution to the supply of electricity.

After years of delay because of protests by local residents and environmental activists, the Ralco plant on the Biobio river was commissioned by Endesa in September 2004, becoming Chile's largest (storage) hydroelectric power station. It is planned to expand the current capacity of 570 MW to 690 MW.

A further four large hydropower stations with a total capacity of 2,400 MW are being planned by Endesa in the Aysen region, and are highly controversial with respect to their environmental impact and sustainability.

Developable locations

New locations that would be suitable for development are mostly situated in remote regions and would require long transmission lines to the consumer centres. Because of improved competitiveness compared with combined-cycle power stations, however, the economic position of medium- and large-capacity hydropower plants (10-100 MW) has also improved considerably in recent years. The economic efficiency of small plants, too, with capacities between 1 and 10 MW, has risen, mainly because of the new provisions on the promotion of renewable energy (among other things, exemption from grid usage charges).

Small and micro hydropower

An interesting option is also to expand hydropower use primarily on a micro scale to supply rural regions or for specific applications (such as telecommunications). Currently there are 110 such systems with capacities of up to 100 kW registered with CNE, mostly located in Regions VIII to XI, with a total capacity of 3.3 MW and a combined annual power output of approximately 6.8 GWh. The market for microturbines is served by about ten local manufacturers.

Initial studies show that particularly in the southern Regions VIII to XI there are sufficient water resources available to install more small hydropower systems. No reliable data is available on potential, however.

CNE and the regional governments are presently implementing a programme for micro hydropower systems to supply isolated municipalities in various regions of the northern and southern zones as part of the rural electrification programme (PER). Three small hydropower plants have been installed in indigenous municipalities on the Bio-Bio river (Region VIII) as part of a demonstration project.[17] In Pallaco in the Tirúa municipality a micro hydropower plant built with UNDP and Japanese assistance was put into operation in November 2001. In 2003, other such facilities were installed in Rio Grande, Talabre and Socaire in the San Pedro de Atacama municipality.

CNE is also working with the Dirección Nacional de Riego to conduct a study to determine the potential for small-scale hydropower in irrigation canals, which could produce interesting results. Only potentials of 2 MW or over are being investigated, which leads to the conclusion that there are an estimated 200 or more locations in the SIC area alone.

17 On the upper reaches of the same river a 570-MW power station is being built by Endesa at the Ralco dam. This is highly controversial due to the need to resettle indigenous groups, and will in future be the largest hydropower facility in Chile.

Chacabuquito hydropower plant

In June 2003 the Chacabuquito hydropower plant was approved as the first project under the Prototype Carbon Fund (PCF). The plant, situated about 100 km north of Santiago, is operated by Hidroelectrica Guardia Vieja and has an installed capacity of 26 MW. With a gross power output of 175 GWh p.a., the project is designed to reduce CO2 emissions by some 2.8 million tonnes over a period of 21 years. As a first step, certified emission reductions worth approximately US$ 3.5 million were sold to PCF.[18]

Another hydropower project in preparation is La Higuera on the Tinguiririca river (Region VI); this has already been registered as a CDM project. With a capacity of 155 MW and projected power generation of 811 GWh per year, it would be the second-largest run-of-river power plant in Chile. The Ojos de Aguas run-of-river power plant on the Cipreses river in Region VII, with a capacity of 9 MW, has also been registered as a CDM project. It is being developed by Endesa Eco, a subsidiary of the utility company Endesa. Other planned run-of-river schemes under the CDM are the Hornitos project in Region V and the Quilleco project in Region VIII.

Wind energy

Despite good regional potential, the use of wind energy to provide power has played only a marginal role so far. Emphasis on the primacy of competitiveness and very low average costs for generating electricity left only limited scope for the exploitation of wind power in the past, for example for supplying remote regions to replace high diesel costs or in non-electrified rural areas. Nevertheless, there are initiatives at least to sound out the options for future applications in more detail. Thanks to the reorientation of Chilean energy policy, which attaches greater emphasis to renewable energy, and against the background of higher energy prices, the chances that relatively large grid-connected wind power schemes will soon be implemented have considerably improved.

Appraisal of wind resources

The first studies to evaluate wind resources in the Atacama Desert date back to the early 1960s, carried out under the auspices of UNESCO. In 1992 the University of Chile published a study on wind directions and velocities at 60 meteorological stations.[19] The study evaluated available readings, only some of which, however, had been obtained in accordance with the international standards that have become established in the meantime.

As part of a project to improve the assessment of wind resources in the north and centre of the country (Regions III to V), at the end of 2003 CNE and the Universidad de Chile presented a new, comprehensive study that linked into the predecessor project in 1992 and likewise referred to data from meteorological stations. This led to the identification of areas which were worth considering for a more detailed site analysis. In the course of a second phase the southern part of the country (Regions VI to X) was then also investigated with regard to wind potential, in this case by the centre for energy resource research (CERE) at the University of Magallanes. The results were published in a study by CNE in May 2005.

Wind measurements are currently being taken at ten locations as part of a UNDP/GEF project (on rural electrification with renewable energy) in order to obtain appropriate basic information for off-grid projects at the coast and on islands. GTZ and CNE/UNDP have also carried out wind measurements and feasibility studies for larger, grid-connected wind farms at a total of eight locations. As well as that, in January and December 2006 GTZ held courses on wind measurements, data analysis and yield calculation, and provided individual advisory services to private and institutional suppliers with regard to site selection and measuring equipment.

In early 2007, CNE and the environmental authority CONAMA presented a guide to the environmental assessment of wind farm projects that they had compiled with support from GTZ.

18 Investment costs amounted to approximately US$ 37 million.
19 CORFO, 1993: Evaluación del Potencial de Energía Eólica en Chile, desarrollado por el Dpto. Geofísica de la Universidad de Chile, 1993.

Projects with small-scale wind power and wind-diesel systems as part of the rural electrification programme (PER)

Three pilot projects for providing isolated supplies to villages (Puaucho, Isla Nahuehuapi and Villa Las Araucarias) in Region IX were launched at the beginning of 1997 by CNE with US assistance. Since then, small wind turbine generator systems have supplied electricity to households, schools, health centres and churches. According to a study by CNE conducted under a cooperation agreement with the USA, more than 3,100 families could be supplied with power from hybrid wind-diesel systems on 32 islands of the Chiloé archipelago in Region X and a further 200 families on Robinson Crusoe Island in the Juan Fernández archipelago.[20]

A first demonstration project of this kind was put into operation on the island of Tac in 2001. In this case, 82 residential buildings with more than 250 residents, a health station and a school were supplied with electricity by two small wind generators each rated at 7.5 kW, a storage battery rated at 100 kWh and a diesel generator providing 12 kW via a 15 km-long isolated grid. The whole system belongs to the regional government. Operation and maintenance are in the hands of the power distributor SAESA, which signed a power supply agreement for an initial ten years and concluded a technical implementation contract with the builder, Wireless Energy.[21] The electricity tariff, comprising a monthly standing charge of US$ 5.7 and a unit rate of US$ 0.24 per kWh, merely covers maintenance and operation, but not the investment outlay amounting to some US$ 200,000. Significant financial assistance was provided from the national fund for rural development and from US cooperation assistance.

Another project of this kind was launched in the Chonchi municipality on Chilóé in November 2003. In this case, nine families are each supplied from their own micro wind power systems, while 12 families obtain electricity from three somewhat larger communal wind power facilities. The project received Japanese financial assistance and is also overseen by Wireless Energy.

In February 2004, CNE issued an international invitation to tender for building and operating a wind-diesel system on Robinson Crusoe Island in the Juan Fernández archipelago, within the framework of PER. In this case the existing expensive generation scheme using diesel engines, run by the municipality, will be partly replaced with small wind turbine generators. In preparation, wind measurements were taken at four locations on the island.

In addition, a few small-scale wind projects have been implemented by CERE at the regional level, aimed at bringing electricity to rural schools and farms.[22]

Large-scale wind power

The Alto Baguales wind farm, which is owned by the parent company of Edelaysen, Sociedad Austral de Electricidad (SAESA) and is situated about 5 km from Coyhaique, has been in operation since November 2001. It has an installed capacity of nearly 2 MW, shared between three turbines rated at 660 kW each, and thus accounts for almost 10 % of the total installed capacity in the Aysén interconnected grid system.

The first privately operated wind power installation, rated at 150 kW, has been in operation since May 2006 at Estancia Flora in the coastal municipality of Chanco in Region VII. This is a second-hand turbine that is mainly used for supplying the owner's own needs but also supplies surplus power to the SIC interconnected grid.

Plans to construct a wind farm with a capacity of 37.5 MW to supply the needs of the state-owned copper company CODELCO have so far not been implemented. Wind measurements were taken for this at three locations and a feasibility study was also drawn up. The possibility of developing additional sources of finance through the sale of CO_2 certificates was also investigated.

20 Altogether there are more than 32,000 inhabitants with no power supply in this region. A provisional wind atlas for Chiloé Island was also drawn up in the course of this project in conjunction with the National Renewable Energy Laboratory (NREL).

21 For the initial operating results, see: Nelson E. Stevens (Wireless Energy Chile Ltda.), Isla Tac Power System – First Year Status Report: October 2000 – October 2001; November 2001, www.wireless-energy.cl.

22 In 1999, for example, in the school at Agua Fresca south of Punta Arenas to support a diesel generator.

Several larger schemes have been examined in the meantime as part of the studies funded by CORFO and GTZ. Five wind farms in Regions III, IV and V with a total capacity of 284 MW are currently undergoing an environmental impact assessment. Endesa Eco has started the groundwork for an 18-MW wind farm (11 x 1.6 MW Vestas) in Region IV (Canela, Coquimbo). The wind farm is supposed to go online before the end of 2007. A 20-MW wind farm in Region VIII is also scheduled to be commissioned in 2008.

Biomass

Despite Chile's extensive agricultural and forestry resources, the use of biomass for generating electricity is still in its infancy. In each of Regions VII and VIII, Energía Verde S.A., a subsidiary of the power producer AESGener, operates an 8.7-MW combined heat and power plant fired with waste wood.[23]

In cooperation with the environment authority and with support and finance from UNDP/GEF, a project to generate electrical energy through the gasification of wood biomass was implemented by CNE on the island of Butachauques in the town of Metahue (Region X) within the context of the rural electrification programme. A 40-kW plant was installed to supply electricity to 31 families. The facility is run by a cooperative set up for this purpose. As the project is oversized, CNE is considering supplying the whole island, comprising approximately 100 households.

In 2006 the national forestry institute (INFOR) and CNE compiled a study into the potential for using industrial waste wood for generating electricity.[24] This countrywide survey was preceded by a study of the potential of residues that can be exploited for energy recovery in the wood working and processing industry in Regions IX and X, conducted by GTZ and INFOR in 2005.

Another study by GTZ and CNE is investigating the potential for generating energy from biogas that can be obtained from the digestion of organic residues arising in various branches of industry.

In addition, a guide to performing environmental impact assessments for biomass projects was drawn up by CNE and CONAMA with support from GTZ.

Solar energy

Solar conditions in Chile are classed as good to excellent, especially in the north of the country. In 1987 the solar laboratory at Federico Santa Maria University published a national inventory with solar irradiation data from 129 measuring stations. Annual irradiation in Regions I and II is among the highest in the world.

Region	Solar irradiation (kcal/m².d)
I	4,554
II	4,828
III	4,346
IV	4,258
V	3,520
VI	3,676
VII	3,672
VIII	3,475
IX	3,076
X	2,626
XI	2,603
XII	2,107
Región Metropolitana	3,570
Antarctica	1,,563

Tab. 7: Annual mean daily solar irradiation on a horizontal surface by region; Chile; kcal/m² per day[25]

23 For more information see www.energiaverde.cl.
24 See www.infor.cl.
25 These data are mainly based on a national archive for solarimetric data founded as early as 1965 at this University.

Photovoltaics

One of the first industrial photovoltaic systems in the world began operation as long ago as 1972 in Antofagasta in the north of the country. However, photovoltaic technology is used mainly in the form of solar home systems in outlying areas in the north under the programme for rural electrification. Between 1995 and 1999 alone, almost 1,000 residential buildings were equipped with such systems.[26]

Solar-thermal energy

The use of solar energy for thermal purposes is also still in its infancy in Chile. In order to demonstrate the capability of the technology, therefore, a large system was installed on the roof of the German School in Santiago in April 2007 for heating water; it was financed by private and public funds from German donors. The copper producer CODELCO also operates a very large thermal system which it uses for heating the ore during bacterial precipitation of the metal. There are still only few solar-thermal installations in use in private houses.

GTZ and GEF projects within the context of rural electrification

Between 1998 and 2002, GTZ in conjunction with the Centro de Energías Renovables at the University of Tarapaca, Arica, and the agricultural extension service INDAP ran a demonstration project using PV water pumps in agriculture. The pump systems were combined with a desalination facility to enable them to be used for desert irrigation and the provision of drinking water. In the course of the project the project partners underwent further training and the wider public was informed about ways of using photovoltaic pump systems for irrigation.

Under the UNDP/GEF project to remove barriers to rural electrification with renewable energies, cofinance was to be provided up until 2005 for the installation and operation of 6,000 PV systems in Region IV, Coquimbo, on the basis of licensing agreements. The region, which in 2002 recorded a degree of electrification of nearly 79% with 38,000 rural households, already had more than 1,000 individual solar power systems at that time. In the period from 2003 to 2006 another 3,100 isolated residential buildings and settlements were then equipped with $100W_p$ solar power systems at a total cost of about US$ 3.8 million. In addition, over 50 schools and health centres were to be equipped with PV systems and existing solar power systems improved.

Geothermal energy

On account of the volcanic zone where Chile lies, prospects are also good for geothermal energy, although hitherto it is been used only on a small scale (0.4 MW_{th}) purely for heating purposes, in the Metropolitana Region (Santiago).

Geothermal exploration

Geothermal explorations under a cooperation agreement between UNDP and the Chilean development institution CORFO (Corporacón de Fomento de la Producción) began as long ago as 1968 in the northern zone along the Andes, where there is known to be volcanic activity. Exploratory drilling near El Tatio and Puchuldiza revealed possible suitability for the exploitation of geothermal energy, including for power generation.

There are also numerous areas in the mid-southern zone with indications of volcanic activity. At the end of 1999, a new three-year research project led by the University of Chile in Santiago was launched in cooperation with the oil company ENAP. The project also involved geothermal and geological institutes from Italy, Germany and New Zealand. Detailed exploration studies were carried out in the regions of Puyehue, Chillán, Copahue and Laguna del Maule.

26 CNE says that between 1992 and 1999 as many as 2,500 individual PV systems were installed in residential buildings, schools and health centres.

The first applications for options on geothermal concessions were submitted in January 2001 for 23 locations under the new legislation. Together with its partner ANEP, AESGener is planning to build a 50-MW geothermal power station. In April 2004 the ministry responsible, the Ministry of Mining and Energy, granted concessions for further exploration at 13 locations. These concessions are valid for up to four years, so exploratory drilling has to take place within that time.

As part of its energy plans, CNE has announced its intention to build a geothermal power station with a capacity of 100 MW by 2010. Since 2003 geothermal energy has also been gaining importance in the future Chilean energy mix due to the activities of German enterprises.

A joint project aimed at the transfer of expertise in the field of geothermal energy has been implemented since February 2006 by the Fundación Chile[27] and the German Federal Institute for Geosciences and Natural Resources (BGR). As part of this project it is also planned to build a small geothermal power station that could subsequently be expanded. Another partner in the project is the Chilean company Geotérmia del Pacífico, which holds an exploration concession at the Sierra Nevada location. CORFO is providing financial support for the project.

3.6 Rural Electrification

Out of a total of roughly 15 million inhabitants, 15 % (about 2.2 million) live in rural areas. The level of power provision in those areas in 1994 was about 59 %, while almost full coverage was achieved in the urban centres.

PER programme

Against this background, therefore, at the end of 1994 CNE launched the Programa de Electrificación Rural (PER), which was extended in 2000 with a second phase to the end of 2005 with the target of achieving coverage of 90 %.[28] Between 1995 and 2005 a total of around 144,700 households were either connected to the public mains or equipped with individual facilities (mostly diesel generators) under the PER programme. This meant that the degree of electrification across the country rose to an average of 92 % by the end of the programme, with the lowest rates in Regions III and IV at a little over 80 %. Despite all of these efforts, even after the completion of the PER there are still over 44,000 households throughout Chile that have to make do with candles, paraffin and batteries.

According to estimates at the end of 2000, of the households lacking a standard power supply, 88,420 could be served via the conventional grid, while about 48,250 households could be supplied from power from renewable energy either individually or through small isolated grids.[29] In addition, there is also potential for households currently supplied from their own diesel generators to be converted to renewable energy, such that altogether over 120,000 rural households could be electrified on the basis of renewable energy sources.

The PER programme took a highly decentralised form in that it left it to the regions to identify, evaluate and finance suitable projects. Each project was subjected to rigorous assessment to determine private investment and the corresponding development assistance tied to the achievement of beneficial social impacts.

27 Fundación Chile is a not-for-profit private company with a public holding which was founded for the purpose of developing application-ready products for key economic sectors and maintains close relationships with both the private sector and academic institutions.
28 Based on a total number of rural households given as 622,500 in 2005. Current statistics, however, indicate only 552,000 households in rural areas.
29 According to a study prior to the GEF application in 2001, the potential market for non-conventional renewable energy (including those already supplied by diesel generators) may comprise as many as 75,000 households. It cites solar energy, biomass and wind energy or combinations of these as the main energy sources. Most of these households are located in Regions VIII and X.

A special role was played by local distribution companies, which had to submit technical proposals. In the event of approval, a rural electrification licensing agreement was concluded according to which the power suppliers undertook an obligation to the local administrative authorities to set up the supply facilities and run them for a certain period (at least 30 years in the case of distribution grids and at least 20 years for supply services involving renewable forms of energy).

The investment costs for generating facilities and distribution lines were borne by local governments (60-70 %), the distributors (20-30 %) and the users (10 %). The electricity consumers had to pay for the meters, the wiring in the houses and the power connection, and were able to pay off the requisite contribution in instalments along with their standard charges.

The public finance came from a national fund for regional development (Fondo Nacional de Desarrollo Regional – FNDR) that was set up to develop the regions through various social sector projects. Since 1995 part of this fund has been earmarked for financing rural electrification (FNDR-ER).

GEF project for rural electrification

In connection with the second phase of the PER programme, a UNDP/GEF project[30] to introduce non-conventional forms of renewable energy in rural electrification has been implemented since the end of 2001. In this project, scheduled to run until 2007, the main focus was on using small and micro hydropower installations, photovoltaic modules (in the north of Chile, Region IV) and small wind generating systems for isolated communities and outlying individual houses. The tasks of the project, which is funded with more than US$ 6 million in GEF assistance, include certifying and standardising products utilising renewable energy (especially PV systems), developing training programmes, implementing large-scale projects, assessing wind resources at several locations remote from the utility grid (particularly on the islands of the De Los Lagos region), converting diesel-fuelled power generation to hybrid systems with the partial use of renewable energy, and establishing a guarantee fund to reduce investment risks. As well as the results from individual wind measuring stations, among other things manuals for users on the application of photovoltaic systems[31] and on the monitoring[32] of such systems have been published in recent years.

Exchange rate (April 2007):
1,000 Chilean pesos (CLP) = 1.39 euro (EUR)
1 EUR = 720 CLP

3.7 Information Sources

- **CDEC-SIC:**
  Estadísticas de Operación, 1996-2005
- **CDEC-SING:**
  Estadísticas de Operación 1996-2006
- **Centro de Estudio de los Recursos Energéticos de la Universidad Magallanes (CERE-UMAG):**
  Mejoría del conocimiento y administración de la información eólica en Chile – Segunda Etapa, Preparado para la Comisión Nacional de Energía, Informe Final, Mayo 2005
- **CERE-UMAG:**
  Mejoría del conocimiento y administración de la información eólica en Chile, Segunda Etapa, Punta Arenas, Mayo 2005
- **Comisión Nacional de Energía:**
  La Electrificación Rural en Chile, Logros de un programa social de Gobierno, 1992-2002, Abril 2003
- **Comisión Nacional de Energía:**
  Presentation "Remoción de Barreras para la Electrificación Rural con Energías Renovables" CHI/00/G32, Proyecto Fotovoltaico IV Región de Coquimbo – Chile

30 Removal of Barriers to Rural Electrification with Renewable Energy, www.renovables-rural.cl.
31 Proyecto GEF-PNUD-CNE, Sistemas fotovoltáicos de electrificación para viviendas rurales, Manual para usuarios, Julio 2005.
32 Proyecto GEF-PNUD-CNE, Sistemas fotovoltáicos de electrificación para viviendas rurales, Guía para monitores, Julio 2005.

- **Comisión Nacional de Energía**:
  Programa de Electrificación Rural, 2000-2006
- **Comisión Nacional de Energía**:
  Chile: Una Década de Electrificación Rural – 1995-2005
- **Comisión Nacional de Energía**:
  Guía para evaluación ambiental de proyectos de energía renovable no convencional:
  Proyectos Eólicos, Octubre 2006
- **Comisión Nacional de Energía/GTZ**:
  Guía del Mecanismo del Desarrollo Limpio para Proyectos del Sector Energía en Chile, Julio 2006
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- **Energética S.A.**:
  Análisis del Sistema Concesional de Energía Geotérmica y su Desarrollo Futuro, Diciembre 2005
- **Fundación para la Transferencia Tecnológica**:
  Mejoría del conocimiento del recurso eólico en el norte y centro del país, Diciembre 2003
  (preparado para la Comisión Nacional de Energía)
- **Gobierno de Chile**:
  Exploración de Interés Internacional en el proyecto Sistema de Generación Eléctrico Híbrido Eólico/Diesel, Comunidad de San Juan Bautista, Isla Robinson Crusoe, Archipiélago Juan Fernández, Chile, Febrero 2004
- **Gobierno de Chile**:
  Chile's Energy Security Policy, November 1, 2006
- **Ministerio de Agricultura/Instituto Forestal (INFOR)**:
  Disponibilidad de residuos madereros provenientes de la indústria de la Madera entra la IV y XII region para uso energético, Enero 2007
- **UNDP/Worldbank**:
  Desafíos de la Electrificación Rural en Chile, ESMAP Technical Paper 082, Octubre 2005
- **U.S. Department of Energy, Energy Information Administration**:
  Country Analysis Briefs – Chile, September 2006

3.8 Contact Addresses

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4 Costa Rica

4.1 Electricity Market

Installed capacities

This country of 4.5 million inhabitants has no domestic fossil energy resources. The installed electrical generating capacity of the National Electricity System (SEN) at the end of 2005 totalled 1,931 MW, with 67 % provided by hydropower, 21 % by thermal power generating facilities[1], 9 % by geothermal plants and 3 % by wind power. The state-run electrical utility Instituto Costarricense de Electricidad (ICE) controls some 80 % of this installed capacity. Private power generators own a share amounting to about 13 % of total capacity, while the remaining 7 % is run by cooperatives for rural electrification.[2] The highest demand for electric power reached to date was 1,390 MW, in December 2005.

Year	Hydropower		Geothermal		Wind power		Thermal power		Total
	MW	%	MW	%	MW	%	MW	%	MW
2001	1,224	72.0	143	8.4	46	2.7	288	16.9	1,701
2002	1,262	71.8	143	8.1	66	3.8	288	16.4	1,758
2003	1,295	67.6	161	8.4	66	3.4	395	20.6	1,916
2004	1,304	67.5	164	8.5	66	3.4	398	20.6	1,931
2005	1,304	67.5	164	8.5	66	3.4	398	20.6	1,931

Tab. 1: Installed electricity generating capacity; Costa Rica; 2001–2005; MW and %[3]

Electricity generation

In 2005, Costa Rica was able to meet 96 % of its nationwide demand for electricity by utilising renewable energy sources. Thermal power plants, which make up 21 % of the electrical generating capacity in the country, are reserved primarily for use in times of low precipitation, contributing a share that amounted to slightly more than 3 % of the total electric power generated in 2005.

Year	Hydropower		Geothermal		Wind power		Thermal power		Total
	GWh	%	GWh	%	GWh	%	GWh	%	GWh
2001	5,651	81.7	986	14.3	179	2.6	99	1.4	6,916
2002	5,963	80.0	1,117	15.0	254	3.4	122	1.6	7,456
2003	6,021	79.6	1,144	15.3	230	3.0	157	2.1	7,554
2004	6,518	80.8	1,206	15.0	255	3.2	83	1.0	8,062
2005	6,568	80.0	1,149	14.0	202	2.5	295	3.6	8,215

Tab. 2: Electricity production according to energy source; Costa Rica; 2001-2005; GWh and %[4]

Electricity transmission

The electricity transmission grid in Costa Rica is based on a 230 kV high voltage line system totalling just under 1,000 km in length and 138 kV medium voltage lines measuring some 700 km in total. Energy losses incurred in electricity transmission lie at about 4 %.

There is little cross-border power transmission capacity with neighbouring countries, amounting to a mere 80 MW. Marginal improvement to this situation is expected from cooperation between the Central American states. Within the framework of the SIEPAC project fostered by Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama, a Central American electricity market is to be created by 2008 by expanding and linking existing transport networks. The accord formalising this effort was signed by six of the region's countries as far back as 1999. The project is being financed for the most part by the Interamerican Development Bank (BID).[5] The envisaged SIEPAC grid is to comprise a central 1,830 km-long 230 kV main line. This should enable the region's interstate grid transmission capacity to grow from 4 % of demand to 10 %.

1 These thermal power generating units mainly use diesel fuel.
2 The distribution grids of the cooperatives for rural electrification are linked to the SEN.
3 Source: ARESEP.
4 Source: ARESEP 2006.
5 Among other things, BID is granting loans worth US$ 240 million for erection of these transmission lines. The total cost of the grid is estimated to amount to US$ 320 million.

Degree of electrification

While in 1970 a mere 47 % of the population had access to electricity, this degree of electrification had increased to 98 % by 2005. Depending on the region, the percentage of the population with access to electricity varies between 80 % in the Puntarenas province in the country's south to almost 100 % in the province of the capital city, San José.

Electricity consumption

Demand for electric power in Costa Rica has grown in recent years by annual rates ranging from 4 to 6 %. Electricity consumption in the years just past has been divided up between the various user groups as follows:

Year	Households		Commerce/Other		Industry		Lighting		Total
	GWh	%	GWh	%	GWh	%	GWh	%	GWh
2002	2,720	42.8	1,613	25.3	1,862	29.2	165	2.6	6,361
2003	2,855	42.5	1,775	26.4	1,913	28.4	173	2.6	6,715
2004	2,951	43.5	1,922	27.4	1,950	27.8	186	2.7	7,010
2005	3,056	41.5	2,068	28.0	2,046	27.8	192	2.6	7,363

Tab. 3: Electricity consumption according to user groups; Costa Rica; 2002-2005; GWh and %[6]

Electricity prices

Electricity tariffs are generally based on the short-term marginal costs of the country's existing power generating facilities. In comparison with other Central American states, electricity prices remain stable and relatively low in Costa Rica owing to the country's lack of dependence on importing primary energy sources.

In 2005, the average electricity price per household was 5.1 €-ct/kWh (33.13¢), while the average rate paid by the commercial sector came to 9.8 €-ct/kWh (43.89¢) and that by industry to 5.3 €-ct/kWh (34.33¢). A further differentiation is made in the tariff system between rates at normal and peak load periods and in relation to consumption quantity. According to this system, households must pay 4.4 €-ct/kWh (28.60¢) for the first 200 kWh during normal load periods, whereas at peak load times the rate is 5.3 €-ct/kWh (34.50¢). Each additional unit of electricity consumed during peak load periods is charged at 9.0 €-ct/kWh (58.00¢), compared with only 7.4 €-ct/kWh (48.10¢) at times of normal loading.[7] Tariffs in rural areas supplied with power by the cooperatives tend to be lower than in the region around the capital city San José. Consequentially, cross-subsidation exists between urban electricity consumers and those in rural parts of the country. In addition, customers who consume more pay on average higher rates than those who consume less.

ICE has submitted a request to the regulatory authority to raise electricity prices in the year 2007. The average price increase of 16.5 % over the 2006 rates is significantly higher than the 9.4 % rate of inflation. Moreover, a rise in rates introduced in early 2005 already raised the price of electric power by an average of 17 %.

Expansion planning

Envisaged additions to the nation's electrical generating capacity are spelled out in national plans for expansion of electricity production that are prepared by ICE about every two years. Such efforts are formulated in coordination and agreement with the National Development Plan and National Energy Plan.[8] ICE bases its calculations for planned capacity expansion on a continuing annual increase in demand ranging between 5.3 and 6 %.

The current plan for expanding electricity production[9] of January 2006 has a planning horizon stretching to 2025 and is intended to ensure a power supply independent of neighbouring countries, i.e. one which is not dependent on possible electricity imports. The initial planning period covering the years from 2006 to 2010 calls for installation of new generating capacity totalling some 500 MW, of which 360 MW is to be provided by hydropower projects, 50 MW by an additional wind farm and 116 MW by Garabito thermal power plant.

6 Sources: ARESEP 2006.
7 A detailed listing of all electricity tariffs can be found on the website of the regulatory authority ARESEP (www.aresep.go.cr).
8 Plan de Desarrollo Nacional and Plan Nacional de Energía 2002-2016, issued by the Ministry of Environment and Energy.
9 See ICE (2006).

Originally Garabito power station was supposed to be completed as early as 2007. However, construction has been postponed indefinitely due to difficulties incurred in financing this gas turbine power plant project.

According to planning up to 2016, thermally generated electric power is to assume a greater role in the coming years. Plans envisage construction of three additional thermal power plants between 2010 and 2015. If all of these projects are indeed implemented, computational analyses by ICE foresee the share of total power generation provided by thermal power plants increasing from just less than 4% today to almost 20%.

Owing to the steeply rising demand for electricity, fears of shortages in electricity supply and a possible need for electricity rationing have already arisen in recent years. Uncertainty as to when Garabito power station is to be completed has aggravated matters even further. Consideration has been given to alleviating this tense situation by leasing mobile power generating units. However, for the time being any power shortages are to be circumvented by electricity imports from the expanding and intermeshing Central American electricity market.

While the go-ahead to implement projects planned for the timeframe 2006 to 2010 has already been given, an assortment of projects has been proposed for the period from 2010 to 2025 for which final selection for implementation remains to be decided. Plans call for installation of 1,400 MW of additional hydropower capacity, 70 MW of new geothermal power generating capacity and a further 180 MW within the scope of wind power projects.

A broad glance at the planning period spanning 2006 to 2020 reveals that 53% of the overall planned capacity of some 3,000 MW is to be based on hydropower, 38% on new thermal power plants, approximately 6% on wind energy and slightly more than 2% on a new geothermal facility.

In addition to the power plant projects of the state-run electrical utility ICE, the plan also includes projects currently under construction thanks to financing by private investors. As expansion of the country's power generation infrastructure cannot be financed by the state alone, it is anticipated that private investment in the form of BOT (Build-Operate-Transfer) contracts will increase in future.

4.2 Market Actors

Government actors

The electricity market is dominated by the vertically integrated state-owned electrical utility ICE, which was founded in 1949.[10] This company is active in the fields of power generation, transmission, distribution and marketing. Owing to the fact that the National Centre for Energy Controlling (CENCE) forms an integral part of this enterprise, ICE also assumes the role of system operator.

The Planning Centre (CENPE) – likewise part of ICE – is responsible within the scope of electricity production expansion plans for ensuring power supply by erecting new facilities providing adequate electrical generating capacity. Furthermore, ICE likewise has a monopoly on the nation's power transmission grids. Regional distribution companies and customers connected to the high voltage grid can use the services of ICE for a flat rate of 0.68 euro cents/kWh (4.40¢). The regulating authority ARESEP sets grid rates.

The power provider Compañía Nacional de Fuerza y Luz (CNFL) was founded in 1941. In 1968, ICE purchased some 98% of the company's shares when the enterprise was nationalised. Private shareholders own the remaining stocks. CNFL is active in the fields of electricity production[11] and distribution. With almost half a million customers throughout the country, it is the largest power distribution company in Costa Rica, serving a 41% share of this market in 2005. This power provider supplies the most densely populated region in the capital city's metropolitan area.

10 See Law 449 from the year 1949.
11 Some 11% of the electricity sold is generated by nine hydropower plants. The remaining 89% is sourced from ICE.

Private actors

Four cooperatives (Coopelesca, Coope Alfaro Ruiz, Coope Guanacaste and Coope Santos) operate in rural regions of Costa Rica, all of them organised on a not-for-profit basis. The primary objective of these cooperatives is to achieve rural electrification[12] in accordance with Law No. 8345 enacted in the year 2003. Two local power provider enterprises, JASEC in the province of Cartago and ESPH in the city of Heredia, assume similar special positions in the nation's electricity market.[13] The primary task of these local power provider companies is to supply the public with electricity. JASEC was founded in 1964 and is active in electricity production[14] and distribution. ESPH, in existence since 1976, specialises in providing water and electrical power, supplying some 65,000 customers in six of the country's cantons.

In addition, there are 27 private generators active in Costa Rica who sell electricity to ICE. Prices paid to such private generators range between 4.65 and 6.92 euro cents per kWh, depending on the specific facility.[15]

Other Actors

Governmental responsibility and authority for energy policy lies with the Ministry for Environment and Energy (MINAE). MINAE leads the Energy Commission (Consejo Subsectoral de Energía), which is composed of the most important institutions and state-run enterprises in the energy sector. These include the Ministry of Science and Technology, the Ministry of Planning and Economic Policy, the regulatory authority ARESEP, the national oil company RECOPE and the national electrical utility ICE. The association ACOPE represents the interests of the private power generation companies.

The regulatory authority ARESEP

The independent regulatory authority ARESEP was created in 1996[16] and is responsible most importantly for determining transit fees and electricity prices. ARESEP specifies these tariffs giving due consideration to economic, social and ecological aspects. In doing so, the regulator is authorised to levy duties for financing grid expansion and supporting low-income groups among the nation's population. An additional important task of ARESEP is to provide supervisory monitoring of the electricity sector at all levels. This also includes technical and safety inspections. The government nominates the regulatory authority's five-member managing board, and these appointments are subject to approval by the Legislative Assembly.

4.3 Legal Framework

Energy and electricity market policy

Despite liberalisation efforts launched in the early 1990s, the electricity market still remains predominantly in the hands of the state. Legislation targeting more extensive liberalisation of the electricity market was rejected by the Legislative Assembly in 1998.

Private power generation

Upon enacting its Law No. 7200 in 1990, Costa Rica became the first Central American state to introduce requirements by law regulating private generation of electric power. The objective of this legislation was to reduce dependence on imports in the energy sector and to promote the use of hydropower and other renewable energy sources. This law allowed private actors to generate electricity based on renewable energy, while the share of the country's installed electrical generating capacity owned by private actors was not to exceed 15 %. Moreover, the output of such renewable energy facilities was not to exceed 20 MW, and contract terms of 15 years were agreed.

12 See section on Rural Electrification.
13 See Law 7789 and 7799 enacted in 1998.
14 JASEC has a 19 MW hydroelectric power plant at its disposal.
15 A detailed listing of the remuneration received by all private power generators can be found on the regulatory authority's website (www.aresep.go.cr).
16 See Law 7593 from the year 1996.

These regulations governing private power generators were subsequently reformed and expanded in 1995 by Law No. 7508. According to this, a minimum of 35 % of the corporate capital of private power generators and cooperatives must be held by citizens of Costa Rica. ICE now purchases electricity from private-sector plants with electrical generating outputs of up to 50 MW. The permitted percentage of total installed capacity that may be owned by private power producers was raised to 30 %.

Concessions for electricity production are awarded by the regulatory authority within the framework of tendering processes. The terms of purchase contracts were extended from 15 to 20 years. These regulations apply equally to cooperatives as well as local provider enterprises.[17]

Procedures for licensing of private power generating facilities were reformed by the regulatory authority in January 2004.[18] In addition to precise description of the project, the main conditions for such approval include a public hearing, submittal of a power purchase agreement with ICE and a certificate issued by the Ministry of Environment and Energy verifying compliance with environmental compatibility review requirements.

4.4 Policy for Promoting Renewable Energy Resources

In Costa Rica, no separately defined tariffs are granted for electricity generated from renewable energy sources, such as within the scope of specific instruments of promotion.[19] Nevertheless, utilisation and promotion of renewable energy constitute an important guiding principle of national energy policy. The current National Energy Plan confirms that use and promotion of renewable energy in the electricity sector makes a major contribution to environmental protection. Consequently, the long-term goal set for the electricity market calls for an increase in the share of electricity generated from renewable energy sources (excluding hydropower) to 15 %.

In addition, several of the country's major laws stipulate promotion of renewable energy sources. Harnessing of hydropower was defined to be a primary task of the state-owned electricity enterprise ICE, anchored in the company's articles of organisation in 1949. Law No. 5961 enacted in 1976 gave ICE a monopoly on research into and use of geothermal energy sources. The country's 1995 Environmental Law states that the state is obligated to investigate the availability of alternative energy sources and to promote their use in order to achieve sustainable economic growth.[20]

The use of hydropower alone is restricted by the regulations of Decree No. 30480 adopted in 2002, which spells out that technologies enabling utilisation of other renewable energy sources are to be given priority over hydropower provided any related negative environmental impacts thereof can be limited. Directive 22 on the Promotion of Renewable Energy, issued in 2003,[21] clearly stipulates that renewable energy sources, with the exception of hydropower, are to be used in the electricity sector provided such use is preferable from an environmental policy standpoint and at the same time economically feasible.

In the Declaration of San Salvador issued in February 2006, the Central American energy and environmental ministers proclaimed their countries' political will to further increase the share of renewable energy sources in the energy portfolio. Furthermore, private actors are to play an important role in future, and potential economic incentives evaluated.

Clean Development Mechanism

Costa Rica ratified the Kyoto Protocol in August 2002. Responsibility for Clean Development Mechanism (CDM) affairs lies with the Oficina Costarricense de Implementación Conjunta (OCIC), which is attached to the Ministry of Environment and Energy. OCIC provides technical support and advises private and public enterprises in the preparation of CDM projects. OCIC had already been set up in 1995 within the scope of the Activities Implemented Jointly programme, the pilot project programme of the Kyoto Protocol.

17 The legal framework for cooperatives was regulated by Law No. 8345 of March 25, 2003.
18 See ARESEP, 2004.
19 All that has been made available is tax incentives for some wind power installations.
20 See Ley Orgánica del Ambiente 7554 of 1995, Article 58.
21 See D22-26389 of 25 March 2003.

At the time of signing of the Kyoto Protocol, an organisation comprising private actors – the Asociación Costarricense de Implementación Conjunta (ASOCIC) – was formed for the purpose of improving financing of CDM projects. Membership of ASOCIC is open to the largest national enterprises in the private and public sectors and the Chamber of Forestry. OCIC reports to ASOCIC in administrative matters. Thus, formation of the Designated National Authority (DNA) in Costa Rica constitutes a case in which certain competencies and authorities were outsourced to enable access to the know-how of private institutions.

Two Costa Rican CDM projects had been registered with UNFCCC (United Nations Framework Convention on Climate Change) by the end of January 2007. The Rio Azul facility for harnessing and using landfill gas was registered in October 2005. This 3.7 MW plant in the capital city San José is under the ownership of the SARET group, which was awarded the contract to implement the project following a call for tenders from CNFL.

In March 2006 the Cote hydroelectric project, with a power output of some 7 MW, was also registered. The plant is located in the northern province of Guanacaste and is being financed by the state-owned company CNFL.[22] The electricity generated is to be fed into the national power grid.

In August 2006 the Spanish electric power utility Union Fenosa achieved registration of La Joya hydroelectric power station with Spain's DNA. This hydroproject, with a generating capacity of 50 MW, has not yet been registered with UNFCCC.

4.5 Status of Renewable Energy Sources

For the time period 2006 to 2025, the current plan for expansion of electricity production calls for greater exploitation of renewable energy sources, primarily of hydropower, followed by geothermal energy and wind power. To a lesser degree it is also planned to utilise biomass as well, in particular biomass (bagasse). Solar energy, on the other hand, is to play only a marginal role due to the cost factors involved.

Hydropower

The technically exploitable hydropower potential of Costa Rica is estimated to amount to 5,800 MW. Feasible exploitability is restricted, however, as some 800 MW of the identified potential lies in national parks where the use of hydropower is prohibited by law. Sites for a further 1,800 MW of potential electrical output are located in areas home to indigenous populations. ICE views implementation of such projects in these regions to be problematic.

Installed hydropower generating capacity at the end of 2005 totalled 1,304 MW. Some 75 % of this installed capacity is provided by large hydroelectric power stations (> 50 MW), 20 % by midsize hydropower projects with outputs ranging from 10 to 50 MW, and the remaining 5 % by small hydropower projects producing less than 10 MW.

State-owned hydropower plants

The hydroelectric generating facilities of the state electrical utility ICE possess an electrical generating capacity of some 1,000 MW, mainly comprising large power plants. ICE has eleven hydroelectric plants that went into operation between 1958 and 2002 and deliver a capacity of between 24 and 180 MW. In addition, ICE owns five small hydropower plants[23] which, added together, can provide an electrical output of 5.3 MW. The state enterprise CNFL owns three hydroelectric plants with a combined capacity of 73 MW.[24]

22 76% of the total project costs of some US$ 8.8 million are being financed by a loan from the American Bank for Economic Integration.
23 The plants in question are Cacao, Echandi, Avance, Lotes and Pto. Escondido.
24 These plants are Daniel Gutiérrez (18 MW), Cote (7 MW) and Brasil (5 MW).

ICE is committed to expanding the use of hydropower in future as well. Its 80 MW Caroblanco hydroproject is scheduled to go on line in 2007, followed by the 128 MW Pírris scheme in 2009/2010. In addition, planning is currently underway for Veraguas Hydroelectric Power Station which, intended to ultimately provide a generating capacity of 631 MW, will become the nation's largest single power generating facility by far. Preliminary feasibility and environmental impact assessments conducted in 2005 have yielded positive outcomes. The preparatory phase is to be completed by the end of 2008. Total project costs are estimated at just under US$ 1 billion.

Privately owned hydropower plants

Two local power provider enterprises, JASEC and ESPH, own several small hydropower projects that together provide a generating capacity of 22.5 MW. With completion of its Los Negros Hydroelectric Power Station, ESPH has expanded this installed capacity by 17 MW.

Another company, Edificadora Beta, has built power plants for three of the country's cooperatives: an 8 MW plant for Coopelesca was commissioned in 1999, and two other generating facilities for 14 MW and 5 MW respectively went on line in 2003. A 17.5 MW plant is currently being constructed for the Coopeguanacaste cooperative, and 2007 should also see building begin on a 15-MW power plant for the Coopesanto cooperative. Further projects by this company are at the planning stage. The Coneléctricas R.L. cooperative is planning to build the Pocosol hydroelectric power station, expanding the power generating base by a further 26 MW. Work on this US$ 47 million project is scheduled to commence in the first half of 2007 and be completed by the end of 2008. The construction of additional hydropower plants is intended to increase the installed capacity of the four cooperatives to a total of 132 MW by 2010, thereby enabling hydropower to meet 80 % of demand in the respective supply regions.

Other private actors held power purchase agreements with ICE in 2005 totalling 127 MW in hydropower output. The share of private generators in the market grew even further with completion of the La Joya (50 MW) and El General (39 MW) projects in 2006, both plants having been built under BOT contracts.

Wind energy

Wind energy potential in Costa Rica is estimated by the government at between 500 and 600 MW. However, ICE is working on the assumption that existing legal restrictions limit the actually exploitable wind power potential to 274 MW, as the harnessing of wind energy (like hydropower) is prohibited in national parks, where many of the suitable sites are located. Wind energy is seen as an appropriate complementary source to hydropower in Costa Rica, as the summer is marked by strong winds that can be exploited to alleviate the consequences of dry periods on hydropower production. ICE began evaluating the national wind power potential as long ago as the early 1980s. A relatively imprecise study of wind conditions was completed that classifies wind speeds in four ranges.[25]

At the end of 2006, Costa Rica possessed installed wind power generating capacity of some 70 MW. With the exception of ICE's 20 MW wind farm in Tejona, the facilities are in private ownership. All four farms in operation are located in the vicinity of the Lake Arenal, a dammed reservoir in the north of the country.

Costa Rica's smallest wind farm, Aeroenergia, was inaugurated by the company of the same name in 1998 and has a generating capacity of 6.4 MW. Project costs came to US$ 9.5 million. Even before that, in 1995, the Inter-American Development Bank made an US$ 18.7 million loan available for a further project, enabling realisation of the world's first private wind power project without state financial support. This 20-MW wind farm comprising 55 units is owned by Planta Eólica S.A.

25 The study was prepared in 1983 by the Swiss firm Electrowatt Engineering Services.

Movasa wind farm, with a total generating capacity of 24 MW, went on line in 1999. This installation, consisting of 32 turbines each rated at 750 kW,[26] is the property of ERGA, a subsidiary of the Italian utility company ENEL. The purchase contract with ICE, however, is for supply of 20 MW. Any failure to feed the power grid with the agreed purchase quantities triggers the threat of penalties, while at the same time any overproduction is not remunerated.

2002 saw the nation's newest wind farm put into operation. The state-owned Tejona wind farm is operated directly by ICE. This facility comprises 30 wind turbines from the Danish manufacturer Vestas, each rated at 660 kW. The average wind speed at the site is 11.7 m/sec. ICE itself paid the lion's share (US$ 18.8 million) of the US$ 26 million price tag for the wind farm, while support was received within the scope of a pilot CMD project from the Dutch power provider Essent (US$ 3.9 million) as well as from the GEF (US$ 3.3 million). According to information provided by the regulator in January 2007, existing wind power installations are paid on average 6.8 euro cents per kWh (8.75 US cents/kWh).

When it was preparing a development plan for renewable energy sources in 2004, CNFL identified six sites suitable for harnessing wind energy. It was thought that the wind farms would be relatively small, with capacities ranging between 3 MW and 20 MW. Wind measurements were also conducted at the potential sites and cost estimates prepared. However, no concrete plans for utilisation of these sites had been presented as of the end of 2006.

Costa Rica's plan for expanding electricity production in the years from 2006 to 2025 includes the installation of an additional 50 MW of wind power generating capacity by year's end 2008. Project contracts were supposed to be awarded through public tendering, although the process had not been completed by January 2007. Planning calls for installation of an additional 20 MW of capacity in the years following 2008.

Biomass

The energy potential of biomass to generate electricity is estimated by ICE to be 317 MW_e. Biomass obtained as a by-product of the sugar industry (bagasse) is to be more extensively exploited in future for power generation. Contracts are currently in place for the purchase of surplus electricity generated by the two plants described below, which use bagasse as a fuel.

The Ingenio El Viejo plant is operated by El Viejo S.A., a sugar factory established in 1955 in the Guanacaste region in the country's northwest. This 4 MW cogeneration (combined heat and power) plant has been feeding electricity to the public grid since 1991. The second facility – Taboga power plant – has an installed electrical generating capacity of 20 MW according to the plant operator. Owing to its location near the country's northern border, some of the electricity generated there is sold to Nicaragua. ICE has power purchase agreements with both plants. According to ICE, both plant operators have plans to expand generating capacity.

To date, the use of biogas for electricity production has been tried only in the Rio Azul pilot project; this was also the country's first CDM project to be registered. The plant was installed in 2004 to harness and exploit the energy potential of landfill gas and has a generating capacity of 3.7 MW. With the exception of bagasse, biomass as a whole is categorised by ICE to be a "new renewable energy source" that is to be put to only limited use, due to technical and economic restrictions.

Solar energy

Average daily solar irradiation in Costa Rica reaches a maximum of 5.0 to 6.0 kWh/m^2, but is subject to broad fluctuations. Photovoltaic (PV) systems are used in Costa Rica almost exclusively to provide electrification in regions remote from the established grid. The theoretical potential of solar energy in Costa Rica is estimated to be 10,000 MW. Heredia National University has been active in related research since 1977. In addition, the use of solar power is being promoted by non-governmental organisations such as the Costa Rican solar energy association 'Sol de Vida' and CEPRONA.

26 The units installed are NEG Micon NM44/750 wind turbine generators.

1,445 solar energy units for power generation had been installed in the country as of 2006. Almost all of these are deployed in decentralised systems providing a total generating capacity estimated to be 140 kW. The first solar energy installation to generate power for the public grid entered operation with ICE's San Antonio solar project. The PV modules used, each rated at 2.4 kW, can generate some 3 MWh per year. According to ICE, based on the experience gained to date, similar grid-coupled installations with a total output of 500 kW are to be erected at other sites.

In collaboration with the country's cooperatives, ICE has installed almost 1,300 solar systems in off-grid regions. The Coopeguanacaste cooperative has installed another 170 solar systems in its supply area. One of the largest PV systems was installed on the island of Caballo. The central system, consisting of 107 modules, supplies the island's 200 inhabitants with electricity for lighting, pumping water and producing ice for the refrigeration of fish.

Exploitation of solar energy for heating water is still in its infancy in Costa Rica. Throughout the country, total installed collector surface area comes to only about 3,000 to 4,000 m^2. In its current energy plan the government has set the goal of further investigating the use of solar energy for water heating purposes. In only a few cases solar power is employed for water distillation.[27]

Geothermal power

The potential of geothermal power in Costa Rica is estimated by some sources to be as high as 900 MW. In contrast, ICE assumes a potential of only 235 MW, as its analysis takes account of restrictive factors. Such restrictions include, first and foremost, the fact that a large number of the suitable sites are located in national parks in the north of the country and that operation of such facilities at these locations is prohibited by law. A legislative initiative that would allow operation of geothermal installations in national parks has had no success to date. At the end of 2005, Costa Rica had an installed geothermal generating capacity of 165 MW, meeting some 15 % of total electricity demand.

Studies investigating the use of geothermal power were initiated in Costa Rica some time ago, in 1974, in response to the first oil crisis. Preparatory work for construction of the first geothermal power plant near the Miravalles Volcano was launched in 1987, culminating seven years later when the first unit, Miravalles I, went on line delivering output of 55 MW. That same year a second geothermal plant named Boca de Pozo began operation, generating 5 MW. The latter facility was expanded twice, in 1996 and 1997, each time by 5 MW of extra capacity. However, the two most recently constructed units, owned by the Mexican state utility CNE, were decommissioned in 1998.

The Miravalles complex was expanded in 1998 with the addition Miravalles II power plant, likewise generating 55 MW. The 27.5-MW Miravalles III followed in 2000, the first unit to be financed by private investors within the framework of BOT contracts.[28] The most recent unit, Miravalles V, expanded the power plant complex's total generating capacity by 15 MW in 2003.

A further geothermal power plant, dubbed Las Pailas, is at the planning stage. Deep wells for the 35 MW plant have already been successfully sunk. According to the plan for expansion of electricity production, the plant is scheduled to be ready for operation in 2011 and will be financed through a BOT contract. Precise information about financiers was not yet known at the end of 2006. The power plant is then to be expanded in 2013 by an additional 35 MW of generating capacity. No further power plants are envisaged within the scope of the plan to expand electricity production.

27 See Nandwani, 2006, for a detailed listing of selected solar energy installations in Costa Rica.
28 The costs, amounting to some US$ 65 million, are being borne by the private consortium comprising Oxbow Power, Marubeni Corp. and José Altmann. A power purchase agreement covering a term of 15 years was concluded ICE.

4.6 Rural Electrification

In view of the fact that over 98% of the nation's population has access to electric power, rural electrification in Costa Rica is also well advanced, constituting an exceptional case in Central America. This development is due in particular to the cooperatives that have been active since the 1960s. These four not-for-profit organisations were founded for the express purpose of achieving rural electrification. All told, the distribution grid of the cooperatives is over 7,000 km long and supplies some 150,000 customers. The supply area of the four cooperatives stretches across 22 % of the nation's territory. However, their few power generating facilities based exclusively on hydropower[29] can meet only 34 % of collective demand, such that remaining electricity needs have be met by sourcing from ICE. It is intended that self-generation should be expanded to meet 80 % of demand by 2010 by building additional hydropower plants. The interests of the cooperatives are represented by the cooperative Coneléctricas R.L., which was founded in 1989 and acts a parent association for all the cooperatives.

Cooperation between UNDP, ICE and MINAE

Under the National Development Plan, the government has set itself the goal of ensuring that every citizen of Costa Rica has access to electricity by 2010. In order to reach the remaining 20,000 households not yet supplied, a national programme for electrification of off-grid areas, to be based exclusively on the decentralised use of renewable energy sources, was set up within the framework of a cooperative effort between the United Nations Development Programme (UNDP), ICE and (MINAE).

The programme is broken down into two phases. In the first phase, an institutional, financial and normative framework is to be created in the energy sector to prepare for rural electrification with the aid of renewable energy sources. The second phase is then to comprise actual implementation of the projects.

In concrete terms, electrification efforts are to concentrate on electrification of 329 municipalities by means of small hydropower plants or photovoltaic systems. 7,000 families stand to benefit from this project, in which the generating capacity of each unit will be less than 100 kW.

For the project's initial phase, which is to cost some US$ 2 million, the GEF has approved subsidies amounting to US$ 1.15 million. ICE and the Ministry of Environment and Energy are to contribute US$ 660,000 and US$ 240,000, respectively. The project contract was signed in May 2005 by ICE and the Ministry of Environment and Energy. 16 municipalities that to date have had neither any connection to the public grid nor any diesel generators are to be supplied with electricity within the scope of pilot projects.

To achieve systematic electrification of the remaining households in Phase II, in October 2006 the UNDP office in Costa Rica issued a call for tenders for a project in collaboration with the GEF. The bidders submitting proposals are asked to prepare a thorough plan for comprehensive rural electrification. This should show the locations that can be reached by expanding the existing distribution network. Consequently, all remaining sites will have to be electrified using decentralised power generating systems based on renewable energy sources. Furthermore, the most cost-effective options are to be identified and elaborated, and studies conducted for implementation of the initial projects.

Exchange rate (27 January 2007):
1,000 Costa Rican colón (CRC) = 1.546 euro (EUR)

29 Coneléctricas and Coopelesca have hydropower schemes with capacities of 17 MW and 27 MW respectively.

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4.8 Contact Addresses

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5 Dominican Republic

5.1 Electricity Market

Installed capacity

The power generating capacity feeding into the public grid in the Dominican Republic totals 3,164 MW (December 2005) and relies largely on fossil fuels (coal, fuel oil and natural gas, totalling 85 %) and, to a lesser degree, on hydropower (468 MW or 15 %). This heavy dependence on fossil fuels, all of which have to be imported, makes power generation more expensive and places a heavy burden on the trade balance of the Dominican Republic.

Lack of supply reliability

2005 saw demand for a maximum output of 1,498 MW. Despite the installed capacity of 3,164 MW, the reserve capacity available on some days was not sufficient to cover this demand. Given an assumed level of deliberate demand suppression of 20 % (corresponding to about 375 MW) currently imposed through rationing, in no way it can be said that there is full provision of supply.[2]

Company		Total	Steam turbines	Gas turbines	Combined-cycle	Fuel oil	Hydropower	Total
		MW	%	%	%	%	%	%
Former CDE generation capacity	Haina	663	10.9	5.2		4.8		21.0
	Itabo	432	8.2	5.5				13.7
State-owned hydropower	EGEHID	468					14.8	14.8
Independent private producers	GPLV: Generadora Palamara La Vega GPLV	195				6.2		6.2
	CEPP: Cia. De Electricidad de Puerto Plata	77				2.4		2.4
	Monte Rio	100				3.2		3.2
	AES Andrés	319			10.1			10.1
	Metaldom: Complejo Metalurgico Dominicano	42				1.3		1.3
	DPP: Dominican Power Partners	236		7.5				7.5
	Seaboard: Transcontinental Capital Corp.	116				3.68		3.68
IPP exclusively for CDEEE	Smith Enron Cogeneration Ltd.	185			5.9			5.9
	Maxon Engineering Services	30				1.0		1.0
	Cia. Eléctrica de San Pedro de Macorix (CESPM)	300			9.5			9.5
	Total	**3,164**	**19.2**	**18.1**	**25.4**	**22.5**	**14.8**	**100.0**

Tab. 1: Breakdown of installed capacities according to producer and type of generation; Dominican Republic; in MW and %; 2005[1]

1 Organismo Coordinador, Annual Report 2005, Table 2.
2 Organismo Coordinador, Memoria 2005, Fig. 6.

This shortage of electricity has characterised the prevailing situation since the end of the 1990s and could not even be remedied by the net expansion of power station capacities by some 630 MW or so undertaken between the end of 2000 and mid-2006. To achieve this expansion of capacity, the state-owned electricity utility, Corporación Dominicana de Empresas Eléctricas Estatales (CDEEE), called for tenders for two 600 MW coal-fired power plants, the contracts being awarded to Emirates Power from the United Arab Emirates and the Chinese company Sichuan Plant and Machinery, respectively. The bases of these contracts are long-term power purchase agreements (PPAs) under which CDEEE covers the fuel costs (coal) and the generating costs are guaranteed for the operator.[3] Construction of these power plants has not yet begun because guarantees demanded have not yet been met.

The reason for the unsatisfactory supply situation is the inability of the electricity sector to pass on the high generating costs and the additional costs incurred through distribution losses to the consumers.[4] To prevent the existing balance – that has to be financed from the national budget – from exceeding the framework laid down by international financing institutions (International Monetary Fund, World Bank), certain end customers are supplied power periodically only, staggered according to their payment behaviour. The success of the government's efforts to make the system more efficient and financeable is being measured, at the request of the World Bank, against the Cash Recovery Index (CRI), which combines the losses[5] and the payment behaviour of the customers by multiplying the two together. At the end of 2005 this index stood at 53, that is, only 53 % of the electricity purchased by the national grid actually generates income. Prior to the capital funding that began in 1997, the CRI stood at just 40. Plans envisage improvement to an index level of 80 by 2012. The financial losses incurred demand state subsidies to the tune of around US$ 600 million per annum (2006). This includes the capital costs of debts amounting to some US$ 170 million from previous years.

Power generation

Gross power generation for the national grid totalled 9,712 GWh in 2005 and was therefore – with rising indicators overall – 6.5 % below the historical record of 2003. In 2005, the three power distribution companies together sold 5,268 GWh to the end customers.

Power generation in 2005 relied on heavy fuel oil (50 %), hydropower (19 %), coal (13 %), natural gas (10 %) and diesel (8 %).

		EDESUR	EDENORTE	EDEESTE	Total
Electricity sales	GWh	2,196	1,447	1,627	**5,269**
Technical losses (distribution only)	GWh	452	285	309	**1,046**
	%	11.6	12.0	11.5	**11.7**
Non-technical losses (distribution only)	GWh	1,246	640	753	**2,639**
	%	32	27	28	**29.5**
Peak load	MW	546	491	463	**1,499**

Tab. 2: Electricity sales and power-distribution losses; Dominican Republic; 2005[6]

Power transmission and distribution

The backbone of the main electricity supply in the Dominican Republic comprises a transmission network that is made up of almost 1,500 km of 138-kV power lines extending radially outward from Santo Domingo to the north, west and east, plus a good 1,600 km of 69-kV lines. To reinforce this grid, a second 138-kV ring stretching 38 km right round the capital city, Santo Domingo, will enter into service at the end of 2006 and a 130 km-long, 345-kV spur will be built northwards to the town of Santiago. The national transmission and distribution networks supply around 85 % of households throughout the country with electricity.

3 CDEEE, Plan de Acción 2006.
4 See section headed "Electricity prices".
5 This includes technical and non-technical losses.
6 Source: Superintendencia de Electricidad, July 2006.

Roughly 45 % of all electricity generated is lost at the transmission and distribution level due to technical and non-technical factors. The number of power purchasers with illegal connections, unlicensed routing of electricity and poor payment behaviour are the causes of large non-technical losses, amounting to twice the level of technical network power losses.

	GWh
Net power demand	11,990
Power deficit	2,278
Gross power generation	9,712
Transmission losses	234
Net power generation	9,478
Supply to distributors et al	8,953
Technical distribution losses	1,046
Non-technical distribution losses	2,639
Electricity sales	5,269

Tab. 3: Breakdown of public power supply; Dominican Republic; GWh; 2005[7]

Power consumption

Of the 2 million or so households in the country, 0.8 million are registered as customers. Their power consumption is metered. Their average consumption is low, amounting to some 300 kWh per annum. This figure is in fact 40 kWh lower than it was in 2003, a fact that can be put down to the rationing measures introduced. Add to these some 480,000 households in the poor quarters of the towns, which, as part of the Programme to Reduce Power Failures (Programa de Reducción de Apagones – PRA), are supplied electricity by the hour and pay only a monthly flat rate of approximately US$ 8. The number of illegal connections is estimated at around 200,000.

The high proportion of total public consumption accounted for by households (47 %) only partially reflects actual reality in the electricity sector as a whole. On the one hand, permanent rationing of electricity is leading to commercial businesses, hotels, etc. increasingly switching to generating their own electricity, which of course does not appear in the statistics. On the other hand, industrial consumers who generate their own power are also not included in the statistics. Their share of the sector is presumably quite considerable, there being around 40 large-scale companies registered that buy in excise duty-exempted hydrocarbon fuels for generating their own electricity. The amount of electricity they generate collectively is, however, unknown. This explains why the amount of power fed from the public grid to industry fell by around 20 % between 2002 and 2005, while the gross national product rose just under 3% in the same period.[8]

	Number of customers	Consumption (GWh)
Households	808,380	2,477
Services	78,952	506
Industry	9,006	1,712
Public sector	6,007	574
Total	902,345	5,269

Tab. 4: Electricity customers and consumption; Dominican Republic; GWh; 2005[9]

Electricity prices

IPP electricity prices

In July 2006, the average contractual producer's price for electricity from all sources (including hydropower) amounted to 13.1 US cents/kWh. At the same time, 9.1 US cents/kWh was achieved on the spot market. The overall market-average producer's price therefore amounted to 12.7 US cents/kWh, an increase of 84 % compared with June 2003 due to the increase in crude oil prices.

7 Source: Superintendencia de Electricidad, July 2006; in-house calculations of losses.
8 CEPAL 2005: annual statistics, GNP in US$ at market prices, Table 2.1.1.3.
9 Source: Superintendencia de Electricidad, July 2006.

Electricity tariffs

The household tariffs (BTS1) have a progressive component for both the fixed, consumption-dependent base prices (standing charges) and the kilowatt-hour rates. The first 200 kWh/month for all private consumers are heavily subsidised in the form of a 9.3 US cents/kWh tariff, while a private-consumer tariff of 14 US cents/kWh for up to 300 kWh/month just about covers the procurement costs. Consumers who require more than 700 kWh/month are charged a tariff of 26 US cents/kWh. These tariffs are subject to monthly adjustment by the Superintendencia de Electricidad, which is supposed to take into account the fuel prices, the exchange rate (Dominican pesos to the US dollar) and the general rate of inflation, but political decisions, too. As a result, it is frequently the case that political expediencies prevent the necessary adjustments from being made and the tariffs are adjusted only to an inadequate degree or not at all. The resulting losses suffered by the distributors are met by the government in the form of monthly compensation payments. The overall level of subsidization for households with a consumption of less than 300 kWh per month is estimated to be just under US$ 160 million for 2006 (and is part of the total subsidy of around US$ 600 million).

5.2 Market Actors

Ever since the early 1990s, as a result of the Law on Energy Sector Development Incentives (Ley de Incentivo al Desarrollo Energético), not only the formerly state-owned Dominican Electricity Company CDE (Corporación Dominicana de Electricidad), but also a dozen (mainly US) independent power providers have been active on the Dominican electricity market. Together, these companies are providing roughly half of the installed generating capacity, which is composed solely of thermal power stations.

State-owned companies

Under the General Electricity Act of 2001, independent state-owned power transmission companies (Empresa de Transmisión Eléctrica Dominicana – ETED and Empresa de Generación Hidro-eléctrica Dominicana – EGEHID) were established and given responsibility for the transmission network and for the operation of hydroelectric power plants, which were not included in the privatisation programme. The tasks of electrification in rural regions and urban fringes, coordinating electricity companies and administering and implementing contracts with independent power producers were combined and assigned to a new company called Corporación Dominicana de Empresas Eléctricas Estatales (CDEEE), which also serves as a holding company for ETED and EGEHID.[10]

Itabo and Haina

CDE's thermal power generating division was split up into two separate companies. The new thermal power operator, Itabo, was partially owned by Gener[11] (Chile) and Coastal (USA), while Seabord and what was Enron (both USA) initially held interests in the power producer, Haina.[12] At the end of 2005, each of those two companies held 34.7 % of the country's total installed power generating capacity.

10 According to the Madrid Agreement dating from July 18, 2001, certain contracts with independent power producers are to be transferred from CDEEE to the distribution companies.

11 Now operating under the name of AESGener, with AES (USA) as majority owner.

12 Ownership has changed a number of times since then. The present owner of the holding is a consortium comprising Commonwealth Development Corporation (UK), Basic Energy (USA) , Fondo Básico del Caribe, Haert Energy (USA) and the Dominican Grupo Nacional de Finanzas.

New power providers

The statistics list the "independent, private" power producers which sell their electricity either directly to a supply contract partner (normally a regional power distributor) or via the electricity bourse (spot market). Alongside these are the IPPs, which operate on the basis of power purchase agreements (PPAs) and generate exclusively for CDEEE. Now, CDEEE is to be gradually relieved of its role as a speculative buyer of electricity based on new negotiations with the power producers and, hence, all these PPAs are to be replaced with new contract agreements.

Distribution companies

The power distribution networks were partially privatized in 1999. A group under the leadership of the Spanish company Unión Fenosa took over the northern and southern grids (EDENORTE/EDESUR), with a 50% holding in each grid, and the US company AES bought itself into the eastern grid (EDEESTE). In both cases, operational management was left to these private co-owners. Due to the poor financial and operational situation of the sales companies, the Dominican Government reacquired, through CDEEE, Unión Fenosa's stakes in EDENORTE and EDEDSUR in September 2003. Efforts made in the meantime to reprivatise these grids have come to nothing.

Other Actors in the Electricity Sector

Comisión Nacional de Energía (CNE)

The duties of the Comisión Nacional de Energía (CNE), which was established in 2001, include the formulation of laws and ordinances and the preparation of supply and demand forecasts. Acting under the auspices of the Ministry of Industry & Commerce and the Ministry of Finance, CNE is subordinate to the Technical Secretariat of the Office of the President, the Director of the Central Bank, the Ministry of Agriculture, the Ministry of the Environment and the Director of the Telecommunications Institute.

This executive body has the legal power to enact regulations for the power sector. Since mid-2003, CNE has a new department for alternative energy sources and rational use of energy (Gerencia Energías Alternas y Uso Racional de Energía).

Regulatory authority SIE

The Superintendencia de Electricidad (SIE), which was established by decree no. 118-98 on 16 March 1998 and began its work in July 1999, supervises market regulation. SIE's status as a public law body was officially established by the General Electricity Act of 2001. Its duties include in particular the supervision of prices for regulated consumers (households, trade & commerce), who have to purchase electricity from one of the distribution companies. By contrast, large consumers are allowed to negotiate freely to procure electricity from the supplier offering the most favourable conditions. A spot market for electricity was set up in June 2000 to enable short-term power purchasing transactions.

Coordination group for the wholesale market

Another new body that was created by way of the 2001 General Electricity Act is Organismo Coordinador, a coordination group with the main task of harmonising the operations of the various power producers and network operators with each other on the wholesale market and ensuring that the necessary capacity is made available on the spot market. This institution serves to promote the market's self-regulating capacities. It is not a state body. Its highest authority is a coordinating committee, the members of which include one representative each from the independent power providers, the power producers with private participation, and the transmission and distribution sectors.

Ministry of Industry & Commerce

The Ministry of Industry & Commerce (Secretaría de Estado de Industria y Comercio – SEIC) deals with the energy policy guidelines and establishes the general framework conditions for the energy sector. Decree no. 146-2000 placed the Non-conventional Energy Programme (Programa de Energía no Convencional) under the auspices of SEIC for the purpose of promoting research & development projects concerning the exploitation of renewable energy sources.

Water management

The Instituto Nacional de Recursos Hidráulicos (INDHRI) is responsible for water resource management. This institute also issues licences for the use of water as a source of energy and attends to its harmonisation with other forms of use, especially with regard to agricultural irrigation.

5.3 Legal Framework

Unbundling and privatisation

Law 141-97 on the reform of public enterprises[13], which was adopted in June 1997, initiated the unbundling and partial privatisation of the erstwhile state-owned power utility, CDE. The generation, transmission and distribution of electricity were separated from each other in 1998. All constituents of the company, with the exception of the transmission lines and the hydroelectric plants, were put up for privatisation and valued to be worth a total of US$ 642 million. Private companies were allowed to acquire 50 % capital interests and to take over operational management of the plants. Private-sector involvement in the thermal power stations was also accompanied by the obligation to build an additional 100 MW of capacity per year[14] and to bring the plants up to World Bank standards within five years. All economic activities on the part of the government in the electricity sector were assigned to the newly formed CDEEE.

General Electricity Act of 2001

A General Electricity Act (Ley General de Electricidad, No. 125-01) was passed by parliament and entered into force at the end of July 2001. This law set out the general conditions for further private-sector involvement, gave customers better legal protection vis-à-vis power providers and created a flexible wholesale market for electricity.

In addition to the institutional changes described in the preceding chapter, the key provisions of the new electricity act relate primarily to the following areas, which from today's point of view are often only inadequately met:

- Ensuring that at least 20 % of all electricity trading is done on the spot market[15]
- Authorising power generators to install connecting lines to the interconnected grid system and/or to their own customers (self-generators)
- Limiting distribution companies' ownership of generating plants to no more than 15 % of the peak load of the grid; renewable energy sources are exempted from this rule
- Regulating electricity tariffs for public-grid customers with a maximum connected load of 2,000 kW (1,400 kW from 2002, 800 kW from 2003 and 200 kW from 2004 onwards), as long as the customers do not enter into direct contracts with the suppliers
- Regulating transit tariffs for the use of transmission and distribution of facilities
- Giving preferential treatment to companies that generate electricity from renewable energy sources with regard to sales and load distribution if prices and conditions are otherwise identical
- Exempting companies that generate electricity from renewable energy sources from national and local taxes for five years
- Creating a national energy commission (Comisión Nacional de Energía – CNE) to develop energy policy measures and long-term planning of the energy sector

13 Ley General de Reforma de la Empresa Pública (141-97).
14 Through this addition of 800 MW between 2000 and 2003, the grid reached its peak installed capacity of 3,430 MW. Since then, its capacity has fallen due to shutdowns/decommissioning and contractual problems, and now (July 2006) stands at just 3,086 MW.
15 In 2005, however, only 8 % of trading was handled through this market.

- Strengthening Superintendencia de Electricidad to establish it as an independent, neutral regulatory authority with far-reaching competences
- Investing 10 % of the proceeds from fines imposed for the theft of electricity in an incentive fund for the development of renewable energy sources[16]

Implementation regulation for the General Electricity Act of 2002

A regulation governing the application of the General Electricity Act (Reglamento para la Aplicación de la Ley General de Electricidad) was adopted as Regulation 555-02, dated 19 July 2002, and modified by Regulation 749-02, dated 19 September 2002. This regulation details the roles played by the various market actors and functioning of the market.

New tariff system

SIE Resolution 31-2002, dated 17 September 2002, introduced a new tariff system for end consumers and substantially reduced cross-subsidisation. The regulated tariffs comprise a component dictated by energy costs and demand costs, regular adjustments for changes in the cost of fuels, exchange rates and inflation rates, plus a fixed amount for power distribution (Valor Agregado de Distribución), which is redetermined at four-year intervals. During the past few years, the system of tariff categories has been repeatedly altered in order to obtain as effective a system of subsidisation as possible for those in need. To this end, approximately US$ 160 million from the national budget will be spent in 2006.

5.4 Policy Promoting Renewable Energy Sources

At the end of 2000, with a view to promoting the use of renewable energy sources, the Dominican Government supplemented the preferential arrangements already laid down in the electricity act by passing a law that levies consumption taxes on fossil fuels and petroleum products. Since 2002, 5 % of these tax revenues are being fed into a special fund for the promotion of alternative energy sources and energy conservation programmes.[17] Tax revenues of around US$ 600 million are expected in 2006, which means some US$ 30 million will be paid into the fund. During the past two years (2004 and 2005), however, 55 % of the money reserved for this fund in the government's budget were reassigned to the general revenues. So far, the remaining funds have not been put to use in a transparent manner, but some funds are known to have gone to research establishments in the form of subsidies, and to have been used to finance 10,000 village PV systems and the free provision of 2 million energy-saving lamps in poor areas of the towns and cities. These funds flow via the Ministry of Industry and Commerce in the period preceding every presidential and parliamentary election.

Law promoting renewable energy sources

The initial draft version of an incentive law for the development of renewable and "clean" energy sources was submitted to the National Congress for debate in October 2001. With support from the GTZ-project Proyecto de Fomento de Energías Renovables (PROFER), the draft was modified in the period from 2003 to 2006 and resubmitted to the Congress in October 2005 under the altered title Proyecto de Ley de Incentivo al Desarrollo de Fuentes Renovables de Energías. It was submitted to the Senate for its second reading and passed in September 2006. The law was finally signed and came into force in May 2007 by the Dominican President, Leonel Fernández.

16 To reduce the level of electricity theft, the President introduced a bill to parliament that proposes up to 5 years in prison for the illegal sourcing of electricity.

17 Fondo de Interés Nacional, for which the Ministry of Industry and Commerce is responsible.

The law promotes wind farms with a capacity of up to 50 MW, mini hydropower plants of up to 5 MW, PV installations of all sizes, concentrating solar thermal power stations of up to 120 MW, biomass power stations with an organic fuel input of at least 60 % and an output of max. 80 MW, and ocean power plants (wave, tidal power plants, etc.).

Preferential arrangements in line with the Spanish system of annually fixed bonuses on top of the respective market price are also envisaged for feeding into the public power grid. Moreover, a quota of 10 % (2015) and 25 % (2025), respectively, is being set for the amount of electricity from renewable energy sources.

Furthermore, approval has been given for customs and tax exemptions for imported components to be employed in installations used to generate and use renewable supplies of energy, and for a fiscal incentive of up to 75 % of investment costs for self-generators.

In addition to power generation from renewable sources, this law also promotes all types and sizes of plant for producing biofuels, as well as cultivation areas and agricultural infrastructures for producing renewable raw materials to be used for power generation, by providing extensive tax relief and exemption over a period of 10 years. Admixtures of E15 and B2 are to be offered. These regulations are aimed first and foremost at the domestic sugar industry, which is equipping itself to produce bioethanol, but the introduction of biodiesel based on 'home-grown' oil plants and the import of biofuel are also not being ruled out.

Finally, the law also promotes technologies for solar thermal heat generation and refrigeration.

All this is being financed by the fiscal charges placed on hydrocarbons in 2000, amounting to around US$ 30 million per annum, charges that are however also supposed to finance measures for saving energy. As a general rule, public, private, public-private, municipal and other applicants count as potential recipients of promotion funds.

GTZ project since 2003

GTZ provided SEIC and CNE with assistance for their projects promoting the use of renewable energy sources between March 2003 and February 2007.[18] The focal areas in this connection were the provision of advice and guidance for the shaping of legal and regulatory framework conditions and for managing the fund for renewable energy, the electrification of rural communities with micro hydropower plants, and the promotion of PPP approaches to the exploitation of renewable energy sources. Starting in May 2005, the cultivation and use of oil-bearing plants in arid zones to generate energy was investigated and assessed in cooperation with a regional project for reducing poverty in the borderland to Haiti.

Clean Development Mechanism

The Dominican Republic ratified the UNFCCC in October 1998 and acceded to the Kyoto Protocol in February 2002. An initial national report on climate protection was submitted in June 2003. In August 2004 the Oficina Nacional del Mecanismo de nesarrollo Limpio (ONMDL) was established by presidential decree. This is the Designated National Authority (DNA), as envisaged in the Kyoto Protocol for utilising the relevant mechanisms.[19] Clean Development Mechanism projects have already been proposed; the Guanillo wind farm operated by Parques Eólicos del Caribe (a subsidiary of Gamesa of Spain), with a planned capacity of 64.4 MW, is the first CDM measure to have been successfully registered (December 2006).[20] Agreements have been reached with the World Bank, the Prototype Carbon Fund, Canada and Spain on the purchase of certified emissions reduction credits (CERs).

18 Proyecto Fomento de las Energías Renovables en la República Dominicana – PROFER.
19 Decree no. 786-04: Decreto presidencial que crea la oficina nacional de Cambio Climático y Mecanismo de Desarrollo Limpio.
20 http://cdm.unfccc.int/Projects/DB/AENOR1153378528.03/view.html

5.5 Status of Renewable Energy Sources

Until now, the use of renewable energy sources for public electricity generation in the Dominican Republic has been limited to hydropower. Nothing has as yet been undertaken to develop existing potentials with respect to wind power, solar energy and biomass, but activity in these fields is expected once the planned law on renewable energy sources has been enacted and come into force.

Hydropower

Despite extensive exploitation, the Dominican Republic still has untapped hydropower resources. Frequently, power generation is closely linked with reservoirs for drinking water and irrigation, as well as with irrigation channels. In all, the country presently has about 20 hydropower plants in the medium-output range from 3 to 100 MW in operation, with a total capacity of 468 MW. At present there are seven other power plants with a total capacity of 167 MW under construction, with a further seven with a combined output of 189 MW in the planning phase.

Mini-hydropower potential – international involvement

In the early 1980s, with Taiwanese assistance (Sinotec Engineering Consultants, Inc., Taipei), the erstwhile hydropower divisions at CDE and INDRHI identified an extensive portfolio of possible mini-hydropower plants (≥100 kW) with grid connection potential and since developed them to the point that they are now ready for implementation. This engendered a total of 25 projects with capacities ranging from 370 kW to 4,000 kW and a total capacity of 30 MW, only two of which were implemented by 1986.

UNDP-GEF provided financial and technical assistance for basic studies into 18 mini- and micro-hydropower plants[21] with ratings of 1.5 kW to 250 kW for supplying electricity to remote communities, and some of these studies are now being further pursued and backed by UNDP and GTZ.[22]

All in all, only half a dozen mini-hydropower plants with capacities totalling roughly 1 MW are presently in operation. Additionally, there are roughly 15 pico-hydropower plants with ratings of less than 1 kW in service.

According to a presidential decree dated 8 December 2000 (No. 1277-0), the private sector is authorised to engage in the licensed use of hydropower resources yielding 1 MW or less. Conversely, this also means that all hydroelectric plants larger than this count as being of relevance to the national interest and therefore may only be operated by the responsible state-owned power utility, EGEHID.

Wind energy

The country's substantial wind resources have so far gone unutilised. The U.S. National Renewable Energy Laboratory (NREL) performed an initial assessment of the wind energy potentials that could serve as a point of departure for major wind-power projects. The main goal of the study was to map the wind resources in all regions of the Dominican Republic and to compile the results in a wind atlas.[23]

The analysis showed the best wind conditions to be situated in the extreme south-west (in the provinces of Pedernales and Barahona) and north-west (in the provinces of Puerto Plata and Montecristi), and in exposed inland areas at elevated altitudes, where suitable sites could be used for providing non-grid electricity (rural electrification). Additionally, some other coastal regions also enjoy good wind conditions.

All in all, some 1,500 km^2, or 3 % of the total land area, were identified as having good or very good wind potential (wind speeds of greater than 7 m/s at a height of 30 m). Together, this would suffice for more than 10,000 MW of power generating capacity. Twenty provinces have a potential of at least 100 MW, and three provinces as much as over 1,000 MW each. However, further studies will be necessary in order to more closely investigate the power transmission routes and to determine the extent of accessibility.

21 Micro-hydropower plants are understood as including the relevant generating systems.
22 A study (PROFER Informe No. 13) reports on the experiences gained during the construction and operation of 13 micro-hydropower plants.
23 To consult the wind atlas, go to www.rsvp.nrel.gov/pdfs/wind_atlas_dominican_republic.pdf.

If the locations with wind conditions that are moderate but sufficient for the purposes of rural electrification are included, the potential even rises beyond 30,000 MW, or 60 TWh per annum. In that case, there are 12 provinces with a wind potential of at least 1,000 MW each.

Plans for wind farms

For some time now implementation plans for large-scale wind-power projects have been available, but none of the 10 projects (with a total capacity of 750 MW) for which the SIE has issued either a partial or a full licence[24] since 2001 has been implemented to date. The wind farm project in Cabo Engaño (Samaná), which is being carried out by the power provider Consorcio Energético Punta Cana (CEPM),[25] is nearing completion. This 8.5-MW project has already been licensed for generating electricity. It is being financed by the World Bank (IFC). The same enterprise also has plans to install a wind farm with up to 100 MW in Juancho in the province of Pedernales, and another one in Matanzas in Peravia province. SIE has already issued power-generating licences to Unión Fenosa for its 100-MW wind farms and to Parques Eólicos del Caribe (a subsidiary of Gamesa of Spain, 90 MW)[26] in 2001. This company's 64.4-MW project at Guanillo in Montecristi is registered as a CDM project. However, it has so far not been possible to keep to any schedule for constructing the plants, because until now all the investors have been waiting for the legislation to promote wind power and the corresponding regulations to be enacted.

Biomass

The main source of energy from biomass utilisation is bagasse, or cane waste from sugar production, which is already in use for generating heat and electricity in sugar factories. However, most of the facilities are outdated, frequently yielding no more than 20 kWh per tonne of ground bagasse, so no electricity is left over for feeding into the public grid. Increasing plant efficiency to an economically viable level by means of adapting the steam regime would yield up to 100 kWh/t, which would mean that 80 kWh could be fed into the grid. Based on an annual sugar cane production rate of 6 million tonnes, it would be possible to generate between 470 and 575 GWh of electricity per year in modern combined heat and power stations in the sugar industry. This would correspond to roughly 5 % of the Dominican Republic's current power generation rate. The level to which the feeding of electricity generated from renewable energy sources has been promoted until now has been insufficient to enable the power producers to realise reasonable and attractive remuneration. The new promotion legislation, however, prioritises the feeding of such electricity into the public grid and contains bonuses on top of the purchase price.

There are also expectations regarding the production of ethanol from sugar as a substitute for fossil fuel. An envisaged admixture of 5 % bioethanol to petroleum necessitates the cultivation of approximately 3 million tonnes of additional sugar cane. At the end of 2006, a Dominican-Swedish-British consortium[27] will begin converting two state-owned sugar refineries (Consuelo and Boca Chica) so they will be capable of producing 15 million litres of ethanol. An initial investment of US$ 70 million is planned. Further investments to the tune of US$ 200 million are also planned, to expand ethanol production in order to supply the US market among others.

24 Partial licences primarily permit the conducting of wind measurements, while full licences cover actual operation.
25 Endesa, Spain's biggest power provider and wind-farm operator, holds shares in CEPM, a private-sector enterprise that primarily provides electricity for the tourism infrastructure in Punta Cana.
26 This Guanillo wind farm, with a capacity of 64 MW, is the first CDM measure to have been successfully registered.
27 Ethanol Dominicana in cooperation with Tall Oil (Sweden), Booker Tate (UK) and Resource Energy Group (USA).

Further organic materials for use in generating power include in particular agricultural residues, most notably for producing biogas from banana trees and from the husks and leaves of rice. Biogas could also be obtained from cattle farming as well as from urban wastes, which contain a large percentage of organic material. The Institute for Innovation in Biology and Industry[28] is currently supporting several biogas projects being conducted in the arable and cattle farming sectors.

Other materials with high energy potential include such oleiferous produce as coconuts and peanuts, the cultivation and marketing of which have drastically declined over the past 20 years due to the availability of cheaper imported oils. The rising prices for imports of mineral-oil products since 2005 have revived discussion concerning domestic biodiesel production: a large number of small-scale enterprises are involved in converting used vegetable oils – primarily from the food industry and hotel trade – into biodiesel. The planting of large castor-oil-plant plantations is being promoted by Brazil, while the cultivation of jatropha is being investigated particularly in poor rural areas; from early 2007 it will be grown in an area of several hundred hectares in the east of the country with financial backing coming from the European Commission and Spain.

Solar energy

According to the available meteorological data for 1970 to 1972, mean daily solar irradiation in the Dominican Republic is between 4,9 and 5,9 kwh/m^2. As such, the conditions for the harnessing of solar energy are favourable.

Photovoltaics

The total number of PV modules now in use for the electrification of remote rural areas has been estimated at more than 23,000 units. In the past, most of the systems were installed on the basis of funds provided by non-governmental organisations and financial assistance from USAID, UNDP and other international donors.

In 2000, the programme for non-conventional energy sponsored by the Ministry of Industry and Commerce (SEIC) put some 600 PV systems into service for rural schools and health centres, military and police facilities, drinking-water chlorination systems, computer-science laboratories, observation posts in national parks and rural homes. In 2004, another 1,800 small PV systems were installed in rural households, with financing provided by the Promotion Fund for National Interests. The same fund has, since November 2005, been backing the installation of a further 10,000 PV systems in the seven provinces on the border with Haiti.[29]

Solar thermal energy

The climatic conditions are ideal for exploiting solar power to heat water. Due to the fact that water is heated for the most part using very expensive electricity, especially in households (in households with a consumption of more than 700 kWh: 21 US cents/kWh), conventional thermosiphon (natural convection) systems pay for themselves very quickly in just 2 to 4 years. Nevertheless, the spread of such systems – estimated at around 15,000 units – is low. The SEIC therefore conducted prequalification of local suppliers of thermosiphon systems in August 2005 as part of its national programme to promote energy efficiency and saving. With support from GTZ's Renewable Energy Sources project for the Dominican Republic PROFER, the market potential in the household sector alone was estimated to be 80,000 systems, and a programme to greatly increase the dissemination of these systems was drawn up. The country's central bank, the Banco de Reservas, is to provide suitable financial instruments for this purpose. Further cost reductions for the users result from the new renewable energy promotion law, which includes tax incentives with deductions of up to 75 % of the investments.[30]

Geothermal energy

The Dominican Republic has no geothermal potential for power generation.

28 Instituto de Inovación en Biotecnología e Industria.

29 The main supplier of these systems is Tecsol, a subsidiary of the Spanish company Isophoton. Isophoton announced in December 2006 that it intends building a thermal solar collector factory costing US$100 mill. in the industrial region of Haina, which it will later expand to incorporate a production line for PV modules, turning the plant into an overall investment worth US$900 mill. (source: Listín Diario).

30 Self-generators can take advantage of subsidies worth up to 75 % of the investment costs (by offsetting against their income tax liability).

5.6 Rural Electrification

It is assumed that some 350,000 of the total of 2.3 million households across the country, most of them in rural areas, still have no access to the national power grid. Most of these households have to get by without any electricity at all.

CDEEE Department of Rural Electrification

Following the establishment of the special department for rural electrification within CDEEE (Unidad de Electrificación Rural y Suburbana), gradual elimination of the still considerable deficits with respect to the supply of all households with electricity is expected. The associated tasks are to be financed in part from the regular revenues of the privatised distribution companies and generating plants. Twenty percent of the total resources from the relevant fund (Fondo Patrimonial) are earmarked for this purpose.

National electrification plan

May 2004 saw commencement of the implementation of a national rural electrification plan (Plan Nacional de Electrificación Rural – PER). The plan was drawn up by the rural electrification department at CDEEE with the technical assistance of NRECA and financial assistance from USAID. In addition to expanding the existing grid, the plan also explores the potentials of renewable-energy technologies for application in off-grid regions, including the relevant financing. The electrification plan is intended to help bring grid electricity to 95 % of the rural population by 2020. By the end of 2006, around US$ 35 million had been invested to connect a good 88,000 households to the grid. With support from USAID (NRECA), a further US$ 6 million will be invested in the near future, 66 % of this figure to be borne by CDEEE. In future, greater emphasis will be placed on the utilisation of micro-hydropower plants and photovoltaics than has been the case until now.

Rural electrification projects involving renewable energy sources

In the past, the non-governmental organisations REGAE, NRECA and Fondo Pro Naturaleza (PRONATURA) have implemented a number of projects in the field of renewable energy sources and rural electrification[31], all in close cooperation with rural regional development programmes and village cooperatives. Most of the financing for those programmes came from GEF (small projects fund) and USAID.

Exchange rate (18 December 2006):
100 Dominican peso (DOP) = 2.42 euro (EUR)

31 Solar home systems and small wind power systems for the basic electrification of rural households and community facilities, and micro-hydropower systems for decentralised village power supplies.

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5.8 Contact Addresses

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6 Colombia

6.1 Electricity market

Installed capacity

At the end of 2005, the installed generating capacity[1] connected to Colombia's national power grid totalled approximately 13,330 MW. That figure was marginally lower than at the end of 2002 (13,468 MW). Hydropower accounts for 67 % of the total installed capacity, with the remainder based on conventional thermal energy.

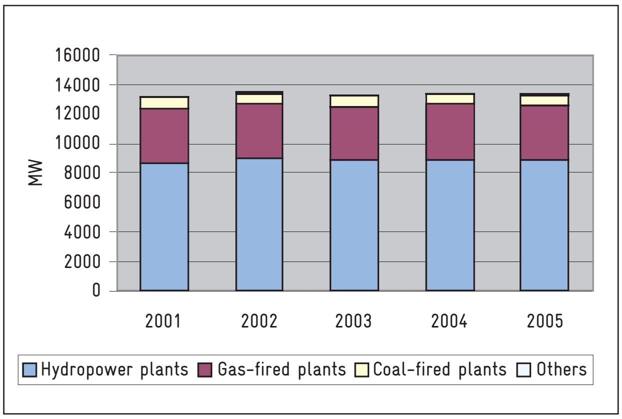

Fig. 1: Generating capacities on the interconnected grid; Colombia; 2001–2005; MW[2]

In the course of the 1990s, Colombia's once nearly complete dependence on hydropower and (to a small extent) coal for generating electricity was overcome with the commissioning of several gas-fired power plants. Despite the dominant growth in gas-fired generating capacities, however, the Colombian power-plant landscape is still largely defined by hydropower, the problem being that the technology's dependence on climatic effects leads to fluctuations in generation yields from year to year and exerts a considerable influence on the electricity price situation.[3] The next few years can be expected to see hydropower regain in its dominance within the power-plant mix.

All in all, 31 large-scale hydropower plants with ratings above 20 MW and 20 thermal power plants, some of which comprise two or more generating units, feed power into the national interconnected grid.

Around 97 % of the total installed generating capacity is managed via the central load control facility, while primarily small-scale hydroelectric facilities[4] feeding into the national grid (approx. 380 MW), together with the country's sole wind farm, are not subject to any form of load control.

Power generation

Following a recession in the late 1990s, with attendant decreases in electricity consumption, the new decade has seen considerable growth in demand. In 2005, some 50,415 GWh of electricity was generated within the interconnected national power grid (Sistema Interconectado Nacional – SIN). That amounted to a 3.7 % increase over 2004. The major hydropower plants contributed 72 % (36,377 GWh) of the total, while small (mini and micro) hydroelectric facilities injected 9 %, gas-fired generators 14 % (6,980 GWh), and coal 4 % (2,086 GWh). Cogenerating plants and wind turbines in turn contributed 0.2 % and 0.1 %, respectively. Due primarily to favourable hydrological conditions and to the decommissioning of several conventional thermal power plants, the percentage share of hydropower-generated electricity was significantly higher in 2004 and 2005 than it had been in previous years.

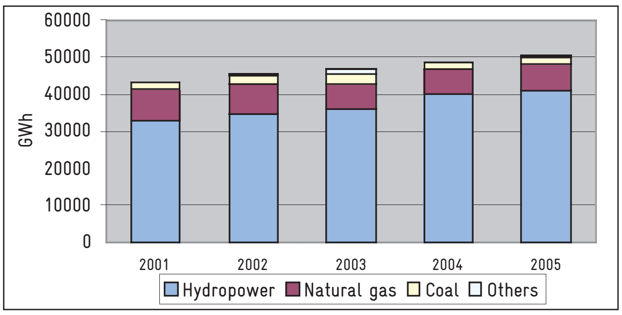

Fig. 2: Net power generation within the interconnected national grid, by primary energy source; Colombia; 2001–2005; GWh

1 Colombian statistics speak of effective net capacity. The mean daily availability of all on-grid power plants is actually lower by about 1,700 MW due to downtime for maintenance.
2 The numerical data for hydropower includes small, decentralised power plants (2005: 391 MW). The "Others" category includes combined heat and power (CHP) plants and autonomous generation facilities.
3 Colombia's dependence on hydropower, which still amounted to about 78 % in the early 1990s, has since decreased considerably.
4 In Colombian statistics, the term "small hydropower" is not particularly selective. As a rule, it encompasses all plants with ratings below 20 MW. On the other hand, the list of large-scale facilities includes one hydropower plant with a rating of only 5 MW.

Colombia is in the comfortable position of still being able to generate its electricity largely without need of imported raw materials. Colombia is South America's biggest producer and exporter of coal and is also a net exporter of oil, especially to the USA. In the medium term, though, Colombia is destined to become a net importer due to its limited reserves of natural gas and petroleum.

Power transmission

The national transmission network (Sistema de Transmisión Nacional – STN) consists of two grids, one serving the Atlantic coast in the north and the other serving the interior, with numerous interconnectors running between the two. The STN comprises three voltage levels (110 kV, 220 kV and 500 kV) and has a total length of some 15,000 km.[5] A new 500 kV transmission line put up by private investors between the Atlantic coast (Bolívar) and Bogotá – a distance of around 1,000 km – was commissioned in early 2007.

It ties into the Venezuelan transmission network, although the connection has hardly been made use of to date. Two new junction lines connecting Ecuador and Colombia went into service in 2003. They are constituents of an agreement between the five Andean countries (Bolivia, Colombia, Ecuador, Peru and Venezuela) which intend to integrate their respective electricity markets into a supraregional electricity market in the medium term. In 2005, most of the power carried by that line was being exported to Ecuador (4,570 GWh), while only a very small volume was imported (132 GWh).

Once again in 2005, the technical and non-technical power losses, at more than 23 %, were very high. Losses in the interconnected grid accounted for only 2.5 %, while all the rest occurred at the distribution level.

Power consumption

After a brief economic recession at the turn of the millennium, Colombia's power consumption has since risen continuously, reaching approx. 38.4 TWh in 2005. Also, according to present estimates, total demand now exceeds the power production capacity by some 10 TWh.

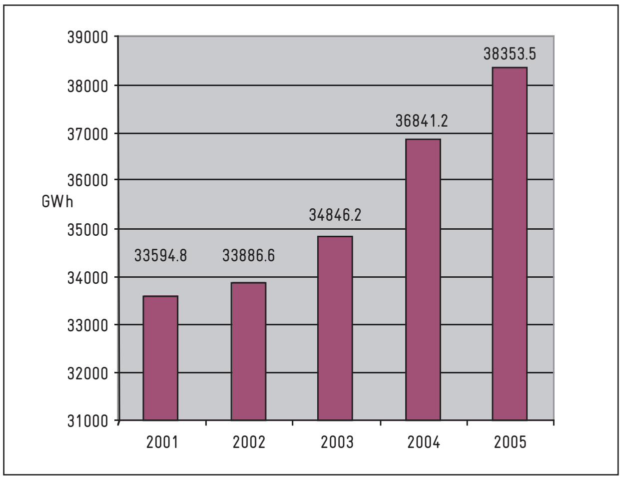

Fig. 3: Trend in power consumption 2001–2005; Colombia; GWh

Between 1999 and 2005 there was a downward trend in the proportion of consumption by private households, from 48 % to 42 % (Fig. 4).

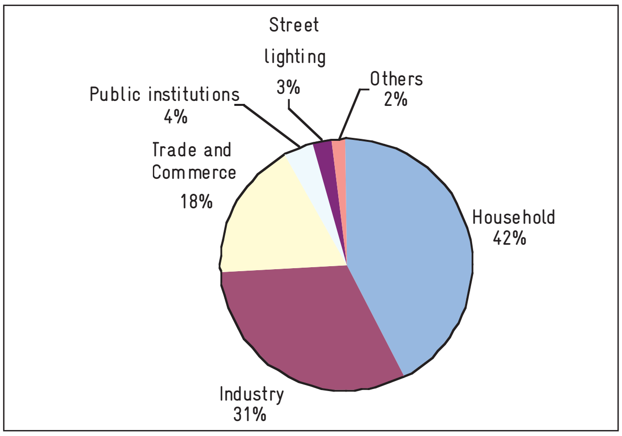

Fig. 4: Power consumption according to user group; Colombia; 2005;% [6]

5 The continental regions Amazonas, Antioquia, Arauca, Caquetá, Casanare, Cauca, Chocó, Guainía, Guaviare, Meta, Nariño, Putumayo, Vaupés, Vichada and the islands of San Andrés and Providencia are not connected to the public power grid.

6 Source: Comunidad Andina (CAN), 2004.

Peak load has been increasing by 2.7 % annually, on average, since 1999. While the interconnected grid system had available power totalling 11,000 MW in late 2005, peak load at that time amounted to only 8,638 MW (or 3.7 % more than the year before). That excess generating capacity, however, can quickly dwindle during dry spells. Hence, if demand keeps rising, supply bottlenecks cannot be ruled out.
An increase in power generating capacity to 67,365 GWh is predicted for the year 2014, at which time peak demand is expected to reach 12,085 MW.

Electricity prices

Electricity prices vary widely from one utility company to another. For example, the price span for private household consumption is 3.5-8.3 euro cent (98 to 230 pesos) per kWh; for industrial consumers, it ranges from 3.3 to 14.2 euro cent (92 to 394 pesos), while trade and commerce pay between 2.1 and 15.0 euro cent (58 to 417 pesos) per kWh. On average, the industrial tariffs are considerably higher than those found in practically any other Latin American country. The price fraction accounting for power generation was estimated at 1.9 euro cent per kWh in December 2003.

Expansion planning

According to the latest energy statistics dating from 2005, some 10,500 MW of additional power generating capacity is presently either under construction or at the planning stage – including approximately 1,230 MW from conventional thermal power plants (186 MW of which was already commissioned in 2006), 8,730 MW from large hydropower plants, and just under 470 MW from small and medium-size hydropower plants.

6.2 Market Actors

At the end of 2005, the actor structure on the Colombian electricity market presented itself as follows: 50 companies were active in the power-generating sector, and 55 % of all power-generating capacity was in private ownership. There were 74 electricity trading companies and 11 (regional and supraregional) transmission companies. A total of 75 regulated companies were involved in the interconnected national power grid (Sistema Interconectado Nacional – SIN), only three of which were completely vertically integrated, i.e. active at all levels (generation, transmission, distribution, sale): EEPPM, EPSA and ESSA.

Power producers

The main power producers are EEPPM, with approx. 2,600 MW of installed generating capacity, EMGESA, with roughly 2,250 MW, and ISAGEN with about 2,100 MW.

Transmission and distribution network operators

The supraregional transmission network Sistema de Transmisión Nacional (STN) is divided up between seven companies that emerged from the old power utilities in the course of the vertical disintegration process, including Interconexión Eléctrica S.A. (ISA), which owns about 70 % of the overall network.[7] Four of the companies (ISA, TRANSELECTRA, EEB and DISTASA) are only concerned with power transmission. The former central grid operator ISA, 59 % of which still belonged to the Government of Colombia in 2005, is responsible for coordinating, operating and managing the interconnected national grid. Some of the co-owners of STN also hold shares in ISA (for example Empresas Públicas de Medellín – EEPPM, with 10.6 %). The regional and local networks are allocated to the various distribution companies, in which power generators are allowed to hold up to 20 % capital interest.

7 The other owners are: Empresa de Energía de Bogotá – EEB, Corporación Eléctrica de la Costa Atlántica – CORELCA, Empresas Públicas de Medellín – EEPPM, Empresa de Energía del Pacífico – EPSA, Electrificadora de Santander – ESSA, Distasa S.A., Central Hidroeléctrica de Caldas – CHEC, Centrales, Eléctricas de Norte de Santander – CENS, Central Hidroeléctrica de Betania – CHB and Electrificadora de Boyacá – EBSA.

For a number of years now, the Colombian power sector has seen itself confronted with guerrilla attacks on its integrated power grid, and some substantial supply problems have resulted. In 2005 alone, 227 attacks on high-tension line towers were reported, and several electricity exporting regions were cut off from their consumer markets. The persistent problems affecting the supply of electricity have contributed to the fact that a number of planned privatisations have had to be temporarily postponed.

Other Actors

Regulatory commission

A national commission (Comisión de Regulación de Energía y Gas – CREG) was set up to regulate the electricity market. This body regulates the general conditions for the efficient supply of electricity, the step-by-step liberalisation of the electricity market, the standards to be applied to the wholesale market, free network access, the transmission and distribution charges, the tariffs for regulated end consumers, protection of the consumers' interests, and matters pertaining to the vertical disintegration of the electricity industry.

Planning unit at the Energy Ministry

Following the reform of the power sector, the state's tasks were essentially restricted to planning functions. The Unidad de Planeación Minero-Energética (UPME), organised within the Ministry of Mining and Industry, is responsible for analysing future energy requirements and the corresponding supply situations and for drawing up the National Energy Plan (Plan Energético Nacional) as well as the plan to expand the electricity sector (Plan de Expansión del Sector Eléctrico). However, this planning is now only of an analytical nature and is no longer a binding stipulation for the expansion projects.

6.3 Legal Framework

Restructuring

A sectoral reform was introduced with enactment of the Law on the Organisation of Public Services (Law no. 142, dated 11 July 1994, Régimen de Servicios Públicos Domiciliarios) and the Electricity Law (Law 143, dated 11 July 1994, Ley Eléctrica). The generation, transmission, distribution and marketing of electricity were separated, and the previous regional monopoly of utility companies was broken up. Free competition was introduced in areas where there is no natural monopoly, i.e. in the generation and marketing of electricity, while the other areas are still regulated and monitored by the state.

The operators of the interconnected grid system, the regional transmission companies (Sistema de Transmisión Regional – STR) and the local power distribution companies (Sistema de Distribución Local – SDL) therefore have to open their networks to every user and generator (non-discriminatory access).[8] Wide-ranging privatisation was also introduced, which has affected all areas of the electric power industry although the process has not yet been completed. Any economic player is free to build additional power generating capacity, as long as the framework of other legal provisions is adhered to.

Wholesale market

Generating companies whose plants supply power to the national interconnected grid system and have a capacity of at least 20 MW are obliged to participate in the wholesale market (Mercado de Energía Mayorista – MEM) that was established in 1995 (per Resolution CREG-054 of 1994).[9] The power generators must address hourly offers for the next day to the national dispatching centre in Medellin, where they are entered in the load distribution list in accordance with their quotations. There is no preferential treatment for certain types of power station in this process.

8 The conditions of access for power generating companies are set out in Resolution CREG-030 of 1996. General information on the legal requirements for regional power transmission companies and local distributors is given in Resolutions CREG-003 of 1994 and CREG-099 of 1997.

9 All electricity traders who supply electricity from the interconnected grid directly to end consumers are obliged to purchase the electricity via the MEM. Operators of plants with ratings between 10 and 20 MW can participate in the MEM voluntarily, while those with less than 10 MW generating capacity are automatically excluded from the MEM. Autonomous suppliers can use the interconnected grid to obtain replacement power or additional power. Operators of combined heat and power plants (cogenerating facilities) can supply themselves or others with electricity and heat for industrial or commercial purposes.

In order to prevent anyone from gaining a dominant position on the market, no electricity supplier is allowed to provide more than 20 % of the total generated quantity, including their capital involvement in other generating companies. Customers are not allowed to address offers directly to the pool. The pool operator compares the offers with the estimated demand as a basis for setting the hourly pool prices. Further distributors and large-scale consumers are allowed to enter into bilateral agreements with power generators, as long as the agreements are registered with the pool operator for invoicing purposes.

Power trading is based primarily on long-term agreements. The Colombian electricity bourse is characterised by uncertainty and widely fluctuating price situations resulting from the country's heavy dependence on hydropower and, in turn, the latter's dependence on sufficient precipitation. Hence, the average price of long-term agreements in dry years regularly drops below the bourse (pool) prices but climbs to above that level in times (years/months) of abundant rain. In 2005, for example, the mean price in bilateral agreements was 2.5 euro cent/kWh (71 pesos/kWh), while the average pool price was somewhat higher at 2.8 euro cent/kWh (76.5 pesos/kWh). On the other hand, the pool price during the wet month of June was only 2.1 euro cent/kWh (59.5 pesos/kWh), while the long-term contact price was situated at 2.5 euro cent/kWh (68.7 pesos/kWh).

Unregulated consumers

Since 1 January 2000, regulation has no longer been binding for end consumers with power requirements exceeding 100 kW or consumption of at least 55 MWh/month, who are therefore now allowed to enter into direct power supply contracts with power producers.

6.4 Policy Promoting Renewable Energy Sources

A development plan for alternative energies (Plan de Desarrollo Nacional de las Energías Alternativas) dating from 1995 proposed measures intended to help promote the use of renewable energy sources. In practice, however, these announcements did little more than pay lip service to the problem and had no discernible impact.

National energy plans

The National Energy Plan of 1997 (Plan Energético Nacional) underscored the importance of renewable energy while emphasising the fact that, thus far, only very inadequate use has been made of it, at least in connection with power generation. Nevertheless, the 1997 National Energy Plan assigned little more than a niche existence to renewable energy sources – with the exception of major hydropower stations – for urban and non-electrified fringe areas or rural and isolated settlements. That remained so in the 2003 National Energy Plan, too, in which the use of natural gas and coal is even more emphatically recommended than before, while the use of renewable energies is only recommended in connection with the further development of small-scale hydropower and pilot projects based on other renewables.

2001 law on the promotion of renewable energy sources

With Law no. 697, of 3 October 2001, the Colombian Government created a framework for promoting the use of renewable energy sources by instituting a programme for the rational use of energy and for the utilisation of renewable forms of energy (Programa de Uso Racional y Eficiente de la Energía y demás formas de Energía No Convencionales – PROURE) under the auspices of the Ministry of Mining and Energy. It is also intended to develop political guidelines and strategies along with instruments to promote non-conventional energy sources, with the main emphasis being placed on regions that do not have access to electricity. Companies that manufacture or import components for use in exploiting renewable energy sources were to receive special assistance.

The law was implemented by way Decree 3683 of 19 December 2003. A supra-institutional commission (CIURE) was set up, headed by MME, with its other members being the Ministry of the Environment and Foreign Trade, the regulatory authority CREG, the Colombian institute for the development of science and technology (Colciencias), the energy planning unit (UPME) and several other expressly invited institutions.

Tax exemptions

The first concrete assistance measure in connection with PROURE is a provision of Law 788, dated 27 December 2002, according to which the sale of electricity from wind energy, biomass or agricultural waste is to be exempted from income tax for 15 years, as long as the following criteria are satisfied: participation in CO_2 permit trading in accordance with the Kyoto Protocol, and reinvestment of at least 50% of revenues from the sale of permits in social projects situated within the area served by the utility. According to Article 95, imported plant and equipment for and to the benefit of CER trading is also to be exempted from value-added taxation.

Moreover, Law 818 and Decree 3172 of 2003 qualified as tax write-offs all investments that serve the cause of environmental protection. To qualify, however, the project developers must apply for an appropriate certificate from the Ministry of the Environment.

Electrification fund for off-grid regions

Law 633 (2000) and Decree 2884 (2001) already established a Support Fund for the Electrification of Non-interconnected Zones (FAZNI). Since July of 2003 the fund has been receiving one peso for each kilowatt hour of electricity that is sold on the interconnected grid. It also benefits electrification projects based on renewable energy resources, such as the installation of hydropower plants.

As yet there are no other incentive programmes in force that focus specifically on the use of renewable energy sources, and in particular any that would feed power into the interconnected grid, because the government is giving first preference to a competition-oriented policy in the development of the electricity industry.

Clean Development Mechanism

Colombia put the provisions of the Kyoto Protocol into national legislation with Law 629 on 30 November 2001. Since May 2002 the Designated National Authority (DNA) has been set up within the Ministry of the Environment, Housing and Territorial Development. In 2005, Resolutions 1812421 and 1812422 defined the greenhouse gas factors to be applied to renewable energy projects of various magnitude that feed into the interconnected national grid. One of the declared goals is to direct at least part of the investment in CDM projects toward schemes geared to improving rural electrification by the use of renewable energy resources, with one of the long-term targets being to replace the estimated quantity of more than 1,000 small diesel generators that are still in use as isolated sources of power in rural regions.

In addition to the Jepirachi wind power project[10], the CDM Executive Board has also registered three other hydropower projects: the Agua Fresca project in Departamento Antioquia, with a rating of 7.5 MW and an annual power output of 63.3 GWh; the Santa Ana project, which is to be integrated into the Bogotá potable water supply system and will provide 13.4 MW; and a pair of facilities on the La Herradura River, also in Departamento Antioquia, with respective ratings of 19.8 and 11.7 MW.

10 See section on "Wind energy"

6.5 Status of Renewable Energy Sources

Apart from the use of hydropower, even on a relatively small scale, the penetration of technologies based on renewable energy, including for the electrification of rural regions, remains considerably lower in Colombia than in other Latin American countries. The government's lack of financial leeway has been a contributing factor to this situation, as has the central authority's partial lack of control over large rural areas of the country.

Statistical records on the use of renewable energy in isolated networks and for autonomous supply are broadly lacking, so no precise details of the extent to which the corresponding technologies are in use can be given here. On the other hand, the National Energy Plan of 2003 does contain at least a brief assessment of the renewable energy sources available for use in Colombia. The following information is based in part on that assessment.

Hydropower

Thanks to geography and ample annual precipitation in large parts of the country, Colombia enjoys good prerequisites for hydroelectric power. In early 2007, UPME and the national meteorological institute IDEAM[11] jointly produced a first atlas of hydro energy resources.

In 2005, hydroelectric power was by far the most important source of energy in the field of electricity generation, both in terms of installed capacity (67 %) and as regards power production (82 %). The use of hydropower for generating electricity in Colombia dates back to about 1920, when it was first employed as a means of supplying electricity to villages along the Atlantic coast. By the 1960s, most large, inland communities had begun to meet their demand for electricity by installing and operating their own mini-hydropower plants.

The oldest hydropower plant contributing to the interconnected national grid dates from 1957. Beginning in the 1960s, numerous large-scale projects were implemented, often with profound social and ecological impacts, and a need for foreign capital. This, coupled with the progressive connection of towns and cities to the interconnected power grid, led to the decommissioning of most small hydropower plants, because they were no longer profitable. The largest plant of all, the 1,240 MW San Carlos hydropower station in the province of Antioquia, was commissioned in 1988. Three more large-scale facilities with ratings ranging from 344 to 411 MW have been added since the beginning of the present decade.

The fact that the power sector accounts for a large share of Colombia's foreign debt, coupled with increased costs of electricity transmission and distribution and greater efforts to broaden rural electrification, has led to the revitalisation of small-scale hydropower now being targeted.[12] At the end of 2005, almost 400 MW of generating capacity was connected to the interconnected grid, distributed between over 70 different generating stations.

Wind energy

In 2006, UPME and the meteorological institute IDEAM presented their first wind atlas based on long-term meterological observations at more than 200 reference locations. Colombia enjoys good to very good regional wind conditions. The La Guajira peninsula in the extreme north of the country, where mean wind velocities of up to 11 m/s prevail at a height of 10 m, is regarded as Colombia's most attractive wind region. The coastal strip southwest of La Guajira, in the Departamentos Magdalena and Atlántico, also has some good locations to offer for the harnessing of wind power. Likewise, mountainous regions in the Departamentos César, Norte de Santander and Santander, as well as the Caribbean islands of San Andrés and Providencia, also have good wind regimes.

11 Instituto de Hidrología, Meteorología y Estudios Ambientales.
12 Below 20 MW.

Colombia's only wind power project to have been completed to date is the Jepírachi project by the generating and supply company Empresas Públicas de Medellín (EEPPM) in the Alta Guajira region on the Caribbean coast, which was implemented with support from the GTZ. The site is located near the coal port Puerto Bolívar and therefore has access to the national high voltage grid. EEPPM is presently investigating the possibility of building another wind farm of approximately the same size just a short distance from the first site.

Jepírachi wind power project

The Jepírachi wind farm entered service in December 2003. It is rated at 19.5 MW (comprising 15 N 60 turbines from the German company Nordex). Based on a power factor of 40 %, the annual yield was expected to be 68 GWh, calculated on the basis of mean measured wind speeds of close to 10 m/s at a height of 50 m. However, the farm delivered only somewhat less than 52 GWh in 2004 and a mere 49.5 GWh in 2005. Due to technical problems stemming from high temperatures and unstable network conditions, the generators' availability was substantially curtailed at times.

EEPPM invested US$ 27.8 million to build the wind farm. The World Bank is contributing US$ 3.2 million to the project within the framework of the Prototype Carbon Fund (PCF) in order to achieve the 800,000-tonne CO_2 emission reduction target by 2012.[13] The subsidy is being paid out in regular instalments subject to the presentation of tradable emission permits to PCF by EEPPM in accordance with the Clean Development Mechanism. Despite the good wind conditions, the cost of power generation is estimated at about US$ 49 per MWh, partly because the tie-in to the grid requires a trunk feeder with a length of 8 km. In order to enable cost-effective operation of the wind farm, Colombia's institute for the development of science and technology COLCIENCIAS recognised it as a 'technical innovation project', thus allowing EEPPM to deduct the initial investment from its taxable gains.

GTZ activities within the scope of the TERNA programme

Preparations for a wind farm project were supported by GTZ within the framework of the TERNA programme, with planning commencing in 1998. From May 2000, EEPPM operated a wind monitoring station near the intended site. After three years of monitoring, an exploitable wind potential of about 5 GW was determined for the Guajira region. GTZ helped EEPPM select the site, perform the wind measurements and evaluate the technical and financial possibilities via wind-yield and feasibility studies. In addition, GTZ advised EEPPM in connection with drafting and evaluating the tendering documents for the wind farm. The first turbines were commissioned in December 2003; ultimately the wind farm is to have a capacity of 19.5 MW.

Biomass

Colombia is rich in biomass resources that could be exploited for energy-generating purposes, although no systematic identification of these potential resources has yet taken place. UPME, IDEAM and COLCIENCIAS are planning to devise an initial atlas for quantifying biomass energy potentials in 2007/08.

The (documented) contribution of biomass to the generation of electricity in Colombia has been very small to date. The main raw material for such applications is bagasse, from sugar cane, usually for use as fuel in combined heat and power facilities. The cumulative output of all such plants amounts to approximately 25 MW. If the biomass used as a supplementary fuel in power generation (for example bagasse in coal-fired power plants) is included, the overall capacity increases to about 100 MW. In addition, various agro-industrial residues such as marc or the husks of rice and other grains are used for heat-generating purposes.

13 In this respect, UPME and Colombia's Ministry of the Environment performed the necessary calculations for the sale of tradable emission permits and submitted them to PCF, which subsequently approved both the employed method of calculation and the resultant reduction volumes.

Solar energy

In 2005 UPME and the meteorological institute presented their newly revised solar atlas, which had first been published in 1993. According to the atlas, Colombia enjoys excellent solar irradiation conditions, experiencing levels of 4.0-4.25 kW/m^2d in the south-westerly regions and along the Pacific coast, and 5.5-5.75 kWh/m^2d in the Guajira region. This corresponds to between 58 % and 84 % of the insolation levels that are recorded in Saudi Arabia, the country with the highest solar irradiation levels in the world. Nevertheless, the use of solar energy for obtaining electricity from solar home systems or for heating water with the aid of solar collectors has remained marginal, even in remote areas.

According to the National Energy Plan of 2003, only around 2 MW of photovoltaic capacity is in place in Colombia. A sizeable photovoltaic facility used for supplying electricity to a small settlement (including a school and a health centre) was installed in the Vichada district in 1995. Then, in October 2003, the power utility Empresa Antioqueña de Energía S.A. (EADE), a subsidiary of Empresas Públicas de Medellín (EEPPM), launched a competitive contracting programme for 60 small photovoltaic systems for village schools situated within in its own service area. Each such system was available for purchase for 500,000 pesos (roughly EUR 156). Above all EADE intended this measure to help stimulate interest in solar home systems.

Geothermal energy

Despite several preliminary studies on the use of geothermal energy over the past 35 years and initial exploratory drilling performed by Geoenergía Andina S.A. (GESA) in 1997, Colombia's geothermal potential is still largely untapped, mainly because other domestic sources of energy, coal in particular, have been so plentiful. The only instance of any geothermal resource being put to use at all in Colombia at the present time is the use of hot spring water for heating medicinal baths.

6.6 Rural Electrification

Within the interconnected zones (zonas interconectadas), some 90 % of all electricity users are already connected, and close to 100 % is being targeted for the year 2019. In off-grid regions (zonas no interconectadas – ZNI) the electrification level is presently 75.5 %.

In 1999 the Ministry of Mining and Energy initiated the implementation of 93 rural electrification projects via the Institute for the Investigation and Application of Energy Solutions for Off-grid Regions (Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas No Interconectadas – IPSE).[14] These projects concentrate on the expansion of existing networks and the establishment of stand-alone solutions, mainly through the installation of diesel generators.

In the meantime, the PROURE programme appears to be engendering intensified interest in the use of renewable energy sources for rural electrification purposes, too, but the implementation process remains sluggish.

Exchange rate (February 2007):
100 Colombian pesos (COP) = 0.03605 euro (EUR)
1 EUR = 2.774 COP

14 See www.ipse.gov.co.

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7 Mexico

7.1 Electricity Market

Installed capacity

The total capacity of all power producers in Mexico (including for export) at the end of 2005 amounted to 53,858 MW (+0.6 % over the preceding year). The state utility companies Comisión Federal de Electricidad (CFE) and Luz y Fuerza del Centro (LFC) accounted for roughly 70 % and 1.6 % respectively (together 38,247 MW), independent power producers about 15 %, self-generators and combined heat and power stations[1] 11 % (together 7,236 MW), and export 2.5 %.

Public supply

The generating capacity for public supply (not including self-generation and combined heat and power but including independent power producers contracted by the state utilities) at the end of 2005 came to 46,534 MW, distributed between 192 power station locations. Independent power producers with power purchase agreements contributed almost 18 % to this (8,287 MW, entirely made up of combined-cycle power plants). Generating facilities were made up of the following types: 23 % hydropower stations, 28 % gas-fired combined-cycle power stations, 47 % other thermal power stations and 2 % geothermal energy and wind power taken together. In 2005 the total capacity fell slightly compared with the previous year. Peak load in the national integrated public grid system (SIN[2]) in 2005 amounted to 31,268 MW.

	2001	2002	2003	2004	2005
Steam power plants	14,283	14,283	14,283	13,983	12,935
Combined-cycle power plants	5,188	7,343	10,604	12,401	13,256
Gas turbines	2,381	2,890	2,890	2,818	2,599
Diesel generators	143	144	143	153	182
CHP stations	2,100	2,100	2,100	2,100	2,100
Hydropower	9,619	9,608	9,608	10,530	10,536
Geothermal	838	843	960	960	960
Wind power	2	2	2	2	2
Nuclear power	1,365	1,365	1,365	1,365	1,365
Coal	2,600	2,600	2,600	2,600	2,600
Total	**38,519**	**41,178**	**44,554**	**46,552**	**46,534**

Tab 1: Generating capacity – public power supply in Mexico (CFE, LFC and independent power producers); 2001-2005; MW[3]

Capacity growth in recent years has been due primarily to the entry onto the market of independent generating companies, which are almost entirely foreign-owned.

Power generation

Total power generation amounted to 248.0 TWh in 2005. The utility companies CFE and LFC contributed 69.2 % to this, the independent power producers 19.1 %, self-generators 5.8 %, industrial CHP plants 2.9 %, export 2.5 % and autoproducers with old contracts (usos propios continuos) 0.6 %.

1 Combined heat and power stations are also generally used for self-generation or for the direct supply of electricity and heat to industrial users, particularly in the oil industry, but they are recorded in separate statistics.
2 SIN = Sistema Interconectado Nacional, interconnected system without the independent grids on Baja California (peak loads 1,909 MW in 2005), Baja California Sur (264 MW) and isolated grids (24 MW).
3 Source: SENER, Balance nacional de energía 2005, México D.F. 2006.

Gross electrical power generation in the public sector in 2005 totalled 219.0 TWh (a rise of 5.0 % over the preceding year), of which 71 % was supplied by fossil-fuelled power plants. 21.6 % (47.4 TWh) was provided by independent power producers (compared with only 0.6 % in 2000). Gross generation from power plants belonging to CFE and LFC amounted to almost 171.7 TWh in 2005. The proportion of electricity generated by gas-fired combined-cycle power plants in particular has increased substantially in recent years (from 9 % in 2000 to more than 33 % in 2005) and will continue to grow in the coming years. According to the latest expansion plan, however, the aim is to try to limit the share of gas in generation capacity to 50 %.

Power transmission and distribution

The high voltage power transmission grid (> 150 kV) belonging to CFE spanned almost 46,700 km at the end of March 2006. The entire transmission grid together with the distribution grid is 96 %-owned by CFE, with 4 % being the responsibility of LFC. The grids in the provinces of Baja California and Baja California Sur are not linked to the national interconnected grid. There are also a few other isolated grids in operation in remote regions.

	2002		2003		2004		2005	
	GWh	%	GWh	%	GWh	%	GWh	%
Steam power plants	79,820	39.7	74,501	36.6	66,346	31.8	65,111	29.7
Combined-cycle power plants	44,836	22.3	54,960	27.0	72,396	34.7	73,381	33.5
Gas turbines	6,434	3.2	6,921	3.4	2,712	1.3	1,385	0.6
Engines	0	0	0	0	626	0.3	780	0.4
CHP stations	13,873	6.9	13,842	6.8	7,928	3.8	14,275	6.5
Hydropower							27,609	12.6
Geothermal	30,360	15.1	26,055	12.8	31,504	15.1	7,299	3.3
Wind power							5	0.0
Nuclear power	9,651	4.8	10,585	5.2	9,180	4.4	10,805	4.9
Coal	16,085	8.0	16,692	8.2	17,943	8.6	18,380	8.4
Total	**201,059**	**100.0**	**203,555**	**100.0**	**208,634**	100.0	**219,000**	**100.0**

Tab 2: Gross power generation for public supply; Mexico; GWh, %; 2002-2005

Losses

Losses in transmission and distribution are heavy; taken together, these losses reached 17.8 % in 2005. Losses for LFC's distribution network in 2005 are stated as having been over 30 %. Non-technical losses are likely to have made up a particularly large part of this.

Electricity exports and imports

Electricity is exchanged via several links with the US states of California, Texas and Arizona in the north and via a link with Belize in the south. A further link to Guatemala has been planned but so far not completed. Electricity trading achieved an appreciable surplus in 2005, with exports of almost 1,300 GWh and only relatively modest imports (93 GWh). Since 2000 electricity imports have declined significantly, while at the same time exports have grown to the same degree.

Electricity consumption

Including self-generation, total national electricity consumption in 2005 was 191.3 TWh, and thus 4 % higher than the previous year. CFE and LFC together sold about 169.8 TWh of electricity in 2005. The average annual rise in electricity consumption (public supply) from 1995 to 2005 amounted to 4.7 %, clearly above the average growth in gross domestic product of 2.7 %. Since 2000, however, rises in electricity consumption have been more restrained. While the 25.5 million or so private households accounted for a quarter of power demand in 2005, almost 60 % of electricity went to meet the consumption of only 181,000 industrial customers,[4] nearly 8 % to the commercial sector and about 5 % to agriculture.

	Customers	Electricity sales		Average consumption	Average prices
	Number [thousands]	TWh	%	kWh/ customer	€ cents/ kWh
Households	c. 25,500	42.5	25.0	1,670	6.4
Commerce	3,056	13.0	7.7	4,250	10.2
Services	158	6.4	3.8	40,500	14.6
Agriculture	107	8.1	4.8	75,700	3.1
Medium-scale industry	181	61.9	36.5	551,000	7.5
Large-scale industry		37.8	22.3		5.4
Total	**c. 29,000**	**169.8**	**100.0**	**5,855**	**7.0**

Tab 3: Electricity consumption and average prices for public supply; Mexico; 2005; TWh; %; euro cents/kWh[5]

A further 21.6 TWh of electricity was produced and consumed by self-generators in 2005.

Electricity prices

Electricity tariffs for final customers are set by the Secretariat of Economy (economics ministry) and adjusted monthly for inflation and changes in fuel prices. In mid-2005 they averaged the equivalent of 7.0 euro cents/kWh. In the course of 2006 the tariffs were raised considerably for all consumption sectors apart from households, agriculture and large-scale industry. In the commercial sector, where the highest electricity prices are charged, they already averaged over 20 euro cents/kWh in October 2006.

Households with low consumption and agriculture (irrigation) enjoy concessionary rates. Household tariffs are graded progressively and vary according to consumer zone and climatic zone. In 2005 they averaged 6.5 euro cents/kWh. In industrial consumption, the average price for which is almost identical to that for households, different tariffs are charged depending on the region. There are also different charges for power consumption at different times in the course of the day, and these differ in turn by region. No tariffs are set for off-grid regions with their own independent electricity supply.

4 The growing proportion of self-generation is also added to this segment.
5 Source of data: CFE, SENER.

Altogether, tariff income is still insufficient for cost recovery despite the adjustments, with the consequence that the power sector is heavily subsidised from government funds; this primarily benefits poorer sections of the population and people living in rural areas. Despite tariff rises, the cost recovery ratio for households in 2002 for example came to only 50 % for CFE and as little as 34 % for LFC. In 2005 the income received by CFE and LFC together covered only 67 % of the generating costs. To compensate for this, in the same year some € 6.5 billion (93 billion pesos) was paid from the national budget in the form of subsidies, two thirds of which had to be used to make up the deficits caused by the low household tariffs.

Expansion planning

The Secretariat of Energy (energy ministry) forecasts average annual rates of increase in national power demand between 2005 and 2015 of 4.8 %, in other words rising from 191.3 TWh[6] in 2005 to 304.7 TWh in 2015, of which 279 TWh will be for public supply. To keep step with this development, power generating capacity for public supply would have to increase by about 20 GW in the same period or by almost 40 % compared with 2005, to 66,600 MW in 2015. In order to meet this extra demand and as a replacement for power station closures, an additional 24 GW of capacity would have to be built within the planning period, including among others more than 11,000 MW in combined-cycle power stations and some 2,400 MW in hydropower plants.[7] Part of the plan for additional capacity also includes six wind farms in Oaxaca with a total capacity of about 600 MW.

7.2 Market Actors

Power utilities CFE and LFC

Since nationalisation in 1960 almost the entire power sector in Mexico has been dominated by the state providers Comisión Federal de Electricidad (CFE), which presently has towards 24 million customers, and Luz y Fuerza del Centro (LFC), serving over 5 million customers (2005). CFE and LFC either own the power stations themselves or conclude longer-term power purchase agreements with private operators. In the last ten years, industrial consumers in particular have also installed generating plant to meet their own needs.

CFE meets approximately 92 % of aggregate national power demand;[8] LFC – with most of its customers in the capital – accounts for less than 1 %. At the end of September 2006 CFE had a capacity of 46,672 MW (including independent suppliers).[9] LFC had just under 880 MW of generating capacity at its disposal in April 2006 (281 MW in hydropower, 224 MW in thermal power stations, 374 MW in gas turbines), but it supplies more than one sixth of all electricity customers in the country in Mexico City and its surrounding regions. The requisite additional power is purchased from CFE.

Besides the two state suppliers, which are vertically integrated, and the independent power producers, which solely serve the purpose of public supply for CFE, other actors on the Mexican electricity market are engaged only in auto-generation for supplying outlying municipalities and for export. A large proportion of the power generated by other producers is accounted for by the state-owned petroleum company Petróleos Mexicanos (Pemex), with about 4 % of all electricity production,[10] and private producers (3 %).

6 Public supply and self-generation..

7 Mexico's energy policy foresees further conversion of numerous power stations from petroleum to natural gas. New capacity will largely be operated with natural gas. By current forecasts, the share of natural gas in total electricity generation will increase to 52 % by 2010. Added to this is an increase of approximately 4,300 MW from self-generators and cogeneration of heat and power.

8 Gross power generation in 2005 totalled 215.6 TWh, including supplies from independent producers.

9 Independent power producers accounted for 9,266 MW of this.

10 Pemex alone has an installed power station capacity of 2,100 MW.

Other Actors

Government institutions

The guidelines on energy policy and future strategies and projections for the power sector are drawn up by the Secretariat of Energy (Secretaría de Energía – SENER), which also oversees tariff policy. Specific expansion plans for the electricity sector are drafted for implementation by CFE, which is answerable to the Secretariat.

All electricity generating facilities belonging to self-generators and independent producers must be approved by the regulatory authority for energy (Comisión Reguladora de Energía – CRE), which is subordinate to the Secretariat of Energy and is also responsible for the gas sector.[11] By the end of 2005 CRE had granted 494 power generation licenses all in all, covering a total of 21,733 MW. Of these, 463 plants (almost 94%) were in operation, with a total output of 16,800 MW. Output and power generation by self-generators and independent producers in 2005 accounted for almost 44% of the figures quoted for CFE and LFC, underlining the importance of this sector for the Mexican electricity supply industry.

Key research work and studies are conducted by the Instituto de Investigaciones Eléctricas (IIE) in the Division de Energías Alternas, which has a subdivision for geothermal energy (Gerencia de Geotermia) and one for non-conventional forms of energy (Gerencia de Energías No Convencionales). The latter is concerned primarily with wind energy, biomass use and rural electrification using photovoltaic technology.

7.3 Legal Framework

The amendment of the law on public power supply of 1992 and the related regulations confirmed the sole right of state enterprises to supply electricity.[12] The right to transmit and distribute electricity and to sell electricity to final consumers is exclusively reserved for the two state suppliers.

Private sector participation

For the first time, the amendment permitted the private sector to invest in power generation, in the wake of a substantial decline in public investment in the power sector at the end of the 1980s. Private enterprises are therefore able to engage in the following activities: self-generation, cogeneration of electricity and heat,[13] operation as small producers (≤ 30 MW) or as independent power producers,[14] supplying remote municipalities where power demand is less than 1 MW (see section headed Rural Electrification), the export of electricity and the import of electricity for their own use.

Since 2000 it has also been possible for independent power producers to run publicly financed power stations and to build and operate privately financed power stations on condition that these are used exclusively for public supply. As a result, considerable investment from the private sector has been successfully mobilised in recent years. By mid-2006 there were already 19 power stations being operated by independent producers.

All plans to expand CFE's supply capacity must be approved by the Secretariat of Energy. It can issue directives for a call to tender to include independent power producers with a minimum capacity of 30 MW. Power purchase agreements concluded in the course of tendering procedures are for terms of 20 to 25 years.

11 The tasks are defined in the Ley de la Comisión Reguladora de Energía of 31 October 1995 (most recently amended version of 23 January 1998).
12 Ley del Servicio Público de Energía Eléctrica, Diario Oficial de la Federación de 23 de Diciembre de 1992; Reglamento de la Ley del Servicio Público de Energía Eléctrica, Diario Oficial de la Federación de 31 de Mayo de 1993.
13 Cogeneration of power and heat is mainly employed in the Mexican petroleum industry.
14 Only plants rated at more than 30 MW which generate power solely for sale to CFE or for export are classified as independent power producers.

Autogeneration and small producers

Industrial, commercial and municipal autogeneration or self-generation by private power producers is also permitted. In every case, however, the power purchaser (i.e. a municipality, for example) must have at least a pro forma involvement in the company generating the power. It is also possible to make use of the public transmission grid if the generation location is some distance away from the place of consumption. A number of enterprises can also found a joint subsidiary for the purposes of self-generation. Optionally, any electricity not used for the producer's own purposes at the time of generation can be sold to CFE at 85 % of the short-term marginal costs of the most efficient generating unit or be fed into a virtual store, with the same amount being obtained from CFE at a later time when needed. In recent years there has been considerable growth in autogeneration in the service sector in particular.

CFE is the sole buyer of surplus electricity. Conversely, the self-generators are obliged to purchase power reserves from CFE in the event of failure of their plant.

Under new provisions from May 2001, self-generators with capacity above 40 MW are entitled to feed the power produced from up to 50 % of their capacity into the public grid. Operators with less than 40 MW can provide up to 20 MW for public supply.[15] CFE must purchase electricity at 85 % of the short-term marginal costs of the most efficient generating unit in the system. Once the generation license has been obtained, the plant operator can conclude a grid access agreement with CFE, for which a set of regulations was drawn up in 2001 (Resolution 140/2001).

Small producers sell their electricity solely to CFE or LFC and receive no reimbursement for assured delivery. Small producers with a capacity of up to 1 MW can also supply power to isolated grids.[16]

Participation of foreign companies

Foreign companies can acquire 100 % ownership in the segments of the power sector that do not belong directly to public power supply. For more than 49 %, though, approval must be obtained from the Comisión Nacional de Inversiones Extranjeras (National Commission for Foreign Investments).

Further reform of the electricity sector

There is agreement that the capital for further expansion of the power sector can only be raised with the help of the private sector. A set of legislation to reform the power sector and open the market wider for private electricity generation was tabled to the Senate by the government in August 2002. The restructuring focussed on the creation of a wholesale market and the separation (unbundling) of transmission and distribution. The tasks of the regulatory authority were also supposed to be reorganised in this connection. CFE was to be converted into a holding company and essentially assume responsibility for the transmission grid and the remaining power stations, while serious consideration was given to licensing private concessionaires at the distribution level as well.

However, the programme met with considerable resistance in Congress and proved impossible to implement during President Fox's term in office (through to 2006), even though privatisation of the two state-owned utility companies had been expressly ruled out. In particular there are fears of growing foreign dominance in the electricity market.[17] It remains to be seen to what extent the new government under Felipe Calderón, which has been in office since December 2006 for a term of six years, will be able to push through significant changes in the power sector.

15 See Diario Oficial de La Federación of 24 May 2001 and the press release of the Secretariat of Energy dated 17 June 2001.

16 Small producers were classified separately to stimulate the use of renewable energies in particular. Due to the otherwise unfavourable parameters however, this expectation proved to be mistaken.

17 Even the involvement of foreign independent power producers is met with considerable political resistance in some cases.

7.4 Policy Promoting Renewable Energy Sources

A lack of priority status for non-conventional, renewable forms of energy and the absence of any separate regulations have hampered the widespread use of renewable energy in the past. Major constraints in this respect are the monopolistic position of the state suppliers and the statutory obligation to purchase or produce at minimum costs and if possible only from 'secure' generating sources. Due to ill-defined or absent provisions in building and planning legislation and lack of experience on the part of authorities and developers, larger projects failed to get off the ground. The prices offered did not usually permit economical operation, particularly as it had to be expected that deductions would be made for non-secured power delivery.

Since the beginning of 2005 there has been the possibility of accelerated depreciation of up to one hundred per cent in the first year for investment in renewable energy projects. The plants must remain in operation for at least five years and serve productive purposes.[18]

As well as that, at the end of 2005 a law on renewable energy[19] was adopted in the lower house of Congress (Cámera de Diputados), although that had not yet been approved by the Senate in the last legislative period. The central thrust of this law is that by 2012 renewable energy sources, not including large-scale hydropower, must contribute at least 8% to electricity generation. In order to achieve this it is envisaged that priority will be given to feeding electricity from such sources into the grid. Over and above that it is intended to set up a special financing mechanism ('Fondo Verde') through which an additional production bonus (in addition to the avoided costs) is to be made available from the national budget for mature energy technologies.

In parallel with this law a proposed law on the promotion of bioenergy[20] (primarily biofuels) was introduced to Congress; its provisions partly overlap with the regulations described above. This legislative programme, which is principally concerned with the promotion of agriculture through the introduction of biofuels, was finally adopted at the end of April 2007.[21] The extent to which the general law on renewable energy sources (LAFRE) will be adopted in the autumn of 2007 will depend on whether agreement can be reached in Congress on the necessary amendments to eliminate the overlaps with the law on the promotion of bioenergy.

COFER

In support of government policy, an advisory board on the use of renewable energy sources was set up in 1997 (Consejo Consultivo para el Fomento de las Energías Renovables – COFER) with members from all the major government and non-governmental institutions. The advisory board is overseen and coordinated by the National Commission for Energy Savings founded in 1989 (Comisión Nacional para El Ahorro de Energía – CONAE) in conjunction with the National Association for Solar Energy (ANES). As well as holding regular working sessions, the advisory board has appointed various specialist teams on individual topics.

18 Diario Oficial de la Federación, 1° de diciembre 2004: Modificación al Artículo 40, Fracción XII de la Ley de Impuesto sobre la Renta.
19 Ley para el Aprovechamiento de las Fuentes Renovables de Energía (LAFRE).
20 Ley para el desarrollo y promoción de los bioenergéticos.
21 Gaceta Parlamentaria, Cámara de Diputados, número 2241-II, jueves 26 de abril de 2007.

Provisions for intermittent electricity from renewable energy

In September 2001 the regulatory authority CRE published special rules on setting transmission charges and other specific issues relating to feeding and transmitting intermittent electricity from renewable forms of energy (hydropower, solar and wind energy).[22]
They require CFE to:

- give priority to feeding the electricity generated from these forms of energy into its grid
- grant discounts for electricity transmission and grid connection of between 50 % and 70 % for operators of plants with a capacity of more than 500 kW
- supply self-generators with the same quantity of electricity at another time if the power fed into the grid is not needed immediately

These rules were used as a basis for devising standard contracts for agreements for connection to the grid between suppliers feeding into the grid and CFE. In early 2006 the regulatory authority put forward new draft contracts according to which even in the case of intermittent infeed payment is made not only for energy but also for demand, on the basis of the monthly average of the energy supplied at peak load time.

Current and medium-term development of renewable energy sources

As part of its national development strategy, the government published a sector paper at the beginning of 2002 on developing the Mexican energy market in the period up to 2006.[23] To attain the set aims, this paper calls for the creation of an annual programme to promote renewable energies, amendment of the legislative framework and the establishment of a national development fund. The sector plan for the current legislative period will be available on the SENER website at the end of 2007.

The target up to 2006 was to double the use of renewable energy in the power sector as compared with 2000. Non-conventional renewable energy was supposed to contribute to the CFE expansion plan with a total capacity of 1,000 MW, in addition to the 1,776 MW to come mostly from large hydropower stations that were already scheduled as power generating capacity from renewable energies. However, it proved impossible to achieve these targets within the specified timeframe. The contribution from renewable energy sources (given comparable hydrological conditions) is likely to have barely changed in 2006 vis-à-vis 2002.

Projects with international assistance

GEF project to promote wind energy

A GEF project to support the objectives in the wind power sector entitled Action Plan for Removing Barriers to the Full-Scale Implementation of Wind Power in Mexico, Phase I, has been in progress since the beginning of 2004. The project comprises revision of the regulatory framework, training of decision-makers and technical personnel by setting up a regional wind technology centre in Oaxaca including a test bed, continuing assessment of wind resources, and the compilation of feasibility studies to prepare for three commercial wind farms of 15 to 20 MW. The assistance from the GEF amounts to US $ 4.7 million. Considerable delays in the acquisition of land for the test bed are the reason why the wind centre is not likely to commence operation until the third quarter of 2007.

The implementation phase of a major GEF-assisted project entitled Large-Scale Renewable Energy Development Project began in early 2007. The project aims to develop tender schemes for large-scale projects designed to generate electricity from renewable energy sources that will be run by independent producers, and to set up a fund to subsidise the power generated over an initial period of five years.

22 Resolution RES/140/2001.
23 Programa Sectorial de Energía 2001-2006.

In the first phase a US$ 25-million wind energy project with a generating capacity of about 100 MW (La Venta III) is to be brought to fruition by an independent power producer.

It is expected that the envisaged subsidy of 1.1 US cents/kWh in Phase I (totalling US$ 20.4 million) can be reduced to about 0.8 US cents/kWh in the subsequent phase, for which a further US$ 45 million are earmarked. In the first phase the project is supposed to focus on the wind power project described above and then also include small hydropower and biomass in the further course of the project.

GTZ project to promote renewable energy sources

Since April 2005 GTZ has been supporting the Government of Mexico with a project to promote renewable forms of energy (PROMOVER) involving the establishment of an efficient and self-sustaining market for renewable energy. This entails cooperation with actors in the public sector, particularly at the federal level, but also with the private sector. Cooperation focuses on the following lines of action:

- development of policies and strategies (with the initial priority on biofuels)
- consultancy on the legislative and regulatory framework
- market and project development (initially focussing on solar thermal water heating)

The project is primarily cooperating with the Secretariat of Energy (SENER), the regulatory authority for energy (CRE), the national energy saving commission (CONAE) and the Secretariat of the Environment (SEMARNAT). In all activities, close cooperation will be sought with companies in German and European industry in order to involve them directly in these newly emerging markets. Phase one of the project will run until March 2009.[24]

Clean Development Mechanism

Mexico joined the Framework Convention on Climate Change in 1994 and ratified the Kyoto Protocol in September 2000. The prerequisites are therefore in place for it to participate in the Clean Development Mechanism (CDM).

Along with Chile and Brazil, Mexico is one of the most promising locations for CDM projects in Latin America. Because of the high carbon intensity, the Mexican baseline (CO_2 emissions using conventional technology) is favourable for renewable energy projects with electricity generation.[25] According to estimates by the Instituto Nacional de Ecología (INE), Mexico's emissions reduction potential for the period 2008 to 2012 amounts to some 81 million tonnes of CO_2 per year. By mid-December 2006, in other words within just one year, there were already 61 projects in the field of renewables registered with the UNFCCC, as many as 34 of which were similar schemes designed to utilise biogas on pig farms.

The Designated National Authority (DNA) is subordinate to the Secretariat of the Environment SEMARNAT[26] and is made up of representatives from five ministries (Comisión Intersecretarial de Cambio Climático, formed in April 2005). Its most important tasks are taken care of by a committee (COMEGEI[27]), which answers to the DNA and was constituted in advance, in January 2004. Regulations governing the procedures for gaining the approval required at the national level for CDM projects (Carta de Aprobación) were laid down and published in October 2005.[28]

As a parallel body to this structure a Comité de Cambio Climático was set up in the Secretariat of Energy (SENER), to which all significant authorities, institutes and enterprises in the energy sector belong, as well as SENER. The committee sees itself as a coordination point between SENER and SEMARNAT for the analysis, definition and monitoring of activities and policies relating to climate change and CDM in the country's power industry. It is also meant to generate CDM projects itself.

24 For more details see also www.gtz.org.mx./bcs/index.htm.
25 Average emissions for the public interconnected power network come to approximately 550 kg CO_2/MWh.
26 Secretaría de Medio Ambiente y Recursos Naturales.
27 Comité Mexicano para Proyectos de Reducción de Emisiones y de Captura de Gases de Efecto invernadora.
28 Diario Oficial, 27 octubre 2005, pp. 42–45.

As yet there are still no specific tax-based incentive mechanisms for CDM projects, nor any additional or exceptional arrangements. The DNA is endeavouring to obtain agreement from the Secretariat of Finance that additional revenue generated by certified emission reductions should be exempt from income tax.

Project	Description	MW	Actors	Estimated emissions reduction p.a. [t CO_2e]	Status (Dec. 2006)
B. Juárez (Oaxaca)	Small hydropower	15	Developer: Impulsora Nacional de Electricidad (INELEC) Sponsor: Corporación Mexicana de Hidroelectricidad (Comexhidro)	40,769	not available
Chilatán (Michoacán)		15		51,794	not available
Trojes (Michoacán)		8		22,562	reg. with UNFCCC
El Gallo (Guerrero)		30		65,704	reg. with UNFCCC
44 pig farms[29]	Use of methane gas	n/a	AgCert	2,422,000	34 projects registered
32 cattle farms		n/a		444,000	21 projects registered
Food industry (Mexico D.F.)	Biogas with CHP	1	Econergy Mexico	7,300	reg. with UNFCCC
Monterrey II, Tijuara, Guadalajara, León, Torreón, Los Mochis	6 projects generating electricity from landfill gas	20	Sistemas de Energía Internacional (SEISA)	c. 600,000	not available
Aguascalientes	Landfill gas	2–4	Biogas Technology S.A.	c. 163,000	reg. with UNFCCC
Ecatepec		2–5		c. 209,000	reg. with UNFCCC
Bii Nee Stipa II – La Ventosa	Wind energy	200	Gamesa Energía	350,000	reg. with UNFCCC
Bii Nee Stipa III – La Ventosa		164		c. 291,000	under review
Eurus (La Venta/Oaxaca)		249	TEG Energía (subsidiary of CEMEX México)	600,234	

Tab 4: Projects with a Carta de Aprobación from the Mexican DNA COMEGEI, as at: August 2006

29 The primary purpose of these projects is to dispose of methane gases harmlessly. Generating electricity is merely a supplementary option.

7.5 Status of Renewable Energy Sources

Despite favourable climatic and geographic conditions, renewable energy sources currently contribute little more than 7 % to Mexico's primary electricity output. Of this, a considerable proportion is attributable to energy sources managed in an unsustainable way: wood[30] and large-scale hydropower. Hydropower and geothermal energy taken together currently account for roughly 16 % of electricity generation (not including self-generation). This proportion is expected to fall in the coming ten years, with hydropower supposed to be increasingly used to cover peak loads.

By October 2006, CRE had granted 55 approvals for electricity generation projects for self-generation or for export on the basis of renewable energy. Among these, 39 plants were already in operation. If the remaining hydroelectric and wind power plants in particular become reality, in this field alone (non-public electricity supply) another almost 1,400 MW of output can be expected in the near future.

Energy source	CRE approvals			In operation (or inactive)	
	Number	Output [MW]	Energy [GWh/a]	Number	Output
Wind	9	1,252.5	4,821	0	0
Water[31]	13	159.0	627	7	58.7
Bagasse[32]	28	299.6	597	27	259.5
Biogas[33]	5	95.3	722	5	95.3
Total	55	1,806.4	6,767	39	413.5

Tab 5: Power-generating plants with CER approval that utilise renewable forms of energy (not including plants belonging to state-owned suppliers), as at: October 2006

Hydropower

At the end of 2005 there were 79 hydroelectric plants with a total capacity of 10,536 MW in operation for public supply on the interconnected network. They produced 27.6 TWh of electricity in 2005, with average precipitation. The share of total electricity generation was 13.3 %, and despite plans to build an additional 3,700 MW this will decline to below 10 % by 2016.

Unutilised water resources are estimated at 11,500 MW, including an estimated 3,250 MW in locations with a capacity of less than 10 MW each.[34] Previously there were many small hydroelectric plants rated at up to 30 MW, but these were gradually abandoned due to problems with statutory approval procedures or for other reasons. CFE has been barely active at all in this sector for more than 30 years, building virtually no new plants. One of the few plants to be built recently was a small plant rated at 2 MW commissioned in September 2005, for public supply.

At the end of 2000 only seven small hydropower stations were operating, with a total capacity of 84 MW. By October 2006, altogether 159 MW had been approved by CRE for self-generation and export, with average annual production of 627 GWh; of this, only some 59 MW has entered operation so far.

The national water law (Ley de Aguas Nacionales) grants private investors the possibility of acquiring water rights as a matter of general principle. The national water authority (CNA) issues concessions for hydropower self-supply projects that allow them to use water for 25 years.

30 An estimated 6 million households currently use firewood as their main energy source.
31 Including plants that are partly fuelled by fossil energy sources.
32 Including plants that are additionally fuelled by oil.
33 Including plants that are partly fuelled by natural gas.
34 CFE even puts the total potential at as much as 52,000 MW, which would therefore mean that only about 20 % of the potential is exploited at present.

Wind energy

Mexico has a number of regions with good to excellent wind conditions. Substantial resources are available in particular in the federal states of Oaxaca in the south[35], Zacatecas in the highlands, Tamaulipas and Veracruz on the coast of the Gulf of Mexico, along the Pacific coast of the Baja California peninsula, along the shoreline of Quintana Roo on the Caribbean, and in the federal state of Hidalgo north of Mexico City. For La Ventosa region in the federal state of Oaxaca alone, with mean wind speeds of 7 to 10 m/s at a height of 50 metres, the exploitable potential is put at 2,000 MW, and the capacity for the whole country using only the best locations is estimated at a minimum of 7.000 MW.[36]

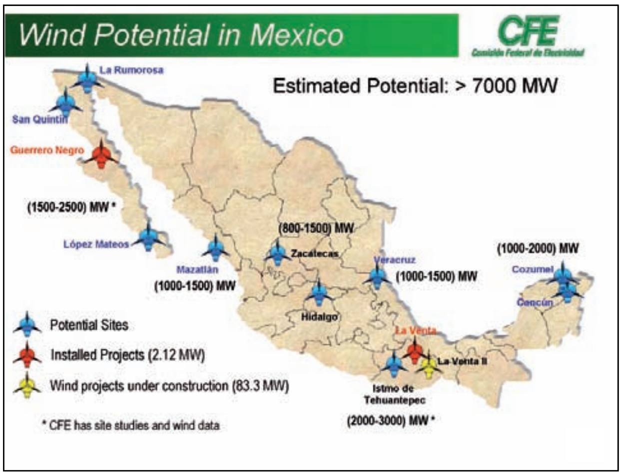

Fig 1: Wind potential by region; Mexico[37]

Experience to date

In mid-1984, CFE began operation at the demonstration project La Venta I, which had seven wind turbine generators and a total capacity of 1.6 MW and is located in the south of the Isthmus of Tehuantepec, 30 km northeast of Juchitán in the state of Oaxaca. Wind measurements have been carried out by IIE at this location since 1984.[38] Another individual 600 kW plant was put into service by CFE at the end of 1998 near Guerrero Negro in the federal state of Baja California Sur. This plant is operated in an isolated urban grid, which is otherwise supplied by diesel generators. Assorted experience has also been gained with hybrid (wind/PV) or multivalent (wind/PV/diesel) systems installed in the last decade.

In October 2006 CFE commissioned the first relatively large-scale wind farm, with a capacity of 83.3 MW (La Venta II), located in Oaxaca. This wind farm has 98 turbines manufactured by the Spanish company Gamesa, each rated at 850 kW.

Planned wind farms

A further five wind farms (La Venta III and Oaxaca I-IV), each with an output of about 100 MW, are to be built by independent power producers in the coming years (2008-2012), generating electricity for public supply. CFE will offer optional locations for these for a period of 20 years, and will conduct the requisite environmental studies and soil tests, clarify rights of way and secure access to the grid.

The first of these wind farms (La Venta III, 101.4 MW) was put out to tender in September 2006 and is set to be the beneficiary of the production-dependent bonus from the GEF assistance grant, as described above. A decision on the selection process was scheduled for February/March 2007, and operation is meant to start by the end of 2008. Whether or not the other planned wind farms will be brought to fruition will largely depend on the establishment of the planned national fund to meet potential additional costs.

35 For further details see the Wind Energy Resource Atlas of Oaxaca of August 2003, compiled by the National Renewable Energy Laboratory with American assistance.
36 Other estimates start on partly far higher numbers. CFE, on the other hand, names a national wind potential of 2.900 MW.
37 Source: CFE.
38 Wind measurements have been carried out by IIE at five other locations in the region: Juchitán, Salina Cruz, Tehuantepec, La Venta and Unión Hidalgo.

Other large-scale projects are at the preparatory stage, intended for municipal or industrial self-generation or for generating electricity for export and therefore launched on the initiative of independent power producers. So far construction has not started on any of the projects that have received a permit under electricity law, so it will not be possible to keep to the commissioning deadlines envisaged for 2006/2007. The Eurus wind farm is the only one to have received national approval as a CDM project.

Biomass

Biomass could be put to far greater use than is presently the case, which is limited to the utilisation of farm residues. Areas that are particularly relevant include generating electricity from landfill gas, producing biogas in livestock farming and making better use of organic residues (bagasse) in the sugar industry.

Project	Output [MW]	CRE approval granted	Purpose / consumer	Location	Envisaged start of operation
Fuerza Eólica del Istmo	100.0	Jan. 1998	Municipal self-generation	Oaxaca	31.12.2009
Baja California 2000	10.0	Jan. 1998	Municipal self-generation	Baja California	31.12.2007
Fuerza Eólica de Baja California	300.0	July 2002	Export	Baja California	31.12.2006
Eléctrica del Valle de México	180.0	Sept. 2001	Municipal self-generation	Oaxaca	31.12.2007
Parques Ecológicos de México	102.5	Sept. 2002	Industrial self-generation	Oaxaca	31.03.2007
Eoliatec del Istmo	163.7	March 2005	Industrial self-generation	Oaxaca	31.10.2007
Vientos del Istmo	120.0	Dec. 2005	Industrial self-generation	Oaxaca	17.09.2007
Eurus	250.0	July 2005	Self-generation cement works	Oaxaca	30.06.2010
Bii Nee Stipa	26.3	Sept. 2005	Self-generation food industry	Oaxaca	01.02.2007
Total	1,252.5				

Tab 5: Wind farm projects by private investors with approval from CRE for self-generation or for export; Mexico[39]

Industrial self-generation projects are generally costed with a 5 to 20% reduction in electricity selling prices compared with the general CFE tariff. In respect of the CDM projects mentioned above it is assumed that under these conditions an economically worthwhile return can only be achieved through the sale of certified emission reductions.

39 Source: CRE statistics, as at October 2006.

Biomass potential

IIE estimates the potential for electricity from sugarcane bagasse at 1,000 MW. When intermediate technology is employed, after the energy required from the production process is deducted at least 100 kWh per tonne of sugarcane can be supplied to the public grid, and thus at least 5,100 GWh per year on the basis of the harvest yields of 2004/2005 (51 million tonnes). To date, bagasse is used for generating the facilities' own power in only 27 of a total of 58 sugar factories, albeit in most cases in conjunction with heavy oil (224 MW), and all but one of the plants were installed before 1992. Currently there is just one new plant under construction, with a capacity of 40 MW.

Over and above that it is estimated (by IIE) that about 160 MW could be generated by utilising landfill gas from domestic waste in numerous towns and cities within a ten-year period.[40] The estimate is based on the use of 44,600 tonnes of high-organic-content waste (2000) that is disposed of every day on the country's 51 landfill sites. The first such scheme in Mexico and indeed in the whole of Latin America was an 8 MW plant on a landfill site near the city of Monterrey in the federal state of Nuevo León; it was commissioned in September 2003 and was cofinanced with US$ 5 million from GEF funds. In this case the electricity is intended for self-supply of municipal facilities and enterprises. Two plants extracting sewage gas have already been in operation in Monterrey for some time, since 1997. It is assumed that by 2020 it will be possible to provide 44 MW in Mexico from the production of landfill gas on refuse dumps and 29 MW from sewage gas.

In 2005 SENER completed a study into the use of biogas in cattle and pig farming. It shows that schemes of this nature are extremely profitable and well suited to trading in certified emission reductions within the context of the CDM. SENER has also conducted investigations into the use of biogas in the cities of Chihuahua and Querétaro, with support from the World Bank/ESMAP.

Solar energy

Mexico has very high average solar irradiation rates, at 5 kWh/m^2 per day. Across 70 % of the area, irradiation is higher than 17 MJ/m^{2}d, and in some parts of the country is even above 19 MJ/m^{2}d.

Photovoltaics

Total installed photovoltaic capacity is put at 18.7 MW (end of 2005), with by far the majority of this distributed among off-grid applications in the domestic (approx. 14 MW) and non-domestic (approx. 4.7 MW) sectors.[41] In 2005 PV systems with a total capacity of only little more than 0.5 MW were installed, including 242 water-pump systems for use in rural settings.

Individual grid-linked photovoltaic systems each rated at up to 2 kW have been installed by IIE in recent years in a pilot project. The first privately initiated PV system entered service on a building in Mexico City in December 2005, with grid infeed and a capacity of 30 kW. In October 2006 residential houses were equipped with grid-coupled PV systems each rated at 1 kW in the city of Mexicali in Baja California, the first time for this to happen in a larger development. The 57 systems installed to date are to be operated under a net-metering contract; this is shortly to receive official approval from the CRE, after which it would be applicable to all such systems across the country.

The sectoral strategy for power expansion between 2001 and 2006 points out that in the programme for the rural electrification of 1,200 mainly indigenous municipalities approximately 860 could receive a basic PV supply, meaning that a total capacity of 22 MW would have to be installed. IIE estimates the total potential for off-grid systems at between about 10 and 20 MW over the next ten years.

40 Here, too, the estimates of potential vary widely. Another source talks of a power generating potential of over 800 MW that could be harnessed simply from exploiting landfill sites in the ten most important cities.

41 The remainder was distributed among stand-alone systems in the commercial and service sectors, for example being used for telecommunications, oil rigs, as cathode protection for pipelines, for street lighting, traffic control facilities, water pumps and other applications.

The ‘Renewable Energy for Agriculture’ programme implemented by the Secretariat of Agriculture through the FIRCO project from 1999 to 2006 with support from the GEF, with envisaged total expenditure of US$ 35 million, included plans for installing around 1,150 PV modules for water pumps and for cooling agricultural products (see below).

Solar thermal electricity generation

A scheme currently in preparation with support from the GEF/World Bank is a combination of a gas-fired combined-cycle power plant rated at 480 MW and a solar thermal electricity generating plant with parabolic troughs, which is expected to produce a maximum output of 31 MW and is to be erected in the desert of Agua Prieta in the federal state of Sonora, directly on the border to the USA. In early October 2006 the World Bank approved a grant of US$ 49.35 from GEF funds for the solar section. The GEF will therefore contribute almost 95 % of the total cost of the solar section. An invitation to tender for this project run by CFE was launched in June 2006, and a decision was due before the end of the year. The entire installation is scheduled to enter service in the spring of 2009.

Earlier attempts to bring a similar project to fruition through an independent power producer came to nothing, primarily because of financing issues.

Solar thermal water heating

It is estimated that the collector area installed for water heating was 842,000 m^2 at the end of 2006.

A major breakthrough is in the offing in the district of Mexico City (Distrito Federal), on the basis of a new statutory provision that since April 2006 all newly built and radically refurbished buildings in which hot water is used for commercial purposes have to meet at least 30 % of their energy needs for water heating from solar energy.[42] To facilitate this, the government district is offering tax incentives.

As well as that, national tax law also allows the possibility of accelerated depreciation for installations used for commercial purposes. A national programme promoting solar collectors devised by CONAE and supported by the above-mentioned GTZ project is expected to be launched in mid-2007.

Geothermal energy

Geothermal sources with sufficiently high temperatures for electricity generation can be found at various locations in the country. In 2005 about 7,300 GWh of electricity was generated from geothermal sources with a combined power station output of 960 MW. All of the installations presently in operation are run by the state-owned utility CFE. Generating costs are put at between 4 and 7 US cents per kWh.

Baja California

In Cerro Prieto in the federal state of Baja California, where the first geothermal power station started operation in 1973, the total electrical capacity presently available is 720 MW; this was used to generate over 5.5 TWh in 2005 alone.[43] Geothermal energy from this source therefore met more than 50 % of the power demand of Baja California, whose grid is operated separately from the rest of the country.

Los Azufres, Los Humeros and further expansion

Other geothermal potential of at least 380 MW has been proven in Los Azufres in the federal state of Michoacán and in Los Humeros in Puebla state. The installed capacity in Los Humeros currently amounts to 35 MW. The most recent and to date largest power station to enter service is Los Azufres II, with 107 MW, which started operation in 2003; its geothermal sources are of volcanic origin. The installed electrical capacity at this location therefore now totals 195 MW, with which about 1,450 GWh of electricity was generated in 2005.

42 Norma Solar, Gaceta Oficial del D.F., 7 April 2006.
43 For more details see http://iga.igg.cnr.it/mexico.php.

Additional sources with estimated capacity of over 1,500 MW could be exploited in the coming years, but only an additional 125 MW is planned to be built in the medium term up until 2014 (see Tab. 6).

In operation	MW	Power generated in 2005 or anticipated [GWh]
Cerro Prieto I-IV in Mexicali (Baja California)	720	5,521
Los Azufres I and II in CD Hidalgo (Michoacán)	195	1,449
Los Humeros I (Puebla)	35	292
Tres Virgenes in Mulegé (Baja California Sur)	10	37
Planned to enter service by 2010		
Cerro Prieto V	100	813
Los Humeros II	25	207
Other planned projects		
Los Humeros Binario	21	not specified
Los Azufres III	50	not specified
Los Azufres Binario	9	not specified
Cerritos Colorados (Jalisco)	75	621

Tab 6: Geothermal power stations in Mexico; MW, GWh; 2005[44]

7.6 Rural Electrification

At present about 94.5 % of the total population of some 108 million (2006), or 99 % of urban dwellers and 85 % of the rural population, are connected to the mains electricity supply. In some southern states the electrification rate is below 90 %. The remaining almost 6 million inhabitants without an electricity supply are distributed among about 89,000 small settlements, each with fewer than 2,500 inhabitants, in gridless regions or areas that are difficult to access.

Coverage is particularly inadequate in communities with fewer than 100 inhabitants and a high proportion of scattered properties, but also among rural indigenous communities. As the population in these regions is growing rapidly and the annual connection rate has been constantly falling since 1995, it is assumed that the number or people without an electricity supply will actually rise.

The state funding made available for electrification has continuously declined since 1997. At the same time the power to decide on the distribution of expenditure for infrastructure projects was switched from the central level to the federal states and municipalities as a result of the decentralisation policy of 1996. This therefore meant that decision-making on rural electrification was also transferred from CFE to the local administrations, although these often lacked the relevant expertise. As a consequence, the electrification rate has remained virtually unchanged since the mid-1990s.

There are rough estimates that at least in the southern parts of the country the only possible option for about 50 % of households is off-grid electrification,[45] with this preferably being provided by renewable energy.

The Mexican electricity law favours rural communities supplying their own power from installations with a capacity of up to 1 MW, as no statutory approval is required for such plants. Municipal institutions, local cooperatives or mixed public-private owners can acquire an interest in generating companies providing these services.

44 Source: own compilation.
45 The cost of grid connection can range between US$ 1,000 and 4,200 per household.

Solely private sector-ownership is not allowed. Moreover, the law on water use also establishes privileges for schemes using water to generate electricity with a capacity of less than 0.5 MW: provided the interference in the watercourse remains minimal, there is no need for a concession under water law.

Integrated Energy Services Project for Small Localities of Rural Mexico, 2006-2011

The 2001-2006 sector programme envisaged the electrification of at least 50,000 households in particularly marginalised, isolated communities. This was meant to increase the electrification rate to 97 %. In addition, 250 facilities in the fields of health, education and telecommunications were to be electrified with the aid of the private sector. Preparations for a programme[46] to achieve these aims have been completed in the meantime, although implementation has not yet begun, being scheduled for the period 2006-2011.

The programme focuses on the provinces of Chiapas, Guerrero, Oaxaca and Veracruz,[47] and is funded in part by US$ 15 million in loans from the International Bank for Reconstruction and Development (IBRD/ World Bank) and the same amount in grants from the GEF.[48] The Global Village Energy Partnership (GVEP) will also play a part in implementation; it has already been involved in preparatory studies. The GEF funding is supposed to be exclusively reserved for promoting schemes which contribute to off-grid electrification using renewable energy sources. The main emphasis is on communities and settlements with between 50 and 500 households. Individual consumers are to receive power supplies from both PV systems (at least 50 % of all communities or roughly 35,000 households) and small wind power systems (about 15 % of the households), while to a limited extent micro hydropower installations and biomass-fuelled generators will supply small isolated grids.

Electrification with solar energy systems

Mexico has gained extensive experience in the use of photovoltaic systems for basic electrification. Even in the 1980s and 1990s, the Government of Mexico invested considerable resources in the installation of PV systems for households and public facilities as part of the Pronasol and Progresa programmes (40,000 solar power systems were installed under the Pronasol programme alone). Particularly in the last decade, this type of power supply in gridless areas has made great headway in catching up with the traditional use of diesel generators. To date, 20,000 solar home systems (SHS) have been sold to private users as well, with no government assistance at all.

As well as this, since the beginning of the 1990s the government has also implemented measures to provide power supplies under a number of programmes to improve infrastructure in poor rural municipalities. In various parts of the country, gridless municipal buildings and households with no prospect of connection were equipped with PV systems for basic supply (lighting/ communications).[49] Altogether, in addition to SHSs hundreds of other systems have been installed in this way for pumping water, for social purposes and for supplying mini electricity grids. However, because of a lack of maintenance and inadequate local training, many photovoltaic systems have not stood the test of time.

46 Integrated Energy Services Project for Small Localities in Rural Mexico.
47 The programme will reach less than 5% of the almost 4,700 communities in these southern states, for which off-grid electrification is the only option.
48 The total cost is put at US$ 96.5 million.
49 The percentage of such households is particularly high in the agrarian federal states Oaxaca, Chiapas, Tabasco and Zacatecas.

Renewable energies in agriculture

Electrification through the use of renewable energy sources in agriculture is supported by the FIRCO initiative[50] overseen by the Secretariat of Agriculture. Grants are provided for the acquisition of water pumps and drives for farm equipment, including those powered by wind and solar power. Since 1999 the GEF-assisted project Renewable Energy for Agriculture (grant: US$ 8.9 million) has worked towards overcoming the relatively major barriers to implementing this programme, which aims in particular at raising the productivity of approximately 600,000 farming enterprises with no electricity supply. GEF assistance came to an end in March 2006 and is expected to be resumed. The largest single component envisaged in this programme was the installation of 1,150 solar-powered water pumps, 55 wind-powered pumping systems and 24 solar-powered cooling tanks for milk.

Exchange rate (12.12.2006):
1 Mexican peso (MXN) = 0.07 Euro (EUR);
1 EUR = 14.27 MXN

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8 Nicaragua

8.1 Electricity market

Installed capacity

At the close of 2006, Nicaragua's national interconnected grid possessed a rated installed electrical generating capacity of 751.2 MW, while effective available generating capacity amounted to only 588.6 MW, 62 % of which was based on oil-fired power generation, 14 % on bagasse, 17 % on wind power and 7 % on geothermal energy.[1] This differential between rated and effective power output is due to the poor technical condition of a number of thermal power plants as well as a loss of geothermal sources.

In the case of cogeneration of heat and power using bagasse as the fuel, actual electrical output effectively fed to the interconnected grid corresponds to the difference between the rated installed capacity and plant-internal power consumption required for sugar production (see Table 1).

Power plants	Rated	Effective
	MW	
Thermal (oil-fired)	432.5	367.6
Cogeneration of heat and power (firing sugarcane bagasse)	126.8	81.0
Hydropower	104.4	98.2
Geothermal energy	87.5	41.7
Total of connected grid	**751.2**	**588.6**

Tab 1: Installed rated and effective generating capacity per power source in Nicaragua; MW; 2006

Spot market

An acute energy crisis was felt in Nicaragua in 2006, with frequent power rationing hitting all consumer groups, brought about by a lack of investment to expand electrical generating capacity, the low availability of thermal power plant capacities, extremely low water levels in dammed reservoirs and rising oil prices. Failure to implement timely expansion of the country's electrical generating capacities proved to be the principal cause of this energy crisis, resulting in an extreme rise in electricity prices on the spot market. There, the average megawatt-hour charge in 2006 rose as high as 158 US$/MWh and the demand price to 168 US$/MW.

Electricity generation

Net power generation in 2006 amounted to 2,829 GWh. State-owned power plants contributed 19 % of this electricity production while the share contributed by privately owned power generating units came to 81 %. Currently, power generation in Nicaragua is predominantly based on oil-fired units.[2]

The hydroelectric plants belonging to the power producer HIDROGESA are located in Jinotega department in the north of the country, while those belonging to CENSA, ORMAT, GEOSA and PENSA are in Leòn department, and EEC and the Monte Rosa and NSEL sugar factories are based in Chinandega department. GECSA and Tipitapa Power operate in the department of Managua.

1 Source: Statistics of the Nicaraguan Energy Institute (Instituto Nicaragüense de Energía – INE).
2 Ibid.

Interconnected grid	Power generation
	GWh
State-owned power providers	**547.6**
Hidroeléctrica S.A. (HIDROGESA)	299.2
Eléctrica Central S.A. (GECSA)	248.3
Private power providers	**2281.1**
Corporación Eléctrica de Nicaragua S.A. (CENSA)	314.2
Empresa Energética Corinto (EEC)	528.4
Generadora Momotombo S.A. (GEMOSA)	225.6
Generadora Eléctrica de Occidente S.A. (GEOSA)	547.0
Tipitapa Power	420.2
Ingenio Monte Rosa	93.9
Nicaragua Sugar State (NSEL)	100.4
Polaris Energy S.A. (PENSA)	51.4
Total power generated within the national interconnected grid SIN	**2,828.7**

Tab. 2: Net electricity generation by power provider in GWh; Nicaragua; 2006

Electricity transmission and distribution

Nationwide, the electrical power network in Nicaragua consists of the national interconnected grid SIN (Sistema Interconectado Nacional), which roughly covers the half of the country with the highest consumer density, and isolated, stand-alone systems supplied in most cases by diesel generators.

Electricity consumption

Total consumption of electric power in the period from January to November 2006 came to 1,716 GWh, with the household sector accounting for 34%, trade and commerce almost 31% and the industrial sector just over 20%.

Sector	January - November 2006	
	GWh	%
Households	580.5	33.8
Trade	523.6	30.5
Industry	345.0	20.4
Irrigation	59.5	3.5
Street lighting	64.9	3.8
Pumps (water supply systems)	137.5	8.0
Total consumption	**1,716.0**	**100.0**

Tab. 3: Power consumption by sector in Nicaragua; GWh and %; 2006[3]

Electricity prices

Electricity tariffs in Nicaragua are determined on the basis of existing power purchase agreements as well as by supply and demand on the spot market, which makes up about 9 to 11% of the total market. One exception in this regard was the year 2005, when the spot market share reached 25%.

Expenditure on fuels (oil and oil derivates) accounts for approximately 70% of the total costs dictating electricity prices for end customers.

Sector	Electricity tariff
	US$/kWh
Households	0.15
Trade and crafts	0.18
Industry	0.14
Irrigation	0.12
Pumps (water supply systems)	0.12

Tab. 4: Average electricity tariffs by consumer sector in US$/kWh; Nicaragua; 2006[4]

3 Ibid.
4 Source: own calculations based on energy sector statistics; the average tariff is calculated on the basis of the quotient from electricity sales revenue and the actual energy quantity billed.

Expansion planning

The recently established Ministry of Energy and Mines (Ministerio de Energía y Minas), previously organised as the National Energy Commission (CNE), is responsible for planning to expand the nation's electrical generating capacities. In May 2005, CNE presented its Indicative Plan for expanding electricity generation over the period from 2005 to 2016.[5] This plan analyses two scenarios for development of an interconnected interstate electrical grid system in Central America (SIEPAC):

(I) "Integration" scenario:
This scenario is based on the assumption that a uniform interconnected grid system will be created at the regional level by implementing new projects and intermeshing the existing national grids in the region. However, this scenario is very unrealistic, as it would require complete integration of all existing networks within and across international borders.

(II) "Coordinated operation of isolated networks" scenario:
In this scenario, it is assumed that the Central American countries will develop their power grids autonomously according to demand in each country, but nevertheless in a coordinated form enabling operation across international borders.

8.2 Market Actors

Power producers

Electric power generation in Nicaragua is provided by state-owned and privately owned utilities.

State-run utility ENEL

Empresa Nicaragüense de Electricidad (ENEL) is the state-owned energy utility company that consolidates as holdings within its enterprise the power producer HIDROGESA, which operates the sole hydropower plant, and the power producer GECSA, which generates electricity on an oil-fired basis.

In addition, ENEL owns and operates the country's isolated, stand-alone systems (fuelled mostly by diesel). ENEL is currently planning to erect new power plant generating capacity based on hydropower.

Private power producers

GEMOSA, a geothermal power plant, is leased to the private power producer ORMAT, while the GEOSA enterprise, operator of two oil-fired thermal power plants, was privatised in 2006.

The following table shows the installed electrical generating capacities of Nicaragua's private power producers that have gone into operation since the liberalisation of the electricity sector in 1992.

Private power producer	Electrical generating capacity [MW]		Year operation began
	rated	effective	
Corporación Eléctrica Nicaragüense, S.A. (CENSA)	63.9	56.9	1997
Empresa Energética Corinto (ENRON)	74.0	70.5	1999
Tipitapa Power Company	52.2	50.9	1999
Nicaragua Sugar Estates Limited (NSEL)	59.3	30.0	1999
Monte Rosa, S.A. (IMR)	67.5	30.0	2002
Polaris Energy Nicaragua, S.A. (PENSA)[6]	10.0	7.5	2005
Total	326.9	245.7	

Tab. 5: Installed electrical generating capacity of private power producers in Nicaragua; MW

The 60 MW effective generating capacity of the two sugar factories NSEL and IMR represents the maximum power output these units can feed to the SIN interconnected grid during the sugarcane harvest. This output slackens towards the end of the sugarcane harvest owing to the diminishing availability of bagasse.

5 Plan Indicativo de la Expansión de la Generación 2005-2016.
6 Polaris recently lost its generating licence (at least temporarily) due to technical problems with existing facilities.

Electricity transmission and distribution companies

Unión Fenosa

In September 2000, the two state-run electricity distribution enterprises were sold to the Spanish Unión Fenosa group, which was thereby granted an exclusive licence for power distribution within its concession area.

Unión Fenosa does not own any concession in the Atlántico Norte and Atlántico Sur Autonomous Regions, nor in parts of the departments of Jinotega, Matagalpa, Chontones or Río San Juan. These are rural areas marked by low population density, difficulty of access and little demand for electric power. Some of these rural communities have been provided with small diesel generators by ENEL or non-governmental organisations.

ENATREL

Empresa Nacional de Transmisión Eléctrica[7] (ENATREL) is the state-owned electricity transmission company that transmits electric power to national and international customers via 69 kV power lines (including transformer substations).

CNDC

Centro Nacional de Despacho de Carga (CNDC) is the grid operator of the national interconnected power network SIN, and forms an organisational unit within ENATREL.

Economic situation of power producers

Pricing of electricity takes place on the power purchase agreement market and a spot market. The spot market takes account of the marginal costs of hourly demand for electricity (coste marginal horario). The National Energy Institute (INE) calculates the wholesale prices for energy and power for the months November to October of each given year based on existing power purchase agreements and the prices prevalent on the spot market. These provisional wholesale prices are recalculated every 12 months and applied to the tariffs as of May of the following year.

If the monthly accumulated deviation between the forecasted and actual electricity prices exceeds 10%, the tariffs are adjusted accordingly.

According to the power distribution company, the fact that the tariff adjustments it continually seeks in view of rising oil prices are not approved in full by the regulatory authority to the amount or for the time period requested results in a financial deficit that, in turn, leads to a failure to make payments to the power producers, ultimately giving the latter cause to ration power supply and shut down power plants.

8.3 Legal Framework

After a period of 13 years in which the electricity sector in Nicaragua remained unaltered in the hands of the state, approval was granted in 1992 to allow private-sector power generation, whereby the state remained the sole buyer.

In 1998, a fundamental restructuring of the energy sector was launched when a new Electricity Law (Ley 272: 'Ley de la Industria Eléctrica') came into force. The production, transmission and distribution (including sale) of electricity were split, and power generation and distribution (including sale) were privatised while electricity transmission remained with the state enterprise ENATREL.

These reforms also included introduction of a wholesale market for electric power (mercado mayorista), power trading between producers and distributors as well as between producers and major consumers, and the trade on the spot market. Law No. 272 provided for splitting of the state-owned energy provider ENEL into separate economic enterprises for power generation (GEMOSA, GEOSA, HIDROGESA and GECSA), power transmission (ENTRESA, now reorganised as ENATREL) and power distribution (DISNORTE und DISSUR).

7 Formerly ENTRESA.

The law designates INE to act as the regulatory authority for the energy sector, its main tasks being to prepare, implement and enforce technical codes and standards, monitor to ensure compliance with the Electricity Law and its provisions, monitor the electricity market, protect the rights of consumers, grant licences and concessions, approve tariffs for regulated consumers and to mediate disputes between market participants.

Furthermore, the law led to the establishment of the National Energy Commission (CNE, Comisión Nacional de Energía), whose principal function is to formulate energy policy based on the indicative planning of the energy sector.

In January 2007, Nicaragua's Law No. 290 came into effect by which the new government created a new Ministry of Energy and Mines to replace CNE in all its functions as well as to assume several additional functions performed up to now by INE, such as granting licences and concessions as well as approving technical codes and standards for the electricity and hydrocarbons sectors.

8.4 Policy Promoting Renewable Energy Sources

Law promoting electricity generation using renewable energy

Nicaragua's Law No. 532 for the promotion of electricity generation from renewable energy sources (Ley No. 532: Para la Promoción de Generación Eléctrica con Fuentes Renovables) serves to regulate efforts to foster hydropower, geothermal, wind and solar energy as well as biomass by implementing the following incentive mechanisms:

- Exemption from value-added tax on equipment and accessories for renewable energy projects, from preparatory planning to design and erection of the power plant and transmission lines to the nearest transformer substation (Art. 7.2.)

- Exemption from income tax (impuesto sobre la renta) for seven years beginning at the time of commissioning of a power generating facility based on renewable energy; revenues from the sale of certified emission reductions within the framework of emissions trading likewise remain tax-free for the same period of time (Art. 7.3.)

- Partial exemption from municipal taxation on revenues received from the operation of power generating facilities for a period of ten years according to the following schedule (Art. 7.4):
  - Exemption from 75 % of municipal taxation for the first three years
  - Exemption from 50 % of municipal taxation for the subsequent five years
  - Exemption from 25 % of municipal taxation for the final two years

- Exemption from taxation on the utilisation of natural resources – such as that levied for geothermal projects or as provided for in the new Water Act – for the first five years subsequent to facility commissioning (Art. 7.5)

- Producers of electricity from renewable energy sources have the choice of selling the power they generate either by way of power purchase agreements or on the spot market; power purchase agreements have a minimum period of validity of ten years; the law obligates electricity distribution companies to give priority to purchasing power generated from renewable energy sources, and grants INE the right to specify minimum quantities for power supplies (Articles 12 and 13)

- In order to establish and ensure equal opportunity in the evaluation of bids submitted within the scope of invitations to tender, bidders offering power from thermal energy sources must include their fuel costs without tax exemption in their proposals (Art. 15)

- The spot market prices for electricity generated from renewable energy sources are fixed within a range of 55 to 65 US$/MWh; INE may update this price range on the basis of the energy policy of the Ministry of Energy and Mines (formerly the CNE) (Art. 16)

- Producers of electricity generated from renewable energy sources must comply with the regulations governing required back-up capacities and other auxiliary services ("reserva rodante y servicios auxiliares") that are defined in the operating codes and standards; the initial 20 MW of installed generating capacity utilising wind energy are exempt from rules requiring verification of dynamic grid stability, but must nevertheless satisfy all other requirements applicable for power feed to the SIN interconnected grid.

Clean Development Mechanism

To date, nine energy projects in Nicaragua have been registered under the Clean Development Mechanism with the Designated National Authority (DNA), which falls under the authority of the Ministry of Environment and Natural Resources (MARENA). Three of these projects are currently at an advanced stage of negotiations with interested purchasers of the CERs; these could be concluded in the first half of 2007.

8.5 Status of Renewable Energy Resources

CNE[8] estimates the nation's technically and economically exploitable potential of renewable energy (hydropower, wind power and geothermal energy) to total approximately 4,500 MW. Despite this enormous potential, however, Nicaragua has made use of only a relatively small proportion of the available resources up to now.

Hydropower

Hydropower is the best researched and documented renewable energy sector in Nicaragua. Studies conducted in the 1980s (e.g. the 1980 Master Plan) and subsequent updates reveal a hydropower potential amounting to 3,760 MW.[9]

A study conducted by CNE of possible known hydropower project sites envisages a gross electrical generating potential of some 3,280 MW, as shown in the table below.[10]

Capacity range [MW]	Number of identified project sites	Share of identified total potential [%]	Potential in this capacity range [MW]	Share capacity range represents of total potential [%]	Comments
0.1–1	30	29	10	0.3	30 small hydropower projects identified in the UNDP project, including two PERZA projects
1–10	14	13.5	60	1.8	Data from CNE and from other studies
10–25	22	21	416	12.7	
25–272	38	36.5	2,796	85.2	
Total	104	100	3,282	100	

Tab. 6: Identified hydropower project sites and estimated generating potential; Nicaragua; MW and %

8 CNE has been replaced by the Ministry of Energy and Mines. Nevertheless, the term CNE continues to be used in the following, as all of these studies of renewable energy sources were conducted by CNE.

9 BID/CNE: Políticas Energéticas Indicativas, Borrador, Managua, Nicaragua, August 2001.

10 Thomas Scheutzlich: Policy Strategy for the Promotion of Renewable Energy – Situation and Perspective of Hydroelectric Generation in Nicaragua, ESMAP study commissioned by the World Bank, Nicaragua 2004.

Estimated gross annual electrical generating potential from hydropower totals approximately 33,000 GWh. However, only about 9,500 GWh of this is classified as being technically exploitable and 6,500 GWh currently as economically exploitable as annual energy potential. Currently installed hydropower generating capacity totals only about 100 MW, i.e. 5 % of available potential.[11]

From the data gathered in numerous investigations and studies, CNE prepared a list of 24 projects that offer promising prospects for implementation, with generating capacities ranging from 7 to 33 MW for a total potential of perhaps 490 MW. CNE furthermore singled out 12 large-scale projects with power outputs of between 41 and 425 MW, including the Copalar project with 350 MW and Tumarin project with 425 MW.

CNE (i.e. now the newly established Ministry of Energy and Mines) is presently conducting a project in which 30 potential hydroelectric plants ranging in output from 100 kW to about 5 MW have been identified and investigated at the pre-feasibility level. Three of these projects are currently under construction, with co-financing from GEF/UNDP and COSUDE.

A fourth project, El Naranjo, will be implemented in 2007 with co-financing by the EnDev-Nicaragua[12] project.

Wind energy

Information available up to now enables only a rough estimate to be made of wind power potential in Nicaragua. CNE, i.e. now the Ministry of Energy and Mines, is currently conducting wind potential assessment studies with the aid of international organisations. An investigation of wind power potential and the wind energy market was carried out in 2003-2004 within the scope of an ESMAP study commissioned by the World Bank.[13]

In October 2002, CNE signed an accord with UNEP to determine wind power potentials and prepare a solar and wind atlas. The UNEP project Solar and Wind Energy Resource Assessment (SWERA), currently under execution with CNE, has already contributed towards mobilising the wind energy sector investment projects noted below.[14]

Collated wind data confirm that Nicaragua's wind energy resources range from good to excellent (Classes 4 to 7), in particular in the previously noted southern regions around Rivas, Lake Nicaragua and the lake's islands, the hilly areas around Managua and Juigalpa, in the west of the country north of Managua and in offshore areas of the southern Pacific coastline near Rivas. The Caribbean coast and nearby islands display good wind conditions (Classes 3 and 4).

It is anticipated that SWERA will continue to yield constructive impulses enabling investment decision-making and formulation of national energy policy and development strategies.

Wind measurement programmes carried out to date have identified a total area of 76 km^2 with wind speeds of over 8 m/s (at a height of 10 m). The resultant theoretically exploitable potential comes to 760 MW.

Based on these resources, various private companies have applied to INE for exploration licences[15] and are already performing wind measurements for investment projects in the following regions:

1. El Crucero (since October 2003)
2. El Sauce (since February 2004)
3. Island of Ometepe (in Lake Nicaragua)
4. Hato Grande
5. Grenada (since February 2004)
6. Corn Island (since July 2004)
7. Zona del Istmo de Rivas (Juigalpa and Rivas in the south on the border to Costa Rica)

11 Ibid.
12 Energizing Development – a project of the Dutch Government under implementation by GTZ.
13 Policy Strategy for the Promotion of Renewable Energy in Nicaragua, substudy on wind power, ESMAP study commissioned by the World Bank, Nicaragua 2004.
14 The SWERA country report for Nicaragua is available on-line at http://swera.unep.net.
15 These are provisional licences valid for a limited period of time (as a general rule, two years) to allow performance of site studies and wind measurements.

Currently, completed wind measurement data have been submitted for two wind energy projects that are already at the planning stage:

1. The Amayo project by ENISA – CDC, with a planned capacity of 40 MW, located on the Istmo de Rivas.
2. The Hato Grande project by VENTUS S.A., with a planned capacity of 20 to 25 MW, located in Chontales.

Unión Fenosa has agreed to purchase the power produced from a total of 40 MW of installed wind-generated capacity, while the national water utility Empresa Nicaragüense de Acueductos y Alcantarillados (ENACAL) has announced it will purchase 20 MW of wind energy.

Biomass

Next to hydropower, biomass is one of the most important renewable energy sources in Nicaragua, with a fuel volume estimated to total some 42 million tonnes per year. This biomass accumulates in the form of agricultural and forestry waste. In addition, a considerable though not yet quantified potential is seen for cogeneration of heat and power based on sugarcane bagasse, as well as in the significant quantities of available eucalyptus wood waste.

Only two companies in Nicaragua are generating electric power from biomass on any large scale destined for the SIN interconnected grid: the two sugar factories NSEL and Monte Rosa. The table below presents an overview of estimated biomass potential in Nicaragua.[16]

Area	Agricultural waste	Forestry waste	Consumption of firewood	Biomass available for other purposes
ha	t/year			
11,855,800	16 million	29 million	2.9	42.1

Tab. 7: Estimated biomass potential; Nicaragua; t/year

Solar energy

CNE, with the support of the SWERA[17] programme of UNEP[18], has investigated the country's solar irradiation potential and developed a solar atlas of Nicaragua. According to this atlas, the area of strongest solar irradiation is located in the country's northwest, in particular in the departments of León and Chinandega.[19]

The investment costs for photovoltaic (PV) solar energy systems currently remain high compared to other renewable energy technologies. As a result, large photovoltaic projects – for which investment costs per MW are some five times higher than for hydropower or wind power projects – are uneconomical, or economical only under particular conditions.

Nevertheless, several PV system projects are currently being implemented in rural areas that possess no hydropower or wind power potential.

PERZA project[20]

A programme for developing Nicaragua's solar energy market has been underway since April 2005, financed by a loan from the World Bank and a grant from the GEF. With a project volume valued at US$ 2.9 million, its goal is to supply some 18,000 inhabitants throughout the country with electricity generated from solar energy.

16 Source: Guía del inversionista-CNE (CNE Investment Guide).
17 Solar and Wind Energy Resource Assessment.
18 United Nations Environment Programme (UNEP).
19 Source: Guía del inversionista-CNE (CNE Investment Guide).
20 Proyecto de Eléctrificación Rural en Zonas Aísladas (PERZA) (Project for Rural Electrification in Isolated Areas).

'Francia Sirpi' subproject

The Francia Sirpi project, launched in November 2006, is likewise being financed by funding from World Bank and the GEF, amounting to some US$ 215,000. The object of this project is to establish a solar-powered battery charging station in the RAAN[21]Autonomous Region that will generate an electrical output benefiting some 2,200 potential users.

'San Juan de Nicaragua' subproject

This project is also being financed by funds from a loan provided by the World Bank and the GEF. The loan for US$ 315,000 is being used to finance a solar-diesel hybrid system scheduled to commence operation in 2007.

PV Systems Project of IDB (Proyecto Sistemas Fotovoltaicos)

This project, financed by the Inter-American Development Bank (IDB), is taking place in Waspán (in the RAAN Autonomous Region). It will supply 1,422 families with individual solar home systems being installed, maintained and managed by a private company.

Geothermal energy

Although Nicaragua possesses enormous geothermal energy potential, the scope of this potential has not yet been thoroughly identified. Preliminary studies speak of resources totalling an electrical generating capacity of 1,500 MW. A potential and market analysis was carried out in 2003-2004 within the scope of an ESMAP study by the World Bank.[22]

In 1999 and 2000, INE issued two licences for project implementation. In March 2006, licences for exploration of the El Hoyo-Monte Galán and Managua-Chiltepe projects were granted to Geotérmico GeoNica, a consortium founded jointly by the Compañía Geotérmica Salvadoreña LaGeo and the Italian power provider ENEL.

Future projects

Hydropower

The following tables list projects presented in the CNE Investment Guide (Guía del Inversionista-CNE, 2003) which are to be opened up to private-sector investment in coming years for realisation. Step by step, the legal framework for private-sector participation has been considerably improved in recent years such that the opportunities for project implementation from this portfolio are thoroughly feasible.

Project	Generating capacity in MW
Tumarín	425
Mojolka	119
Brito	260
Copalar	350
Valentin	62
Pintada	203
Kuikuinita	63
Paraska	41
Kayaska	54
Piedra Fina	102
Paso Real	48
Tendido	94
Total generating capacity	**1,821**

Tab. 8: Hydropower projects > 30 MW; Nicaragua

21 Región Autónoma del Atlántico Norte (RAAN).

22 Policy Strategy for the Promotion of Renewable Energy in Nicaragua, substudy on geothermal energy, ESMAP study commissioned by the World Bank, Nicaragua 2004.

Projects	Generating capacity in MW
Namasli	9
Coco Torres	19
Kinunu	8
Kayasla	33
Daka	5
Arrawas	7
Esquirin	14
Paso Real	30
Santa Elisa	18
Lipo	22
Zopilota	18
Quililon	22
Sofana	26
Loro	20
Bosayan	18
Posa Brújula	22
Consuelo	31
Pajarito	23
La Estrella	19
Piedra Pintada	25
El Salto	27
Pantasma	24
Larreynaga	17
La Sirena	33
Total generating capacity	**490**

Tab. 9: Other hydropower projects; Nicaragua; MW

Project	Generating capacity in MW
El Hoyo Monte Gala	200
Managua Chiltepe	150
Total generating capacity	**350**

Tab. 10: Geothermal energy projects currently underway; Nicaragua; MW

Wind energy

The regional development council (Consejo de Desarrollo Departemental) in Estelí has expressed interest in siting and promoting a wind power project in the region of San Nicolas south of Estelí. Further details of these plans are not yet known.

The National University in Managua (Universidad de Ingeniería, UNI) intends to prepare a detailed national wind atlas and conduct feasibility studies for eight commercial wind farms in the communities of El Sauce, San Nicolas, Matagalpa, Rancho Grande, Chontales, Puerto Cabezas, Bluefields and Corn Island.

8.6 Rural Electrification

CNE has prepared a National Plan for Rural Electrification (Plan Nacional de Electrificación Rural, PLANER) covering the timeframe 2003 to 2013, the main goal of which is to increase the national electrification rate of 55 % (2003) to 71 % by 2013. An investment volume of US$ 270.4 million has been earmarked for implementation of this plan, in which those regions where no concessions are granted for PV solar systems and/or hydropower projects are to be given priority. This funding is to come from bilateral and multilateral sources and administered by the Development Fund for the National Electricity Industry (Fondo para el Desarrollo de la Industria Eléctrica Nacional, FODIEN). Most of the investment implemented to date within the scope of rural electrification has targeted grid expansion projects in concession areas of Unión FENOSA.

Nicaragua's Ministry of Energy and Mines is continuing to pursue the national energy policy defined by CNE, addressing the following objectives:

- Development of the National Plan for Rural Electrification (PLANER). Priority is being given to those regions with the greatest potential for increasing productivity.

- The guidelines of the Development Fund for the National Electricity Industry (FODIEN) are undergoing reform with the objective of achieving sustainable and transparent acquisition of international funding for implementation.
- Funding for implementation of the PLANER electrification programme is being allocated from the state budget and administered by the FODIEN development fund.
- Efforts are being made to establish a pricing and subsidisation policy for rural areas to enable granting of direct and transparent subsidies for rural electrification projects.
- Utilisation of renewable energy sources for rural electrification is being promoted.
- New codes and standards are being introduced to the electricity sector to meet needs dictated by the particular conditions of rural electrification and isolated off-grid systems.

The measures noted above were initiated and promoted by CNE. However, they have either not yet been approved by the government – in particular those measures that require direct subsidisation and commitment of government funding – or not yet been implemented by the appropriate regulatory authority.

Rural electrification projects

Projects for conventional power grid expansion as well as those based on renewable energy sources are being conducted within the scope of the PLANER rural electrification programme.

Grid expansion projects

Puerto Cabezas: The objective of this project is to improve the quality of the power supply system in Puerto Cabezas and 12 adjacent municipalities. Funding budgeted for this project comes to US$ 1,925,000.

Rural electrification in six departments: In this project, electricity networks are to be expanded, thereby connecting 33 municipalities (1,294 households; 7,551 inhabitants) in five departments (Estelí, Matagalpa, Jinotega, Madriz and Boaco) to the grid. The project budget amounts to US$ 1,750,000.

Development of the milk industry in Boaco and Chontales: This project targets promotion of productivity in the region by improving technological processes and introducing new alternatives. Plans call for a commercial-level power supply system (120/240V) for 19 dairies in the municipalities of Boaco and Chontales and electrification of 13 municipalities located in the vicinity of the planned grid lines. The total budget for this project comes to US$ 3,000,000.

Productive zones of the concession area: The goal of this programme is to significantly increase the number of households with access to electricity in rural areas, in particular in communities that demonstrate clear potential for economic development. Planning envisages expanding the grid by 278 km in the RAAS Autonomous Region and the departments of Río San Juan, Boaco und Chontales. Some 38,000 inhabitants in 163 municipalities are meant to benefit from these efforts. The programme budget totals US$ 4,750,000.

Rural electrification fund (Fondo Electrificación Rural, FAROL-ER): The project area is in Nicaragua's north in the Nueva Segovia, Jinotega, Matagalpa, Madriz and Estela departments and the DISNORTE concession area. Here as well, rural areas where there is considerable potential for economic development are to be given preference.

Electrification projects utilising renewable energy sources:
Implementation of the following hydroelectric projects is underway within the framework of the UNDP/GEF project 'Uso Productivo por medio de Minicentrales Hidroeléctricas', financed by GEF/UNDP and COSUDE (Swiss Government) as well as in part by the GTZ project 'EnDev Nicaragua':

- Rio Bravo small hydropower project: This project, with an installed electrical generating capacity of 170 kW, is located in the Waslala municipality of the RAAN Autonomous Region. Installation work on the hydropower facility was begun in 2006, and operation is scheduled to commence in the first half of 2007.
- Bilampí small hydropower project: This project, with an installed electrical generating capacity of 300 kW, is located in the department of Matagalpa. Installation work on this hydropower facility likewise began in 2006, and the plant will go into operation in the first half of 2007.
- El Najanja small hydropower project: This project, with an install electrical generating capacity of 210 kW, is located in the municipality of El Najanja, the Waslala area of the RAAN Autonomous Region. Investment in this hydropower facility is being co-financed within the scope of the GTZ project 'EnDev Nicaragua'. Project implementation is scheduled to begin in 2007.
- El Bote small hydropower project: This project, with an installed electrical generating capacity of 900 kW, is located in Matagalpa in the Waslala area of the RAAN Autonomous Region. Installation began in 2004, and the plant has been in operation since early 2007. The project was co-financed by the Government of Switzerland.
- Salto Kepí small hydropower project: This project, with an installed electrical generating capacity of 1.5 MW, is located in the municipality of Mulukukú in the Paiwas area of the RAAN Autonomous Region. The project is scheduled for implementation in 2007.
- Salto Molejones small hydropower project: This project, with an installed electrical generating capacity of 630 kW, is located in the north of the municipality La Esperanza in the RAAS Autonomous Region. This project is likewise scheduled for implementation in 2007.

Further projects for rural electrification are based on photovoltaic systems and currently under execution within the scope of projects noted above, i.e. PERZA (WB), 'Francia Sirpi' (WB/GEF), 'San Juan de Nicaragua' (WB/GEF) and 'Proyecto Sistemas Fotovoltaicos' by IDB in Waspán (RAAN Autonomous Region).

Exchange rate (6 May 2007):
1 Nicaraguan cordoba (NIO) = 0.0418 euro (EUR)

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Caribbean States

9.1.1 Energy sector in the selected Caribbean states – a summary

The Caribbean states presented below comprise the four Windward Island states of Barbados, Grenada, Saint Lucia and Saint Vincent & the Grenadines (SVG), and the island of Dominica, in the Leeward Islands. While Barbados is situated some 100 miles (160 km) to the east of the Antilles arc and can be described as a relatively dry, low, limestone island, the other islands all have volcanic origins and are accordingly characterised by distinctive, partly steep and craggy, mountainous landscapes and rather high precipitation (>2000 mm per annum). With the exception of Grenada, they all have substantial geothermal potential. All of these islands are exposed to north-easterly trade winds and therefore possess correspondingly good wind power potential.

Another common attribute of all the islands (excepting Dominica) is that they are each supplied with electricity from a national power utility company with a monopoly on power generation, transmission, distribution and sale. In Dominica, the energy sector was (partially) liberalized in 2007, but that of the other countries is still in transition. Sometime within the next few years, reforms are expected to open up the electricity market, primarily for investments by independent power producers. Thanks to high electricity tariffs coupled with improving framework conditions, the wind power and solar energy sectors are the most attractive on all of the islands, and the same applies to geothermal and hydroelectric power on several of them.

The following table surveys the basic energy sector data for the selected OECS (Organisation of Eastern Caribbean States) members and Barbados.

Electricity sector					
	Barbados	**Dominica**	**Grenada**	**St. Lucia**	**SVG**
Population (approx.)	280,000	74,000	100,000	160,000	118,000
Area [km^2]	432	750	344	616	389
Utility	BL&P	DOMLEC	GRENLEC	LUCELEC	VINLEC
Universal license until	2028	2015 (new, from 2007)	2073	2045	2033
Installed capacity [MW]	239.1	23.5	45.1	65.8	39.98
Installed RE capacity [MW]	2 kW (PV)	7.6 (hydropower)	15 kW (PV) 80 kW (wind)	none	5.7 (hydropower)
Peak load [MW]	154.2	14.4	24.0	49.2	20.6
RE share	0% (15%*)	35-40%	0%	0%	19-27%
Electrification level	100%	99%	99.5%	99%	99%
2005 sales volume [GWh]	885.0	67.8	131.6	323.6	103.7
Electricity tariffs [US$/kWh]	0.24 (2006)	0.37 (2006)	0.30 (2006)	0.26 (2006)	0.28 (2004)

Electricity sector					
	Barbados	Dominica	Grenada	St. Lucia	SVG
Current RE policy					
National energy policy	draft stage	processing stage	none	draft stage	draft stage
National energy action plan	none	draft not yet adopted	draft not yet adopted	adopted by cabinet	draft not yet adopted
RE targets	2012: 10% of national consumption, 2026: 20% of national consumption	2008: 48% of installed generating capacity 2015: 65–70% of installed capacity	none	2007: 10% of peak load	none
IPPs allowed	no	yes	with sublicence from utility	with sublicence from utility	with sublicence from utility
Autonomous generation allowed	with sublicence from utility	yes, up to 20 kW unlicensed	yes, net metering up to 10 kW	yes, but only off-grid	yes, but only off-grid
Injection by IPP regulated by law	no	yes	only net metering up to 10 kW and subject to unit verification	no	no
Utility's position on RE injection	own generation preferred	regulated by new law	own generation and net metering	own generation preferred	generation and willingness to purchase
Incentive mechanisms for solar water heaters	income tax relief, import-tax exemption	no tax on imported equipment and components	tax exemption for hotels importing equipment and components	income tax relief, import tax exemption	case by case decisions (approval required)

*** Thanks to the use of solar water heaters, renewable energy sources contribute approx. 15% of all power used.**

Tab. 1: Survey of the energy sector situation in the selected Caribbean states[1]

More than 90% of power supplies in the region are dependent on imported fossil fuels. Most Caribbean islands with the exception of Trinidad and Tobago have little or no oil, natural gas or coal resources. As a consequence, some countries, Grenada for example, have to spend as much as half of their export revenues on imported fossil fuels. Within the framework of the 2005 PetroCaribe Alliance, Venezuela supplies crude oil and petroleum products on concessional terms. The majority of Caribbean states have already joined the alliance, although St. Lucia and Barbados are yet to do so.

Most of the Caribbean states' economies rely mainly on income from tourism and agricultural exports, in addition to private transfers from workers in foreign employment. Only on the larger islands, such as Jamaica and Trinidad & Tobago, are there any energy-intensive industries to speak of.

During the period of rising oil prices in 2005/2006, the already comparatively high electricity tariffs escalated to levels between 0.24 US$/kWh (Barbados) and 0.37 US$/kWh (Dominica).[2] Those rates are among the highest in the world; they include the usual Caribbean fuel surcharges that are added to the base tariffs.

1 Thomas Scheutzlich: German Contribution to the (CREDP/GTZ), paper presented at the Caribbean Environmental Forum (CEF-3), Antigua, 5-9 June 2006.

2 At 0.04 US$/kWh, electricity tariffs on Trinidad and Tobago are very low, thanks mainly to indigenous oil and natural gas resources.

9.1.2 Status of renewable energy sources in the selected Caribbean states – a summary

Despite considerable potential for wind and solar energy and, to a lesser degree, hydropower, geothermal and biomass resources, renewable energy still only accounts for about 3 % of all electricity generated in the CARICOM[3] region.

The main reason for such an exceptionally low level of renewable energy utilisation is the unfavourable political and legal context, which imposes a whole range of barriers – such as the monopolies enjoyed by national power utility companies in all the countries examined, a lack of incentives for RE utilisation and, conversely, a lack of sanctions for non-utilisation (which explains the absence of investment by IPPs) but also the utilities' lack of awareness of RE technologies, and their resultant lack of planning and maintenance capacities for RE systems.

The steep oil price rises of 2005/2006 had very serious consequences, primarily for electricity consumers, since any increase in the price of oil is usually passed directly on to them via the fuel surcharge, but also for the governments, which are having to contend with hugely greater outflows of foreign exchange to pay for imported oil. Increasing pressure from governments and consumers alike led to the national power utilities opening themselves up to the application of RE technologies and development of their potential, and they are now pressing ahead with RE projects to differing degrees of intensity and at various rates.

Since most of the countries have sufficient generating capacities in place to avoid bottlenecks, the more pressing problem is their desire, or indeed need, to reduce the high prime costs of power generation. Hence, RE technologies are regarded mainly as 'fuel savers' and only secondarily as a means of creating new generating capacity.

Regional programmes for the development of renewable energies

The problematic situation outlined above was the point of departure for the Caribbean Renewable Energy Development Programme (CREDP), which since 2003 has received from GEF/UNDP and the Government of the Federal Republic of Germany (BMZ) funding to the amount of approx. US$ 7 million and is now being coordinated by the CARICOM Secretariat in Guyana. The objective of the project, in which 11 of the 15 CARICOM member countries are participating, is to eliminate the aforementioned barriers. The present phase of the programme is concentrating on the provision of advisory services to the governments of the OECS states (Organisation of Eastern Caribbean States) in their efforts to create advantageous and secure regulatory frameworks, and to identify concrete RE projects and help bring them to a state of investment maturity.

CAWEI[4] is a regional initiative that was originated by the CREDP/GTZ project and co-financed by the EU Energy Initiative (EU EI/PDF[5]), and which is now being coordinated by CARILEC.[6] Its objective is to bundle and to dispose by joint international tendering as many Caribbean wind farms as possible in order to minimise, through economies of scale, the cost to the suppliers for transactions, maintenance and repair.

CAWEI also provides a platform for the exchange of expertise and experience among power providers who are already operating or planning wind farms. Just recently, tendering documents for regional-scale competitive bidding on three wind farms were drawn up via CAWEI and are presently been discussed by the participating power utilities. The documents afford special treatment to such factors as the Caribbean Basin's specific situation (small, often weak isolated grids; low capacities; hurricanes; seawater erosion; etc.).

3 The Caribbean Community (CARICOM) has 15 member states.
4 CAWEI – Caribbean Wind Energy Initiative.
5 PDF – Partnership Dialogue Facility, a promotion instrument of the EU Energy Initiative (EU EI).
6 CARILEC – Caribbean Electric Utility Services Corporation, based in St. Lucia.

Above and beyond that, power providers in other Caribbean countries, for example Jamaica, Cuba, Dominica, Grenada, St. Kitts & Nevis, Anguilla, Montserrat, Guyana and Surinam, are also expressing interest in the installation of (additional) wind farms. In principle, the planners of such wind energy projects can count on future support from CAWEI.

UNEP/OAS (Organization of American States) is also providing assistance to a regional programme devoted to the development of geothermal energy in Dominica, St. Lucia and St. Kitts & Nevis.

The latest developments in the use of renewable energy resources in the five countries that are the subject of this study are summed up in the following sections.

Hydropower

Few Caribbean states[7] have much hydropower potential. In fact, of the countries under discussion, only Dominica and SVG have any significant potential at all.

The first hydroelectric plant in Dominica was installed in 1952, and by the 1960s the country was meeting roughly 90 % of its energy requirements with hydroelectricity. However, as time passed, the increasing use of diesel fuel, coupled with dry season water shortages, ageing equipment and technical problems, caused that percentage to drop drastically. The installed capacity (6 MW) is not available all year round, but decreases to about 3.6 MW during the dry season.

The downslide was particularly noticeable in 2001, when numerous new diesel generators were installed to cover rapidly rising demand and grid expansion.[8]

Dominica presently has three hydropower plants with a total cascaded output of 7.6 MW, only 6 MW of which, however, is technically available. They were constructed between 1965 and 1988.

In 2005 CREDP/GTZ conducted a feasibility study on the rehabilitation and expansion of power-generating capacities at the Old Trafalgar and Padu power stations in Dominica. The study established the fact that such a project would be both technically and economically feasible and viable. However, the owner of the plants (Dominica Electricity Services, Ltd. – DOMLEC) has not yet acted on the suggestion.

Due to the 2006 amendment of the Electricity Supply Act (ESA), more independent and autonomous power producers can be expected to emerge in the future. For example, the operators of a tourist resort on the east coast have expressed interest in generating their own electricity from hydropower, as have a number of industrial enterprises, and a number of independent power producers would like to engage in the commercial operation of hydropower plants.

One concrete project for which CREDP/GTZ is presently conducting a feasibility study for the Dominica Water and Sewerage Company (DOWASCO) – the 'Newtown' project – would be able to utilise an existing potable water conduit for generating approximately 150 kW output. The commercial feasibility is outstanding, and DOWASCO is expected to implement the project.

CREDP/GTZ's conservative estimate of Dominica's untapped hydropower potential is put at roughly 5 to 10 MW.

St. Vincent has approx. 5.2 MW installed capacity in the form of hydropower plants that provide between 19 % and 27 % of the country's electricity (albeit with major dependence on annual precipitation levels). Many years ago, in the early 1970s, hydropower still accounted for 80 % of all electricity produced in St. Vincent. The plants, all of them run-of-river facilities, are located at South Rivers on the east coast (0.9 MW), Cumberland on the west coast (3.7MW) and Richmond, also on the west coast (1.2 MW).

7 Outside of St. Vincent and Dominica, substantial hydropower potentials can also be found in Guyana, Surinam, Belize, Cuba and Jamaica.
8 Vidal, 2004.

CREDP/GTZ also conducted a feasibility study for St. Vincent in 2005. The results documented the technical and commercial feasibility of rehabilitating and optimising the Richmond and South Rivers hydropower stations, and in 2006 the VINLEC supervisory board agreed to launch the project. A project prequalification programme published by VINLEC expires at the end of April 2007.

St. Vincent's available but as yet untapped hydropower potential ranges somewhere between 5 MW and 8 MW.

With its Millet River Dam, St. Lucia has a small hydroelectric reserve capacity of some 150 kW. A feasibility study on the utilisation of excess flow and of the minimum ecological flow established the technical and commercial viability of such a project. The study was forwarded to the St. Lucia Water and Sewerage Company (WASCO), but no decision has yet been taken. This would be a strictly 'fuel-saver' type of project that could help WASCO reduce their pumping station operating costs.

In Grenada, possible hydropower potentials were studied in the 1980s, but nothing beyond about 500 kW was discovered.

Wind energy

Wind energy is an RE technology that nearly all Caribbean states can make use of, although site-dependent differences in yield must be anticipated.

While wind farms have been in operation in Curaçao (Netherlands Antilles) and Guadeloupe since the 1990s, it was not until mid-2004 that the first wind farm was commissioned in the Anglophone Caribbean (Wigton Wind Farm in Jamaica, 20 MW). There was also a 250-kW turbine in Montserrat (a British overseas territory) until it was destroyed by a volcanic eruption.

In the eastern Caribbean, regional and international organisations (CDB, OECS, OAS[9]) have been conducting and supporting wind measurements and site searches since the 1980s. However, many of the originally identified locations have since been built on and are therefore no longer available. The technically useful wind potential is practically only limited by the permissible penetration rate for the existing isolated grid and by the number of sites that are both suitable and available. Especially on small islands, a lack of the latter often poses a nearly insurmountable barrier.

There are presently three wind farm projects in planning: the Lamberts plant on Barbados, with approx. 11 MW; the 12 MW Sugar Mill project on St. Lucia; and the 7 MW Ribishi Point project on St. Vincent. Hoping to attract the attention of the international wind industry, the three power providers Barbados Light & Power (BL&P), LUCELEC and VINLEC have pooled their efforts in a Caribbean Wind Energy Initiative (CAWEI) designed to achieve a 'critical mass' for joint international tendering on wind farms with a total output of 30 MW.

Barbados has made the most progress toward actually building a wind farm that can produce between 26 and 30 GWh annually. An environmental impact assessment was commenced in 2006 and is already completed.[10]

In Dominica and Grenada, the respective utilities DOMLEC and GRENLEC are in the process of searching out locations and gathering anemometric data, which, when they are finished, should enable implementation of small wind farms in the capacity range of 5-8 MW.

On Grenada, in March 2007, an 80-kW wind turbine was erected on the premises of a holiday resort near Paradise Bay on the east coast. As of May 2007, the new plant is to join a diesel generator in supplying electricity to the complex. GRENLEC has promised to purchase any surplus output.

9 CDB – Caribbean Development Bank, OECS – Organisation of Eastern Caribbean States, OAS – Organisation of American States.
10 The last public hearing on the matter took place in Barbados on 24 February 2007.

Biomass
In Barbados, bagasse is the main source of biomass. It is used for cogenerating purposes in sugar factories, but only on a seasonal basis. The possibility of producing ethanol from bagasse has also been investigated. The government commissioned a feasibility study on the development of power generating capacities based on bagasse, the goal being to secure an additional 30 MW of electricity for the public grid.

Biofuels
Biofuels for power generation and the transport sector are a topic of growing relevance in the Caribbean, too. On St. Vincent, for example, the possibility of cooperating with Guyana to cultivate jatropha (Barbados nut/physic nut/purging nut) in Guyana is under consideration as a biofuel material that could be jointly processed and marketed.[11]

Solar energy
Given grid coverage of nearly 100%, the use of solar energy to generate electricity presently (still) amounts to little more than a niche technology in the countries under discussion.

As is typical of Caribbean islands, Barbados enjoys an insolation rate of the order of 5.6 kWh/m^{2}d. Various photovoltaic systems have been installed in Barbados, the largest of which is a 17.3 kW system located at Harrison's Cave near the centre of the island.

An interesting approach has been adopted in Grenada, where the private-sector company GRENSOL sells and installs photovoltaic systems and recently entered into an agreement with the power utility GRENLEC to inject power from systems with ratings up to 10 kW into the local grid in a net-metering arrangement. Three such systems were installed in 2006 (3.3 kW$_p$, 2.3 kW$_p$ and 1.3 kW$_p$), and two additional systems are planned for the first half of 2007.

Barbados is the Caribbean country with the largest number of installed solar water heaters (SWH), and it even ranks high globally in the use of this technology. An estimated 35,000 systems were in operation in 2005 (NREL, 2005), saving the country some US$ 6.5 million annually on oil imports. Three local companies build the SWHs, which are now considered standard equipment for all new buildings on the island.

Additional solar applications include: (I) solar distillation projects, primarily among educational institutions, where solar-powered stills are used for producing distilled water; and (II) solar drying of harvest crops.

A market study on solar water heating practice that CREDP/GTZ conducted on the islands of Dominica, St. Lucia and St. Vincent revealed substantial latent demand for solar water heaters, particularly in the hotel and tourism sector.

Geothermal energy
Due to pronounced volcanic activity in the area, Dominica has major geothermal potential. Several different studies conducted in recent years have identified some promising locations, particularly in the southern part of the island, for example around Wotten Waven, Boiling Lake and Soufrière. A study carried out by Electricitè de France (EdF) in the 1980s indicates sufficient potential for plants with ratings as high as 100 MW, mainly in the southern part of the island, and other studies estimate the theoretically available potential as even higher (300 MW). If those resources were to be developed, Dominica could install undersea cables and export energy to other islands, particularly to Guadeloupe and Martinique.

11 As reported by SVG Prime Minister Dr. Ralph Gonsalves at a meeting in March 2007.

The OAS and other partners are promoting and exploring Dominica's geothermal resources by way of the Eastern Caribbean Geothermal Development Project (Geo-Caraïbes), which was launched in 2005. This regional initiative also involves St. Lucia and St. Kitts and is being financed by the Global Environment Facility (GEF). Its objective is to create an amenable context for the commercial exploitation of geothermal energy in the eastern Caribbean area. It addresses technical aspects (e.g. quantification of potentials), the legal framework (e.g. legislative and policy reforms and strengthening of local institutions) and financial considerations (e.g. launching of a venture capital fund for geothermal drilling).

Thanks to high levels of volcanic activity, geothermal energy probably constitutes one of the most important renewable sources of energy on St. Lucia, where a number of exploration programmes have been conducted over the past two decades. The findings confirmed the existence of geothermal resources that could become a substantial component of the island's overall blend of power-generation energy sources. Despite the findings, however, no plans have yet been drawn up to further investigate the potentials. On the other hand, the government and a Canadian IPP by the name of Unified Network of the Eastern Caribbean (UNEC) signed a letter of intent in 2004 to partner in the development of geothermal springs, especially in the vicinity of Soufriere.

Future projects in the region

CREDP has a portfolio of some 23 projects that have already passed their first project triage and are slated for implementation within the next few years. Seven of the projects (three wind power projects and four hydropower projects) are being processed by CREDP/GTZ.

In the wind power sector, still-cautious utility companies could take the lead in accelerating some additional projects. This refers in particular to DOMLEC (Dominica), GRENLEC (Grenada), NEVLEC (Nevis) and ANGLEC (Anguilla). Jamaica is planning to expand the existing Wigton Wind Farm by an additional ~15 MW.

In Dominica, a local investor group has requested help from CREDP/GTZ for identifying a suitable site and planning a hydropower project.

The Government of Barbados Millennium Project has seized upon existing plans for establishing a Centre of Excellence for renewable energies. The centre is to serve research, development, training and information-dissemination purposes for all branches of the renewable energy sector.

Further information on the activities of the entire CREDP programme, including the part financed by GEF-UNDP, is available at www.caricom.org.

9.1.3 Information Sources – General

- CREDP/GTZ:
  Followup mission on renewable energy policy in the Caribbean (St. Lucia, Dominica, St. Vincent and Jamaica), Final Report, October 2-19, 2004

- CREDP/GTZ:
  German contribution to the CREDP/GTZ,
  Paper presented at Caribbean Environmental Forum, June 2006

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  The status of energy policy in selected Caribbean countries, 2005

- ECLAC:
  Renewable Energy Sources in Latin America and the Caribbean: Situation and Policy Proposals, Santiago de Chile, April 2004

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  OECS Energy Issues and Options, 2006
- **Lambrides, M.**:
  Eastern Caribbean Geothermal Development Project (Geo-Caraïbes), Organization of American States Presentation, 2005
- **Menke, C.**:
  Investment in renewable energy and energy efficiency: Does it pay back? Paper presented at Third Caribbean Environmental Forum & Exhibition (CEF-3), Antigua and Barbuda, June 5-9th, 2006

Barbados

9.2.1 Electricity market

Contrary to the other Caribbean islands (apart from Trinidad), Barbados possesses a limited amount of petroleum resources that serve along with imported fossil fuels to cover the country's energy requirements, including power generation. In 2005, imported oil cost the country some 140 million euros (BD$ 350 million), a sum that was substantially larger than in the preceding years. Thanks to the extensive use of solar water heaters instead of the otherwise customary electric models, renewable energies are now contributing approximately 15 % of the overall energy supply.

Installed capacity

The total installed electricity generating capacity in 2005 amounted to 239.1 MW, with peak load reaching 154.2 MW. In May of 2005, two older-model generating facilities with a capacity of roughly 31 MW were replaced with a pair of new generators rated at 30 MW each. This yielded a 14 % net increase in overall output. The new generators are more efficient and run on low-grade heavy fuel oil. As such, they have helped dampen the effects of increasing oil prices.

Power generation

Most of the generators used for producing electricity are diesel-electric units that run on heavy fuel oil. Some gas turbines are kept in reserve for peak loads and emergencies. In 2005 BL&P generated 953.4 GWh of electricity. That was 6.4% more than the year before and, hence, higher than the average increase of 4.1 % per year over the past five years.

Power consumption

In 2005, all consumers together paid US$ 172 million for 885 GWh of electricity. Household power consumption rose by 6.5 % over 2004 to 294 GWh (Fig. 1), and similar growth (6.4 %) was registered in the industrial/commercial sector, where 591 GWh was consumed.[12] Other major users include the public sector and the hotel branch, each of which accounts for around 15 % of total consumption.[13]

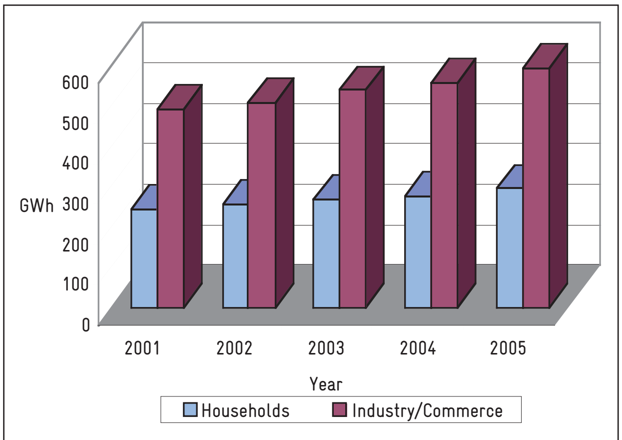

Fig. 1: Power consumption according to sector in Barbados; GWh; 2001-2005

Electricity prices

Due to the global rise in the cost of crude oil between 2004 and 2006, the cost of fuel now accounts for more than 45 % of total expenditures at the Barbados Light & Power Company. In 2005, electricity tariffs had to be ratcheted up some 31 % between January and December due to the increasing surcharge on fuel. In October and November 2006 the adjustments amounted to 94.2 and 89.4 US$/MWh respectively.[14]

The household electricity tariff comprises a monthly fixed charge[15] of US$ 1.52 and the following tariff classes:

Monthly consumption rate	Basic charge (US-ct/kWh)
First 100 kWh	8.93
Next 900 kWh	9.95
Over 1000 kWh	10.96

Tab. 2: Electricity tariffs in Barbados, in US-ct/kWh

The fuel surcharge is added to the basic charges. Small-scale commercial users have a similar tariff structure; they pay an availability fee (energy rate) of 2.54 US$/kVA and a consumption-dependent demand rate of 0.115 US$/kWh. Major consumers are exempted from a fixed fee, instead paying an energy rate of 1.52 US$/kVA and a consumption-dependent demand rate of 99.50 US$/MWh.

This puts the electricity tariffs in Barbados at the lower end of the region's electricity prices. This is partly attributable to the island having its own oil fields.

Development planning

The island's generating capacities are being expanded, and its distribution network is being upgraded in order to satisfy increasing demand for electricity while improving the reliability and efficiency of supply. Additional generating capacities totalling 240 MW (gas turbines and slow-running diesel generators) are in planning for Trents Plantation, St. Lucy. This capacity expansion project will be spread out over the next 20 years, beginning with the installation of a 30 MW gas turbine in 2008. Also, a new sugar factory is being designed for combined heat and power generation straight off the drawing board.[16]

A wind farm with a rating of approx. 10 MW is being planned and scheduled for international tendering sometime in 2007 with the assistance of CREDP/GTZ's Caribbean Renewable Energy Development Programme.

12 Source: BL&P Ltd. 2005 Annual Report.
13 Source: Sealy, 2006.
14 www.blpc.com.bb.
15 All cited tariffs are exclusive of the legally prescribed 15 % value-added tax.
16 BL&P Ltd., 2005 Annual Report.

The national power utility BL&P Ltd. has earmarked some US$ 41 million[17] for the upgrading and new construction of substations and for the installation of a new 132 kV transmission line for moving large quantities of electricity between the southern and northern regions of the country.[18]

9.2.2 Market actors

Barbados Light & Power Company Ltd.

The power utility company Barbados Light & Power Company Ltd. (BL&P) has a universal licence for generating, transmitting and distributing electricity in Barbados until 2028. BL&P is a limited liability company in the majority ownership of the local National Insurance Board (28 %) and the Canadian International Power Co. Ltd. (37 %).[19]

Other actors

Fair Trading Commission (FTC)

The FTC assumed responsibility for regulating the various power utility companies in Barbados in 2001. Its task is to ensure that regulated power utilities such as BL&P comply with the provisions of the Utilities Regulation Act and other laws concerning consumer protection and fair competition.

Recently the FTC issued a set of service standards applicable to the power utility operations of BL&P; the set includes a standard on the quality of electricity.

Ministry of Energy and Public Utilities

The Ministry of Energy and Public Utilities is responsible for decisions relating to energy and natural resources, public utilities, the National Petroleum Corporation and the Barbados National Oil Company.

9.2.3 Legal framework

The energy sector is governed by the Electric Light and Power Act (1899) and regulated by the Fair Trading Commission Act, Cap. 2000-31, and the Utilities Regulation Act, Cap. 2000-30.

The currently valid regulations do not provide for power generation by independent companies because the power utility holds a monopoly on the generation, transmission and distribution of electricity. While the law does allow autogeneration, i.e. the generation of electricity for in-house consumption, it prohibits the sale or injection into the grid of such electricity.

The electricity supply tariffs are set according to the provisions of the Utilities Regulation Act; responsibility for doing so lies with FTC. The law defines the principles, tariffs and service standards, makes adjustments, and monitors the law's implementation by users.

9.2.4 Policy promoting renewable energy sources

The Barbados Ministry of Energy and Public Utilities has overseen the drafting of an energy policy for Barbados in connection with which the government set itself the ambitious goal of seeing to it that renewable energy sources contribute more than 30 % of the island's primary energy requirements by 2012.

The new energy policy is also intended to pursue the following two objectives:

1. reduce dependence on fossil fuels through focussing on renewable energies
2. promote research and development in the field of energy efficiency, oil and natural gas exploration and renewable energies (Sealy, 2006).

17 BL&P Ltd. Northern Expansion – BL&P news article: www.blpc.com.bb/wattsnew.cfm?ID=24.
18 The voltage level in the existing high-tension lines is 24.9 kV, with the exception of one buried transmission line rated at 69 kV.
19 Barbados Light and Power: Our History (www.blpc.com.bb/aboutus/history/history5.cfm).

Several provisions of the tax code are designed to promote renewable energies, particularly with respect to solar water heaters. The Fiscal Incentive Act of 1974 grants import benefits and tax exemptions to producers of such equipment. Tax concessions are also offered for the installation of solar water heaters under the 1984 Income Tax Amendment: the cost of such systems can be directly and fully deducted from the purchaser's income tax. In addition, all electric water heaters are subject to a 60 % consumption tax, and are accordingly unattractive to purchase.

Clean Development Mechanism

Barbados signed the Kyoto Protocol in August 2000 and has established a Designated National Authority (DNA). To date, no CDM energy projects have been registered.

9.2.5 Information Sources

- **Barbados Government Information Service**:
  Energy Conservation

- **Barbados Light and Power Company Limited**:
  Annual Report, 2005

- **Barbados Light & Power Company Limited**:
  Environmental Impact Assessment Study for Proposed Low Speed Diesel Plant at Trents, St. Lucy, TC51603, February 2006

- **CREDP – Caribbean Renewable Energy Development Project**:
  Volume II, Country Report Barbados, Projekt-Consult GmbH, March 2000

- **Fair Trading Commission**:
  Decision on Standards of Service for the Barbados Light and Power Company Limited.

- **Fair Trading Commission**:
  Act. Chapter 326B

- **Government of Barbados**:
  Economic and financial policies of the Government of Barbados, presented by the Rt. Hon. Owen Arthur, Minister of Finance, January 16, 2006

- **Sealy, H.**:
  The role of hydrogen in the economy of a small island developing state like Barbados, International Seminar on the Hydrogen Economy for Sustainable Development, September 28-29, 2006, Reykjavik, Iceland

9.2.6 Contact Addresses

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9.3.1 Electricity market

Dominica's power sector is based on a mixture of imported fossil fuels and locally produced hydroelectric power. The latter accounts for approximately 33% of the overall power output (2005). Dominica has so much untapped hydropower, wind energy, geothermal energy and solar energy that the country could actually obtain all of its electricity from renewable energy sources and even have some left over to export.[20] The Caribbean Renewable Energy Development Programme (CREDP/GTZ/UNDP) and GeoCaribe, a geothermal energy project sponsored by GEF-UNEP and OAS, are presently rendering assistance.

Installed capacity

In 2005, the installed generating capacity at the disposal of Dominica Electricity Service Company (DOMLEC)[21] amounted to 23.5 MW, of which 7.6 MW stemmed from hydroelectric plants. The guaranteed generating capacity was 14.8 MW, including 3.2 MW dry-season hydropower. The peak load in 2005 amounted to 14.4 MW.

Capacity expansion

DOMLEC expanded its generating capacity by 3 MW in 2005 by adding a new diesel generator and had planned to add another 3 MW in 2006, but that has not yet taken place.

Between 2000 and 2005, technical and non-technical power losses averaged a comparatively high 17.3% (LUCELEC: approx. 10%) and were mainly attributable to losses occurring in the low voltage grid. DOMLEC therefore commissioned a study for the purposes of identifying the causes and developing a programme to reduce the losses. Countermeasures were introduced, including the replacement of low voltage lines and defective capacitors, plus reductions in the ratings of underutilised transformers. Some of the switchgear at Padu Hydropower Station has already been replaced, and a meter replacement programme (MRP) is being implemented.

20 Scheutzlich, Thomas, 2005.
21 DOMLEC lost its monopoly in all parts of the sector when the new electricity law took effect.

In addition, approximately 3,000 pre-paid meters were installed in 2005, and another 2,000 are scheduled for installation by the end of 2006.

Power generation

Power generation increased by 6.3 % between 2004 and 2006. This was mainly due to an increase in the use of diesel generators (plus 22.6 %), while the share contributed by hydropower dropped 17 %. This, in turn, was partly attributable to low precipitation levels and partly to technical problems at one of the hydropower facilities.

A 2005 feasibility study conducted by CREDP/GTZ illustrates the technical and economic options for rehabilitating and expanding the capacity of the existing hydroelectric power plants. DOMLEC, however, has not yet implemented any such option.

Power consumption

Following a 2.3 % drop in physical turnover in 2003 caused by a recession in Dominica (due to a decline in tourism), sales of electricity increased by 5.9 % in 2004 and 2.1 % in 2005.

Dominican consumers paid US$ 23 million for 67.8 GWh of electricity in 2005; that corresponds to an average price of 0.34 US$/kWh, or 2 % higher than in 2004. The domestic and commercial sectors registered consumption increases of 1 % and 4 %, respectively, while the industrial and hotel sectors consumed less electricity than before. The decline is regarded as a result of rising fuel prices that have had negative effects on autogeneration by some of the electricity customers.[22]

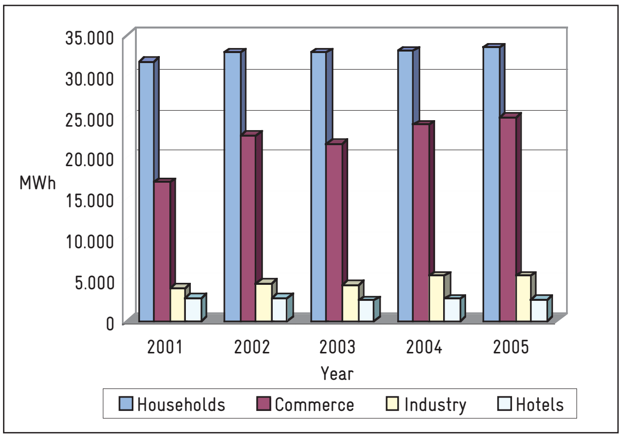

Fig. 2: **Power consumption according to sector in Dominica; MWh; 2001-2005**

Electricity prices

Electricity tariffs in Dominica are among the highest in the region. The average domestic tariff is 0.37 US$/kWh, including a fuel surcharge to the amount of roughly 0.17 US$/kWh. In 2005, the cost of fuel accounted for more than 50 % of the overall cost of power production. That was 46 % more than in 2004.

For five years running and despite all efforts, DOMLEC has been unable to achieve the legally prescribed fuel efficiency level of 17.5 kWh/gallon[23] (actually achieved: 17.4 kWh/gallon).

22 DOMLEC: 2005 Annual Report.
23 1 imperial gallon = 4.55 litres.

9.3.2 Market actors

Dominica Electricity Services Limited (DOMLEC)
At the moment, DOMLEC is still the only power provider on the island. Its main owner is WRB Enterprise Inc., based in Florida. However, when the new Electricity Supply Act was enacted in November 2006, DOMLEC lost its monopoly, and the market was opened up for independent power producers.

Other actors

Ministry of Housing, Lands, Telecommunications, Energy and Ports
The Ministry of Housing, Lands, Telecommunications, Energy and Ports is responsible for formulating Dominican energy policy.

Ministry of Public Work and Public Utilities
The Ministry of Public Work and Public Utilities is responsible for operating the public utility companies DOWASCO (water) and DOMLEC (electricity).

9.3.3 Legal framework

The power sector is regulated by the recently amended Electricity Supply Act (ESA). The new ESA was passed by parliament in November 2006 and entered into force in January 2007.

The new energy law dating from 2006 replaces the old ESA dating from 1996, which had granted DOMLEC a universal licence up until 2025. Under the old law, other companies required permission from DOMLEC to engage in autogeneration. The new law, though, abolishes DOMLEC's monopoly by opening up the energy market for companies interested in generating, distributing and marketing electricity on the island.

One key element of the 2006 ESA is the establishment of a regulatory authority (Independent Regulatory Commission – IRC) whose responsibility it is to regulate all power-sector enterprises and licensees to protect the interests of all market participants, and to approve electricity tariffs.

9.3.4 Policy promoting renewable energy sources

In parallel with the institution of the new regulatory authority, the National Energy Commission is also in the process of formulating an energy policy that will reflect the political will and long-term vision of the government.[24]

A Sustainable Energy Plan (SEP) was drawn up in connection with the Global Sustainable Energy Islands Initiative (GSEII), but it has not yet been officially adopted by the government. The plan contains, among other things, measures for promoting renewable energy in order to diversify the national energy mix while enhancing energy efficiency.

24 CREDP/GTZ is helping the Government of Dominica establish a regulatory authority and formulate its energy policy.

While the government has not yet formulated any particular RE promotion policy, all RE systems are already exempt from import taxes and value-added tax.

The new electricity law dating from November 2006 now declares the use of renewable energy resources an official goal of the government's energy policy, whereby the following individual objectives are being pursued:

a. Optimisation of present applications and further development of hydroelectric resources.

b. Development of solar energy – the government has already invested in a small-scale PV system (in Morne Diablotin National Park) and regards solar thermal systems (water heaters) as an important contribution toward reducing power consumption levels.

c. Further development of wind energy resources, particularly as 'fuel savers'.

d. Participation in a geothermal energy project[25] – a GEF-financed, OAS-coordinated sub-regional initiative encompassing Dominica, St. Lucia and St. Kitts & Nevis for the purpose of analysing and developing geothermal resources.

Clean Development Mechanism

CDM measures on the island of Dominica are still at a very early stage. Dominica signed the Kyoto Protocol in January 2005 but has not yet established a Designated National Authority (DNA). No CDM-based energy projects have yet been registered.

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25 The Eastern Caribbean Geothermal Development Project (Geo-Caraïbes).

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Grenada

9.4.1 Electricity market

As in most other Caribbean states, Grenada's energy supply is almost completely dependent on imported fossil fuels. On average, half of all export revenues are spent on fossil fuel imports. The latter, in turn, account for approx. 11 % of all imports. The sharply increasing price of oil in the past few years has worsened the situation. However, and again like most other Caribbean islands, Grenada has wind and solar energy resources, and in addition has biomass in the form of nutmeg production residue.

Grenada Electricity Services Ltd. (GRENLEC), as the only power provider serving Grenada, Carriacou and Petit Martinique, operates on a universal licence that runs until 2073. While there have been no commercial approaches to the exploitation of RE resources taken to date, since 2006 GRENLEC has been making preparations for a wind farm with a rating of approx. 5 MW. There was also a plan to install a small 900 kW wind farm on the island of Carriacou, but that plan had to be abandoned because GRENLEC was unable to acquire a suitable piece of property. GRENLEC is now in the process of redefining its internal policy with regard to net-metering and autogeneration.

Also since 2006, Grenada Solar Power Ltd. (GRENSOL) has been marketing photovoltaic systems, five of which – with ratings up to 9 kW – have already been installed.

The Paradise Bay Hotel situated at the southeast end of the island installed an 80 kW wind energy conversion system from Netherlands-based Wind Energy Solutions BV (WES) in March 2007. For the time being, the system will be operated in conjunction with a diesel generator to feed an isolated grid. GRENLEC has promised to purchase the surplus current.

Installed capacity

At the beginning of 2007 Grenada's power generating capacity amounted to 45.1 MW, with peak load running at 24 MW. Due to the catastrophic effects of Hurricane Ivan (September 2004), that peak-load level was only 92% as high as the mean load in 2004. A certain degree of recovery had been achieved, but not enough to re-attain the previous year's level. Hurricane Emily also grazed Grenada in 2005 but it mainly affected the smaller island of Carriacou.

Capacity expansion

Most activities in the power supply sector between mid-2004 and 2006 had less to do with capacity expansion and upgrading than with reconstruction of the power grid, which was completely destroyed by Hurricane Ivan. That work was brought to completion in April of 2005.

Still, GRENLEC was able to effectively expand capacity in the southern part of the island by commissioning a pair of 8-MW diesel generators and a transmission network there. A new 33-kV medium voltage line is now accommodating the anticipated increase in power consumption, but will continue to carry only 11 kV until the network is completed.

Power generation

GRENLEC relies exclusively on diesel generators for power production purposes. A total of 147.3 GWh of electricity was generated in 2005. That was 8.3% higher than the year before, but still 7.4% lower than in 2003 (159.2 GWh), i.e. the 'pre-Ivan level'.

Power consumption

In 2005, GRENLEC sold a total of 131.6 GWh of electricity for US$ 39 million. That reflected an increase of 3.3% in the household sector, 4.5% for commercial consumers, and 24.1% in the industrial sector (see chart). The increase in industrial-sector demand, at 7.4%, was the highest yet in the post-hurricane period.

Technical and non-technical losses in 2005 amounted to only 10.7%. That was a substantial improvement over the average 'pre-Ivan' level of 13.2% (2000-2003).

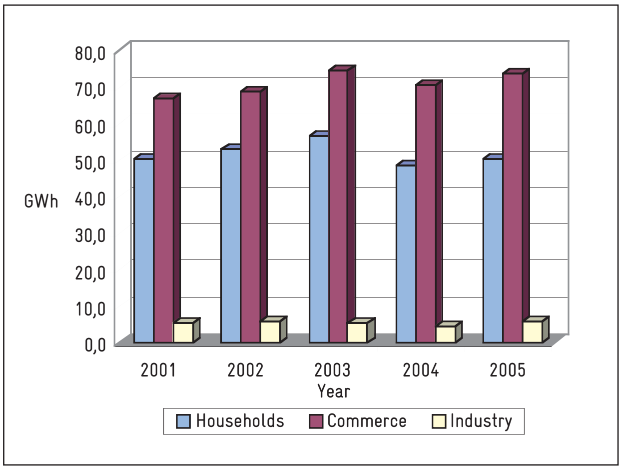

Fig. 3: Power consumption according to sector, in Grenada; GWh; 2001-2005

Electricity tariffs

The average cost of electricity for domestic customers in Grenada, at 0.30 US$/kWh (2006), is very high. To a significant extent, this is due to the – now customary – attachment of a fuel surcharge to the electricity bill in recent years. In 2003, the surcharge amounted to 40 % of the average basic tariff. Then, between 2004 and 2006, the percentage increased markedly in the wake of global oil price developments. In 2005, for example, rising oil prices made it necessary to increase the fuel surcharge to 42.7 % – and pass it on to the consumers. Between 2004 and 2005, the fuel surcharge increased from an average of 97 US$/MWh to 139 US$/MWh.

9.4.2 Market actors

Grenada Electricity Services Ltd (GRENLEC)

GRENLEC has a universal license for generating, transmitting and distributing electricity until 2073. GRENLEC is a private company whose majority owner (more than 50 %) is the Florida-based company WRB Enterprises Inc.; employees, local investors and the Government of Grenada each have smaller stakes in the company.[26]

Other actors

Ministry of Agriculture, Lands, Forestry, Fisheries, Public Utilities, Energy and the Marketing and National Importing Board (MNIB)

MNIB is responsible for the energy sector and related policy formulation. It is the only ministry in any of the OECS states with its own internal energy agency as a government authority.

Ministry of Finance and Planning

This ministry's responsibilities include the formulation and implementation of the National Climate Change Policy and Action Plan, which, among other things, provides for liberalisation of the energy sector.

9.4.3 Legal framework

The electricity sector is regulated in accordance with the 1960 Electricity Supply Ordinance and the 1974 Electricity Supply Act (ESA). Since 1993, GRENLEC is also responsible for providing power to Carriacou and Petite Martinique.

A regulation dating from 1961 allows autogeneration by individuals, but only with permission from GRENLEC and with governmental approval. The same applies to other electricity market activities (transmission, distribution and/or sale of electricity, plus generation). Work has been ongoing since 2001 on a new electricity law, but it has not yet progressed beyond the draft stage.

9.4.4 Policy promoting renewable energy sources

The government does not yet have an official energy policy. It does offer an incentive to use renewable sources of energy, however, in that alternative energy products, including solar and wind energy systems, are exempted from the general consumption tax.

A Sustainable Energy Action Plan (SEP) was drafted in 2001 by the Global Sustainable Energy Islands Initiative (GSEII). The plan provides for a renewable energy promotion strategy, but it has not been adopted by the government and, as a consequence, the measures it proposes have only been implemented in isolated cases, on an ad-hoc basis, or not all.

For several years now, a National Climate Change Policy and Action Plan has been the subject of public discussion, and especially after the Hurricane Ivan disaster of 2004 it gained more immediate relevance. A draft version of the plan has been completed and was up for final discussion in April 2007 pending adoption by the government.[27]

26 WRB is the main shareholder of the utility company DOMLEC in Dominica.
27 National Roundtable on Draft National Climate Change Policy and Action Plan, 5 April 2007.

According to that plan, GRENLEC's monopoly and some stiff residual taxes on RE components and energy-efficient appliances are the main impediments to reductions in greenhouse gas emissions. The plan therefore calls for liberalisation of the energy sector and comprehensive renewable energy promotion measures.

The envisaged liberalisation of the energy sector would include provision enabling licences to be issued to independent operators for the generation, transmission and distribution of electricity. Priority is to be attached to the generation of electricity from renewable energy resources, and the creation of a renewable energy promotion fund is planned.

Clean Development Mechanism

CDM measures on Grenada are still at a very early stage. Grenada signed the Kyoto Protocol in August 2002, but has not yet established a Designated National Authority (DNA). No CDM-based energy projects have been registered to date.

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Saint Lucia

9.5.1 Electricity market

As in most other Caribbean states, power generation on St. Lucia is almost completely reliant on fossil fuels. St. Lucia imported about 120,700 barrels of oil to meet its energy requirements in 2005.

Despite very considerable renewable energy potential in the form of wind energy, geothermal energy and solar energy, the only renewable resource that is even in marginal use is solar energy for heating water. In St. Lucia, too, the actual renewable energy potential has not yet been fully quantified.

Installed capacity

St. Lucia Electricity Services Ltd. (LUCELEC) is still the sole provider of electricity on St. Lucia and is operating on a universal license that does not expire until 2045. The island's total installed power generating capacity in 2005 amounted to 65.8 MW (diesel only), including a new 10.2 MW diesel generator that was commissioned early in that year. The peak load in 2005 amounted to 49.2 MW, or 5.6% higher than in 2004.

Capacity expansion

Recent years have seen massive expansion of the 11-kV distribution network along the west coast and in the north, and preparations are also under way for the erection of a 66-kV transmission line.

In connection with the electrification of rural inland areas, the distribution network has been expanded and its carrying capacity increased at numerous points. Like all of the other islands discussed here, St. Lucia boasts a very high electrification level (approx. 98%).

Power generation

The primary source of energy for power generation on St. Lucia is imported diesel fuel. LUCELEC, however, is pursuing the option of developing wind energy in order to achieve substantial savings on fossil fuel (fuel-saver function). This will help stabilise and, eventually, lower the cost of electricity for power consumers.

Total power production in 2005 came to 323.6 GWh; that was 4.9% higher than in 2004.

Power consumption

Demand for electricity is rising steadily in most consumption sectors, particularly in the commercial sector, where consumption has been increasing disproportionately for the past five years. Consumption there rose 4.6% (158.5 GWh), followed by the household sector with 2.9% (98.9 GWh); only the industrial sector registered no significant growth, increasing by only about 1% (12.5 GWh).

Technical and non-technical losses came to 10.2% in 2005. That was only marginally higher than the targeted 10%.

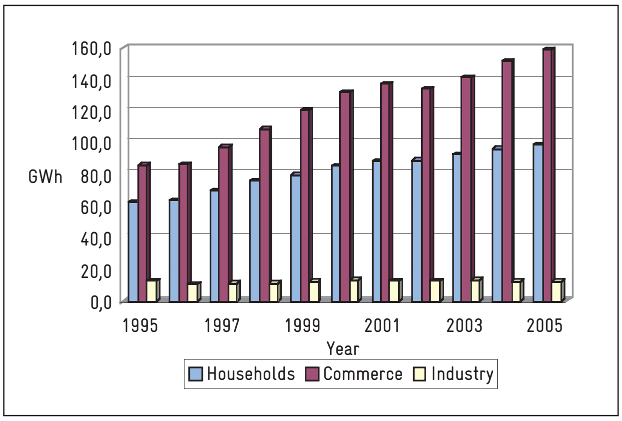

Fig. 4: Power consumption according to sector; St. Lucia; GWh; 1995-2004

Electricity prices

The average cost of electricity for private households, at 0.26 US$/kWh, is very high in St. Lucia, too. As is the case on the other Caribbean islands, all of which are subject to the fluctuations in global oil prices, the cost of fuel accounts for a large percentage of the overall cost of electricity. In 2005, the average cost of fuel was 2.81 US$/gallon, or 0.618 US$/litre. In 2006, 45% of the overall cost of power production was expended on imported diesel. [28]

Expansion planning

Based on the high probability of continued growth in tourism, the electricity sector will have to keep expanding its power generating capacities. St. Lucia had 26% reserve power in 2005 and is planning to expand that to 29% in the course of 2007. An additional 10.2 MW generator is scheduled for commissioning in 2007.

9.5.2 Market actors

St. Lucia Electricity Services Limited (LUCELEC)

LUCELEC is a listed corporation owned in part (more than 40%) by public institutions. In 2005, its main shareholders were as follows:

Shareholder	Percentage
CBPF Saint Lucia Ltd[29]	20%
First Citizens Bank Ltd. of Trinidad & Tobago	20%
National Insurance Corporation of St. Lucia (NIC)	16.79%
Castries City Council	16.33%
Government of St. Lucia	12.44%

Tab. 3: Share-capital composition at LUCELEC, in%

The remaining shares are held by various local and regional investors.

Other actors

Ministry of Economic Affairs, Economic Planning, National Development and Public Service

Newly established after the elections of 11 December 2006, the Ministry of Economic Affairs, Economic Planning, National Development and Public Service is responsible for, among other things, developing energy policy and engaging in energy planning.

Ministry of Communications, Works, Transport and Public Utilities

The Ministry of Communications, Works, Transport and Public Utilities is responsible for the national power utility LUCELEC.

28 LUCELEC: 2005 Annual Report.
29 Caribbean Basin Power Fund.

9.5.3 Legal framework

According to the 1964 Power Supply Regulation, LUCELEC holds a universal licence for generating, transmitting, distributing and selling electricity until 2045. While the 1964 regulation was superseded by the 1994 Electricity Supply Act, LUCELEC's exclusive licence was preserved. The 1994 ESA does allow auto-generation, but only with the approval and a sub-licence from LUCELEC and only subject to certain constraints and conditions.

9.5.4 Policy promoting renewable energy sources

In 2001, the government advocated a sustainable energy policy prescribing as target objectives the utilization of renewable energy sources in the electricity sector and reductions in the planned demand for electricity. A Sustainable Energy Action Plan (SEP) was elaborated with the assistance of the Global Sustainable Energy Islands Initiative (GSEII) and then adopted by the government. The plan specified quotas for renewable energy power generation capacity for the years 2005 and 2010: 5 MW (7%) and 17 MW (20%) respectively.

One of the measures that the government has implemented up to now is to offer incentives promoting the use of solar water heaters: the cost of the equipment can be offset against tax.

Until now, however, the renewable energy sector goal set for 2005 still has not been reached. Despite the help of the government, LUCELEC has been unable to purchase or lease the plot of land that was selected as a site for a wind farm. Nevertheless, LUCELEC is still professing to endeavour to meet its 10% renewable energy goal for power generation by the year 2007. This will involve erection of a 12.6 MW wind farm at an alternative location on the island's south-eastern coast. With average wind speeds well above 7 m/s, this location is outstandingly suited to the task in many respects. Consequently, the CREDP/GTZ project advised the government to reserve the entire region for additional wind farm installations, which would allow gradual expansion up to 40 MW.

The new government, which took office on 11 December 2006, has stated that it intends to abide by the previous administration's policy of promoting the use of renewable energy resources and to cooperate closely with the Caribbean Renewable Energy Development Programme (CREDP/GTZ).

Clean Development Mechanism

St. Lucia signed the Kyoto Protocol in 2003 and has since established a designated national authority (DNA). However, no CDM energy projects have been registered to date.

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9.5.6 Contact Addresses

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St. Vincent and the Grenadines

9.6.1 Electricity market

In St. Vincent and the Grenadines (SVG), too, power generation is predominantly dependent on imported fossil fuels. However, St. Vincent's main island does have some hydropower reserves that are being tapped by three hydroelectric plants that presently cover some 20 % of the island's overall power output. Like all other Windward Islands, SVG also enjoys outstanding wind conditions and, most likely, geothermal resources, though the latter have not yet been explored. Lastly, the main island possesses untapped hydropower potential.

Installed capacity

St. Vincent Electricity Services Ltd (VINLEC) is the only power utility serving the main island and four smaller islands. VINLEC's universal licence expires in 2033. The islands of Mystique and Palm Islands in the Grenadines chain also have some privately operated power providers.

In 2006, VINLEC's total installed generating capacity came to just below 40 MW, 85 % of which was provided by diesel generators and the remaining 15 % by hydroelectric plants. VINLEC's facilities are spread across the main island at St. Vincent and the smaller islands. A breakdown of nominal outputs is shown in the following table:

Location	Output [MW]
St. Vincent	33.2
Bequia	2.2
Union Island	1.3
Canouan	3.1
Mayreau	0.18[30]

Tab. 4: Isolated networks operated by VINLEC in Saint Vincent and the Grenadines; MW

The output of St. Vincent's hydroelectric plants is subject to the usual seasonal fluctuations in water flow. Between June and December (the rainy season), when capacity can reach 5 MW, the hydroelectric plants serve as base-load stations, but their output drops to 2.5 MW during the dry season from January to March.

The peak load registered in 2005 was 20.6 MW, or 11 % higher than the year before. That increase is largely attributable to rapidly expanding demand on the main island of St. Vincent.

Capacity expansion

Electricity generating capacities have had to be expanded due to economic developments in SVG. VINLEC commissioned the island of Mayreau's first power grid and diesel engine power plant, with a rating of 180 kW, in 2003. The following year, 2004, VINLEC purchased the diesel power plant on the island of Canouan. Until then, the plant had belonged to the government but was already being operated by VINLEC.

30 All installed capacity on the small islands consists of diesel generators; the only hydroelectric plants are located on St. Vincent.

Power generation

Total power output in 2005 amounted to 120.7 GWh, 23% of which came from hydro-electric facilities. Between 1999 and 2003, overall output increased by 4.8% per annum on average.

Power consumption

As far as consumption according to sector is concerned, private households and commercial establishments registered increases of 7% and 21% respectively in 2004 (there was particularly strong growth in the commercial sector), while industrial consumption fell 6%.

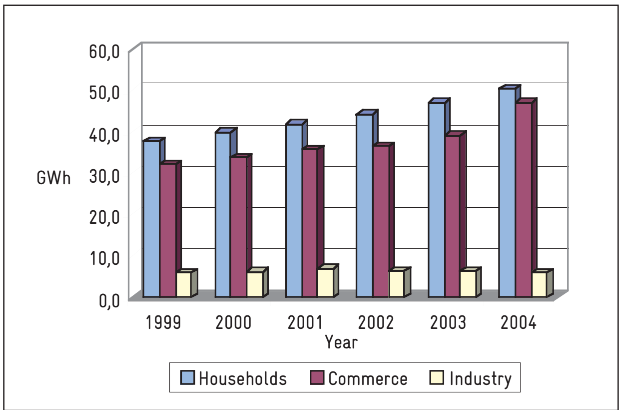

Fig. 5: Power consumption according to sector for St. Vincent and the Grenadines; GWh; 1999-2004

Technical and non-technical system losses in 2005 added up to only 9.8%. That has been so since 1999. As such, the losses here are lower than on the other OECS islands.

Electricity prices

In 2004, consumers paid US$ 29.3 million for 103.7 GWh of electricity. The cost of electricity includes the adjusted fuel costs, which translate to an average price of approximately 0.28 US$/kWh. The average price in 2006 probably increased to above 0.3 US$/kWh as a result of the higher fuel surcharge.

According to VINLEC, the basic charges for electricity have remained constant for many years, while the effective tariffs fluctuate because of the fuel surcharge. In 2004 the actual cost of electricity was 0.28 US$/kWh., with the fuel surcharge accounting for 36% of the price. That was 5% higher than in 2003. In 2005 and 2006, the high cost of oil made the price of electricity fluctuate between 0.3 and 0.34 US$/kWh.

The table below lists the electricity tariffs (which have remained constant for some years):

Households	
≤ 50 kWh	16.0 US-ct/kWh
> 50 kWh	18.9 US-ct/kWh
Service charge	1.90 US$/month
Commerce	
Work	18.11 US-ct/kWh
Power	5.70 US$/kVA
Service charge	4.50 US$/month
Industry	
Work	16.6 US-ct/kWh
Power	4.5 US$/kVA
Street lighting	
Work	21.3 US-ct/kWh

Tab. 5: Electricity tariffs in St. Vincent and the Grenadines; US$/US¢

The (fluctuating) fuel surcharge has to be added to all tariffs.

Expansion planning

A 0.4 MW expansion of the generating capacity on the island of Bequia is scheduled for April 2007. This is to be followed by another expansion in 2008/2009, when the first 8 MW diesel generator is commissioned at the new Lowmans Bay Power Station on St. Vincent's south-western coast. Lowmans Bay has enough space for an additional 18 MW generating capacity that could be installed within the next few years if necessary.

VINLEC, like other utilities in the region, is receiving technical assistance from the Caribbean Renewable Energy Development Programme (CREDP/GTZ) in connection with the rehabilitation and expansion of two hydroelectric generating facilities for which international tendering was already advertised in February 2007. The expansion and rehabilitation programme will add about 0.8 MW to the existing capacity and increase each unit's output by 30 to 40 %.

Also with assistance from CREDP, VINLEC is likewise preparing for the erection of a 7 MW wind farm at Ribishi Point on the south-eastern coast. Both projects – hydropower and wind power – are focussing on the fuel-saver aspect.

9.6.2 Market actors

St. Vincent Electricity Services Limited (VINLEC)

VINLEC is wholly owned by the state and remains the only institution responsible for the supply of electricity in SVG.

Other actors

Ministry of Telecommunications, Science, Technology and Industry

The Ministry of Telecommunications, Science, Technology and Industry is responsible for energy affairs in SVG, in particular for alternative energy sources and energy policy.

Ministry of Transport, Works and Housing

The Ministry of Transport, Works and Housing manages the development and distribution of energy reserves in SVG.

9.6.3 Legal framework

The 1973 Electricity Supply Act (ESA) granted VINLEC a universal licence for generating, transmitting and distributing electricity in SVG until 2033.

Under the ESA, other companies are also allowed to generate, transmit and distribute electricity, but only with VINLEC's permission or as VINLEC licensees, and then only with the approval of the competent minister. Power generation for the owner's own use (autogeneration) also requires VINLEC approval.

According to the ESA, all equipment (machines, consumables, spare parts, etc.) required for power generation, transmission and/or distribution are exempted from customs duties and all other import restrictions. Moreover, the ESA conferred the water rights for all three hydroelectric plants on VINLEC at no cost.

By its own account, the government of SVG is open for liberalisation of the energy sector according to the same model as that which was recently adopted in Dominica.

9.6.4 Policy promoting renewable energy sources

Until now, SVG has had no particular initiatives aimed at promoting electricity generation from renewable energy sources, except that imported components for RE systems are exempted from customs duties on a case-by-case basis.

CREDP/GTZ is presently helping the government formulate an energy policy, and a Draft National Energy Action Plan[31] has been drawn up.

31 CREDP/GTZ: Draft National Energy Action Plan, SVG, 2006.

Clean Development Mechanism

In St. Vincent and the Grenadines (SVG), CDM measures are still at a very early stage of development. SVG signed the Kyoto Protocol in December 2002, but has not yet established a Designated National Authority (DNA). No CDM-based energy projects have yet been registered.

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9.6.6 Contact Addresses

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10 Egypt

10.1 Electricity market

Installed capacities

At the end of 2005 Egypt possessed installed power generating capacities totalling 20,593 MW. Compared with the previous year (20,168 MW), that amounted to a 2 % increase in overall output capacity. The generating capacities of EEHC, the government-owned and -operated Egyptian Electricity Holding Company, consisted of the following elements in 2005: 62 % conventional steam power plants, 14 % combined-cycle power plants (CCPs), 8 % gas turbine power plants, 15 % hydropower plants and 1 % wind energy conversion systems (WECS). Since 2003 three private-sector power utilities have been contributing an additional 2,049 MW of generating capacity (10 % of overall countrywide capacity) from three gas-fired steam power stations.

	2000	2001	2002	2003	2004	2005
	Installed generating capacity (MW)					
Gas turbines	715	715	715	1055	1,019	1,519
CCPs	2,605	2,605	2,605	2,605	2,605	2,605
Steam	8,498	9,158	10,525	11,203	11,610	11,535
Hydropower	2,745	2,745	2,745	2,745	2,745	2,745
Wind power	68	68	68	98	140	140
Private sector (steam)			683	2,049	2,049	2,049
Total	**14,631**	**15,291**	**17,341**	**19,755**	**20,168**	**20,593**

Tab. 1: Installed capacity by generation method; power plants serving interconnected power grid system; 2000–2005; MW[1]

The once outstanding importance of the Aswan dam for Egypt's power sector has declined markedly over the past 30 years. In 1978, the annual output of the dam's 2,100 MW hydropower plant (8,153 GWh) sufficed to cover 54 % of the country's power requirement. Now, however, even considering the increase in the plant's output to a good 9 TWh/a by 2005, it is no longer of central importance for the country's present total overall power production of 101 TWh per annum.

Egypt has 34 power-generating facilities situated in remote areas that are not connected to the national grid. They supply electricity to local users, including various tourist resorts. Together, these facilities have a total generating capacity of 280 MW and produced 303 GWh of electricity in 2005.

The five-year plan for the period from 2002 to 2007 assumed that the total power plant output would increase by 7.5 % annually. Plans called for 5,610 MW of new power plant capacity, including 4,500 MW in the form of combined-cycle plants (with 1,500 MW each in Cairo and Nubaria, as well as 750 MW each in Talkha and El-Kureimat).

Power generation

Four regional utilities and one company responsible for hydropower are the main contributors to the Egyptian power grid. All five emerged from the break-up of the erstwhile national power utility and belong to the government-owned Egyptian Electricity Holding Company (EEHC). The power plants operated by those five producers generated some 87 TWh in 2005.

In addition to that, independent power producers generated 13,200 GWh, while the Zafarana wind farm produced 523 GWh and 69 GWh of surplus power was bought in from industrial enterprises. Altogether, this adds up to some 101 TWh produced for the countrywide public power grid.

1 Source: Egyptian Electricity Holding Company (EEHC).

Sector	2004 GWh	2005 GWh	% change
Conventional steam power plants	50,781	54,300	+ 6.9
Gas turbines	564	3,360	+ 496
Combined-cycle plants	16,603	16,900	+ 1.8
Total thermal	**67,948**	**74,560**	**+ 9.7**
Hydropower	13,019	12,644	– 2.9
Wind power (Zafarana)	368	523	+ 42.1
Total public grid	**81,335**	**87,727**	**+ 7.9**
Purchased from industrial sector	77	69	– 11
Independent power producers	13,501	13,200	– 2.2
Sum total	**94,913**	**100,996**	**+ 6.4**

Tab. 2: Power generation for public grid according to source; 2004, 2005; GWh[2]

Power production for the public grid grew, on average, 7.8 % per year between 2001 and 2006.

Year	2001	2002	2003	2004	2005	2006[3]
Generated power [GWh]	77,956	83,003	88,951	94,913	100,996	108,690

Tab. 3: Time history of power production (incl. wind and independent power producer output); 2001–2006; GWh[4]

Since Egypt has been successful in developing its natural gas resources while crude oil production declines, the country is now endeavouring to generate as much power as possible with natural gas. In 2005, 76 % of all fuel consumed in Egyptian power plants was natural gas.

Power transmission and distribution

The government-owned Egyptian Electricity Transmission Company (EETC, an EEHC subsidiary) is responsible for the countrywide transmission of electricity. Via its national load distribution centre and regional control centres, the company ensures that the generated power reaches the regional and local distributors through a countrywide network of high voltage power lines.

	500 kV	400 kV	220 kV	132 kV	66 kV	33 kV
Transformer capacity [MVA]	7,765	n.s.	25,240	3,491	31,170	1,783
Total length of power lines [km]	2,262	33	13,920	2,467	16,248	2,725

Tab. 4: The Egyptian transmission network, key figures; 2005[5]

In 1998, Egypt and the neighbouring countries of Libya and Jordan interconnected their power transmission grids, and Syria joined the international grid-connected system in 2000. This interconnection made it possible for the countries' individual markets to share electricity and helped stabilise their individual grids. According to EETC, the measure has served well both technically and economically.

	Libya	Jordan
Voltage level [kV]	220	400
Max. capacity [MW]	150	250
Exported current [GWh]	123	750
Imported current [GWh]	104	70
Difference (export surplus) [GWh]	19	680

Tab. 5: Power-sharing network; 2005[6]

2 ibidem.
3 Relevant to the 2005/2006 accounting period.
4 Source: EEHC.
5 ibidem.
5 Source: ibidem and North African/Middle East/European Electricity Cooperation & African Interconnection Report (NREA).

In November 2002, Egypt was chosen as the host country for the international coordination and control centre, the purpose of which is to distribute the electricity through a planned integrated Mediterranean power grid. In addition to the countries already mentioned, a number of others are also intending to participate in this international power pool: Lebanon, Iraq, Turkey, Tunisia, Algeria and Morocco.

In 2001, in connection with the restructuring of Egypt's power sector,[7] nine regional and local companies were commissioned to distribute electricity to ultimate users. The various distributors each have their own grids with medium- and low voltage lines, and they are also responsible for operating isolated grids with no connection to the national network. Altogether, the power utilities had 129,647 km of medium voltage lines and 213,960 km of low voltage lines in 2005.

Power consumption

Annual per capita power consumption in Egypt amounts to about 850 kWh. A sectoral breakdown of ultimate users, i.e. of the distributing companies' customers, yields the following profile in terms of electricity sold countrywide:

	Number of customers	%	Electricity sold [GWh]	%
Industry	415,171	2.2	13,609	20.3
Agriculture	60,402	0.3	2,646	3.9
Government/public authorities	165,424	0.6	8,181	12.2
Private households	15,687,337	86.0	31,312	46.7
Small businesses, trades and crafts	1,176,203	9.1	2,127	3.2
Miscellaneous	330,205	1.5	3,219	4.8
Street lighting	n.s.		5,919	8.9
Total	17,834,742		67,013[8]	100.0

Tab. 6: Customer breakdown and electricity sold by Egyptian distribution companies; 2005[9]

Peak load situation

Peak loads in the Egyptian interconnected power grid increased by approximately 27% annually between 2001 and 2005. In 2004 and 2005, power consumption peaked between 9 p.m. and 10 p.m. on 19 and 20 June, respectively.

	2001	2002	2003	2004	2005	2006
Peak load [MW]	12,376	13,326	14,401	14,735	15,678	17,300

Tab. 7: Peak loads in the interconnected power grid; 2001–2006[10]

Electricity prices

The price of electricity in Egypt counts among the lowest in the world. Low voltage users pay 2.0 euro cents (0.148 EGP)/kWh on average, while high voltage customers are charged 1.5 euro cents (0.111 EGP)/kWh. The prices are fixed by the Egyptian government, by cabinet decision, and apply in equal measure to all regions. Ninety percent of all households receive electricity at a price that covers less than 50% of the cost of generation.

In October 2004 several electricity tariffs were raised, by an average of 8.6%, for the first time since 1992, and further 5% price increases were set for all electricity customers for each of the following five years. This step is intended to gradually accommodate the electricity tariff to the cost of generation. On the other hand, in the face of annual inflation rates exceeding 5%, these increases may not suffice.

The price levels for private and commercial customers are conspicuously progressive.

7 See section entitled "Market Actors/Public Power Corporations".
8 The difference between electricity produced and electricity sold is primarily attributable to technical and non-technical losses (power theft). No precise pertinent data are available.
9 Source: Egyptian Electricity Holding Company (EEHC).
10 ibidem.

Tariff group	Electr. price [€ ct/kWh]	Electr. price [millim/kWh]
High voltage (220/132 kV)	1.52	111
High voltage (66/33 kV)	1.83	134
Housing societies	1.76	129
Medium voltage (22/11/6.6 kV) and low voltage (380/220 V) purchased volume > 500 kW (monthly demand rate: 1.18 €/kW)		
Energy rate	2.50	183
Private (kWh/month)		
0–50	0.68	50
51–200	1.37	100
201–350	1.86	136
351–650	2.68	196
651–1000	3.83	280
> 1000	4.68	342
Commercial (kWh/month)		
0–100	2.91	213
101–250	4.23	309
251–600	5.38	393
601–1000	6.66	487
> 1000	6.99	511
Local government and clinics	2.94	215
Public lighting	4.87	356

Tab. 8: Electricity tariffs for public power supply; as of December 2006; in € ct/kWh and millim/kWh[11]

Development planning

The government-owned Egyptian Electricity Holding Company (EEHC) is projecting a peak load of 23,800 MW for 2012. New generating capacities totalling nearly 7,000 MW are supposed to be established between 2008 and 2012. Cogenerating facilities (CCPs) will account for 5,250 MW, and conventional gas-fired steam power plants the remaining 1,675 MW.

The Egyptian Ministry of Electricity and Energy announced in June 2002 that Egypt is planning to build a nuclear power plant on the Mediterranean coast, some 150 km west of Alexandria. In cooperation with the International Atomic Energy Agency (IAEA), studies were conducted to clarify the design and type of power station, which is also intended to be used for seawater desalination. According to the competent minister in September 2006, a 1,000 MW nuclear power plant will be constructed at El-Dabaa. It is scheduled to come on stream by 2015.

10.2 Market actors

Public power corporations

Prior to the sector's nationalization in the early 1960s, private enterprises produced and distributed electricity in Egypt. With the amalgamation of the production, transmission and distribution segments under the auspices of a single government agency in 1965, the state effectively bundled the entire power sector.

In the late 1970s there emerged some initial signs of a tendency to decentralise and regionalise the monolithic, since dismantled Egypt Electricity Authority (EEA).

Seven regional electricity supply companies, each responsible for generating and distributing electricity in their respective region, were established in 1998. The EEA served as the parent company of those various regional power utilities and retained responsibility for the countrywide transmission of electricity.

In connection with a reform of the power sector in the year 2000[12] to open it up for private investors, the production, transmission and distribution sectors were legally separated and partially regionalised. This yielded 13 individual companies, comprising four operating companies for thermal power plants, one operator for hydropower plants, one national power transmission company, and seven local/regional distribution companies.

11 Source: Egyptian Electric Utility and Consumer Protection Regulatory Agency.
12 Based on law no. 164 from the year 2000: "Transferring the Egyptian Electricity Authority into an Egyptian Joint Stock Company".

Two of the latter were split up again a few years later, so that there now 15 (+1)[13] public power corporations organised within the state-owned Egyptian Electricity Holding Company (EEHC): five power plant operating companies, one national power transmission company, and nine distribution companies. The holding itself is supervised by the Egyptian Ministry of Electricity and Energy (MEE).

Independent power providers

In addition to the public-sector electricity undertakings (public power corporations - PPC), the electricity sector in Egypt is also populated by a number of private-sector companies (independent power providers – IPP) including three independent power plant operators, three private, vertically integrated electricity companies on the Red Sea, and three small, privately operated power corporations that generate and/or transmit electricity for the interconnected power grid in the greater Cairo and Alexandria areas.

Generation companies	Head office	Installed capacity [MW]	Annual output [GWh]
West Delta Generation Company	Alexandria	4,024	17,274
East Delta Electricity Generation Company	Al-Dakahleya	4,819	24,256
Cairo Electricity Generation Company	Cairo	3,681	21,926
Upper Egypt Electricity Generation Company	Giza	1,968	11,104
Hydro Plants Electricity Generation Company	Aswan	2,783	12,644
New and Renewable Energy Authority – NREA (wind power)	Cairo	140	523
Transmission companies		**Supply system [km]**	
Egyptian Electricity Transmission Company	Cairo	37,655	
Distribution companies		**Transforming capacity [MVA]**	**Electricity sold [GWh]**
Alexandria Electricity Distribution Company	Alexandria	3,413	6,330
South Cairo Distribution Company	Cairo	9,172	16,178
North Cairo Electricity Distribution Company	Cairo	7,283	13,232
El Behaira Electricity Distribution Company	Damnhour	2,905	4,930
South Delta Electricity Distribution Company	Tanta	2,717	6,578
North Delta Electricity Distribution Company	Mansoura	3,105	7,182
Upper Egypt Electricity Distribution Company	Aswan	3,001	5,966
Middle Egypt Electricity Distribution Company	Minia	3,116	6,895
Canal Electricity Distribution Company	Ismailia	3,901	12,643

Tab. 9: Overview of public power corporations organised within EEHC; 2005[14]

13 The NREA – actually a research institute – also presents itself as the operator of the Zafarana wind farm and is therefore included here as a generation company.

14 Source: EEHC.

It was mainly the expectations of international donors that disposed Egypt to open up its electricity sector for private investors in the 1990s. The first contract for a privately operated power plant with foreign investors was concluded in 1998 according to the BOOT principle.[15] Two further such agreements followed in 1999.[16] The three practically identical gas-fired steam power plants that went on line in 2002 (Sidi Krir) and 2003 (Suez and Port Said), with their combined output of 2,049 MW, account for approximately 10 % of the country's installed generating capacity.

Generation companies	Installed capacity [MW]	Annual output [GWh]
Port Said East Power Company	683.0	3,850
Suez Gulf Power Company	683.0	4,300
Sidi Krir Generating Company	682.5	4,600

Tab. 10: Survey of independent power producers; MW, GWh; 2005[17]

The following table lists some additional private enterprises in the field of electricity generation and distribution.

	Installed capacity [MW]	Annual auto-production [GWh]	Distributing capacity [MVA]	Electricity sales [GWh]
Distribution companies				
Egyptian Chinese Joint Venture Company for Investment			30	3
Generation and distribution companies				
Global Energy Company	13.0	0.12	108	119
Alexandria Carbon Black Co. SAE	23.8	128	10	6
Om El Goreifat Company	7.0	13	8	13
National Electricity Technology Company (Kahraba)	6.4	42	8	42
Mirage Company	6.8	9.35	8	28
Sendeian Company for Paper Industry	14	99	17	99

Tab. 11: Overview of independent power producing and distributing companies; 2005[18]

Other Actors

Regulatory authority EEUCPRA

The regulatory authority for the electricity sector was established by decree in 1997.[19] The Egyptian Electric Utility and Consumer Protection Regulatory Agency (EEUCPRA) is seated in Cairo and came into formal existence in 1998. It was, however, not until 2002 that the agency actually commenced operations following the instalment of its first general manager. Officially, it is directed by the Minister of Electricity and Energy, an arrangement which relativises its independence from government institutions.

15 Build Own Operate Transfer – when this plant has logged 20 years of operation, its ownership will be transferred to EEHC.
16 The investors were InterGen (a joint venture between Shell and Bechtel), Edison and EdF (Electricité de France). In 2006, EdF sold both plants (in Suez and Port Said) to the Malaysian company Powertek.
17 Source: EEHC.
18 ibidem.
19 Basis: Decree no. 326 of 1997: "Establishing The Electric Utility and Consumer Protection Regulatory Agency".

The primary task of the regulatory authority is to balance the interests of power producers, power providers and ultimate consumers. It is supposed to ensure a reliable long-term supply of electricity while promoting and supervising environmental protection and operational reliability in the energy sector. It is also responsible for licensing the construction and operation of power generation, transmission and distribution facilities as well as for electricity trading.

One of the authority's declared objectives is to create an enabling environment for market-based competition within the framework of existing laws and to prevent the formation of commercial monopolies in the energy sector. In view of the present primacy of national, governmental approaches in Egypt's policy toward further development of the energy sector, however, the authority seems not to be able to achieve the aims it has set itself.

The following functions are also ascribed to EEUCPRA:

- Assessing plans for expansion of the generation system and extension of the power grid to ensure that capacities develop in line with demand
- Controlling the cost of electricity generation, transmission and distribution
- Ensuring that profits from power generation suffice to provide a sound basis for the further development of power generating capacities[20]
- Supervising the national coordination and control centre, the purpose of which is to ensure optimal countrywide distribution of produced power while allowing for the interests of all participating operators
- Assuring the quality of all technical and administrative services that are offered to ultimate consumers.

Actors in the renewable energy sector

A number of Egyptian organisations are working to further the use of renewable energy sources and to increase energy efficiency.

New and Renewable Energy Authority (NREA)

The Ministry of Electricity and Energy established the NREA in 1986 for the purpose of bundling activities aiming to promote both renewable sources of energy and energy efficiency. Its task scope includes the development of technologies for utilising renewable resources on a commercial scale. In the long term, its activities are intended to reduce the country's dependence on fossil fuels and to prevent detrimental effects on the environment.

Together with other competent Egyptian and international institutions, the NREA is supposed to develop and implement renewable resource utilisation programmes. For example, it recently completed a pan-Egyptian wind atlas for which data were collected since 1991. The atlas was published in 2006. The NREA also operates some wind power installations, which up to now have served mainly as demonstration projects: a hybrid wind/diesel system in Matrouh governorate and a 5.2 MW wind farm near Hurghada on the Red Sea coast. The latter, which was commissioned in 1993, includes wind generators from various international producers.

In addition to such test and model facilities, the NREA also operates the commercially oriented Zafarana wind farm on the Gulf of Suez. Beyond its wind-sector activities, the agency also and primarily works to advance solar thermal research projects and is active in the field of biomass utilisation. As well as this, the NREA has a central laboratory for testing and certifying apparatus and equipment for utilising renewable energy resources. Finally, the NREA offers training and upgrading courses, organises workshops and conducts studies – both on its own and in cooperation with international partner organisations.

20 … albeit with no direct influence on tariffing. The government sets electricity rates by cabinet decision.

Organization for Energy Conservation & Planning (OECP)

This governmental organisation was established by decree in 1983. It attends to Egypt's long-term energy planning. Since the early 1990s the organisation's experts have increasingly been investigating matters concerning energy efficiency. The OECP performs energy audits in the public sector and for private companies. The organisation views itself as a mediator between the concerns of sustainable development and other national interests. It addresses the Egyptian public directly with diverse publications on energy conservation.

Egyptian Solar Energy Society

The ESES is a non-governmental society, the members of which are persons engaged in the generation, development and utilisation of renewable energy resources and who work together to establish renewable energy resources as a strong industrial sector. Since 1986 the ESES has been hosting the triennial International Conference on Applications of Solar and Renewable Energy (ASRE) in Cairo. ESES members are developing wind-powered water pumps with the aid of funding from the Global Environment Facility (GEF). Their pumps are already being built and successfully marketed by an Egyptian licensee. The ESES holds national-level conferences and workshops, provides upgrade training, and publishes its own periodicals. The society also represents Egypt in the International Solar Energy Society (ISES).

10.3 Legal Framework

Reform of the electricity sector

But for some minor concessions, the clearly government-dominated electricity market is still resisting all further-ranging liberalisation and privatisation efforts. Article 7 of Law No. 100 dating from 1996 stipulates that local and international investors can obtain concessions for building and operating power plants. A new investment law enacted in 1997 includes various incentive mechanisms such as state guarantees for investors.

At the time of contract negotiations concerning the supply of electricity from privately built power plants in the late 1990s, an initial public offering of stock in all seven of Egypt's state-owned monopolistic power providers was in preparation for the Egyptian stock exchange. However, due to lack of interest among investors, the plan was never implemented.

The last significant step of reform took place in the year 2000, when the Egyptian Electricity Authority was restructured to become the Egyptian Electricity Holding Company (EEHC). That conversion is regarded as a step toward a more entrepreneurial approach because, for example, EEHC is expected to finance future projects out of its own budget and with no governmental intervention.

The conversion also included the break-up of formerly vertically integrated utility companies into individual enterprises (see above), each of which is now an independent undertaking with its own, autonomous management and separate accounting. An internal bidders pool for the exchange of power between the companies is intended to yield market-based incentives.

EEHC was created as a new approach to the privatisation of its subsidiaries, but no part of any state-owned enterprise has yet been sold. Via EEHC, the Egyptian government still controls 90 % of all power production and is maintaining its monopoly on power transmission and distribution.

Cross-subsidisation is a common phenomenon on the Egyptian electricity market, despite the fact that the reduction of such practices is a declared objective. The state's influence is underlined by the circumstance that the Minister of Energy is also the chairman of EEHC.

Despite hesitant reform efforts to date, the government is still planning to establish a future electricity market in which direct, freely negotiated, bilateral agreements between electricity consumers and electricity producers will be possible. It also envisions opening up the power transmission network for the pipelining of power. Independent power producers need to have access to the electricity market without having to commit themselves to long-term agreements with EEHC that can last for decades.

In this regard, the regulatory authority has proposed that, to begin with, 70 major industrial power consumers would be allowed to cover 20% of their annual additional power requirements via direct agreements with power producers. That way, the situation on the Egyptian electricity market should gradually become more flexible, but the Ministry of Energy is still refusing to approve any such opening up of the market on the grounds that neither the power plant operators nor the ultimate consumers are adequately prepared for such flexibilisation.

EEHC itself has stated a number of future reform objectives. Break-even electricity tariffs are supposed to be introduced by 2009. An independent electricity trader is supposed to ensure that supplies to major customers take place under competitive conditions. The distribution companies are to be commercialised and their business practices reorganised.

At present, however, no one is planning any further competitive contracting for private investments in the power generation sector. Even in the booming wind sector, there is no sign of any private investors being invited to participate in new projects.

10.4 Policy Promoting Renewable Energy Resources

The Egyptian Ministry of Electricity and Energy began concerning itself with renewable energy resources in the 1970s. A strategy for including renewable energy resources in the scope of national energy planning was developed in the 1980s and has since repeatedly been adapted against the background of emerging opportunities for the utilisation of renewable energies. Present plans call for three percent of the demand for electricity to be met by renewable energy[21] – primarily wind and solar energy – by 2010.

International Promotion

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), Germany’s Kreditanstalt für Wiederaufbau (KfW) is engaging in financial cooperation with Egypt on a number of projects in the energy sector, including information and training initiatives on renewable energies, the construction of mini-hydropower plants, wind farms in Zafarana and Gabal El-Zayt, the ecological upgrading of existing power plants, and the rehabilitation of transformer substations and generators at the Aswan dam.

The planning for an international “Centre of Excellence for Renewable Energies” in Egypt is still ongoing. The centre’s envisaged research and training activities will be devoted to promoting the development of renewable energy resources in the Middle East and North Africa.

Over the past ten years, some 70 million US$ has been appropriated for energy and climate protection projects in Egypt within the scope of Global Environment Facility projects. Most of that money, more than 50 million US$, is accounted for by the 150 MW hybrid power plant in Kuraymat, the promotion of which was pledged in 2004.[22]

21 In addition to the use of large-scale hydropower.
22 GEF Project ID 1040.

Clean Development Mechanism

Egypt signed the Kyoto Protocol on 15 March 1999, and ratified it on 12 January 2005. A study conducted in 1997 with the support of the National Strategy Studies Programme[23] was intended to encourage consideration for environmental and climate change related aspects of future developments in the energy sector. The study provided a foundation for Egypt's national CDM strategy,[24] which was adopted in October 2002. That strategy comprised the establishment of the requisite administrative framework for CDM projects and a portfolio of potential CDM projects that could provide a basis for as quick a start as possible in Egypt.

The Designated National Authority (DNA) established in 2005 serves as the contact point for all CDM-related matters. Organisationally it is part of the Egyptian Environmental Affairs Agency (EEAA).

In the meantime, a number of legal, technological, social and ecological criteria to be met by CDM projects have been elaborated and written down in the Guide Book for Project Developers, which is available from the DNA website.[25] The Guide Book includes much other useful information for planners wishing to implement CDM projects in Egypt.

As of this writing, two Egyptian CDM projects have been registered with the CDM Executive Board.[26] One of them, a landfill gas project in Alexandria, has the capacity to reduce annual greenhouse gas emissions by a CO_2 equivalent of some 371,000 tonnes.

In its CDM portfolio the Egyptian DNA features further 22 potential projects in the following fields: renewable energy (five projects), industry (four projects), energy efficiency (six projects), fuel switching (six projects) and afforestation (one project).

10.5 Status of Renewable Energy Sources

Since Egypt has its own natural gas resources, the country is still largely reliant on fossil fuel for generating electricity, but it is nonetheless active in nearly all areas of the renewable energy sector.

Hydropower

Egypt has been using hydropower to generate electricity since 1960. The first (low) dam to straddle the Nile near Aswan was mainly intended to help control water levels for irrigation. The new (high) Aswan dam and power station, located 7 km south of the first, was commissioned in 1967. A third Aswan power plant was put into operation in 1985. Then, in 1995, a new set of locks was installed across the Nile at Esna (approx. 50 km south of Luxor). In 2005, hydropower accounted for 12.5 % (or 12,644 GWh) of all electricity produced in Egypt.

Plant	2004	2005
	GWh	
High Aswan Dam	9,374	9,049
Aswan I	1,492	1,497
Aswan II	1,690	1,663
Esna	446	420
Naga Hamady	17	15
Total	**13,019**	**12,644**

Tab. 12: Power output of Egyptian hydropower plants; 2004, 2005; GWh[27]

Future hydropower projects now at the planning stage encompass a total generating capacity of 114.5 MW. A new power plant in Naga Hamady is scheduled to bring its 64 MW on line some time in 2008. New hydropower plants with ratings of 5.5 MW and 32 MW, respectively, are being built in Zefta and Assuit. Another new power plant rated at 13 MW, in Kanater, is scheduled for completion by the end of 2009.

23 The National Strategy Studies Programme was a joint initiative of the World Bank and the Swiss Government.
24 Egypt National Strategy Study on the Clean Development Mechanism [www.cdmegypt.org/NSS.htm].
25 See: www.cdmegypt.org/publications.htm.
26 Status: January 2007.
27 Source: Egyptian Electricity Holding Company (EEHC).

Mini- and micro-hydropower plants

A UNEP study[28] dating from April 2004 lists Egypt's maximum potential for mini- and micro-hydropower generating facilities as 30 MW. Certain points along the Nile and a few of its tributaries make suitable locations for such power plants. In addition to the aforementioned sites and facilities, the study also makes mention of four more potential sites for small-scale stations[29] with a total estimated generating capacity of 7.4 MW. The study cites 15 possible locations for plants with ratings between 150 kW and 1,200 kW. All in all, these facilities could generate close to 50 GWh annually.

Wind energy

Wind potential

Egypt has outstanding siting conditions for wind energy. In the coastal regions in particular, high wind speeds are frequent and the thinly populated areas are relatively easily accessible to allow the construction of large wind farms without too much difficulty. The addition of wind-generated power to the country's generation portfolio will diversify the available range of energy options as the proportional contribution from hydropower declines. All wind energy projects to date have been implemented and operationally backstopped by NREA. For the time being, private-investor involvement is not advocated.

A detailed wind atlas is available.[30] Its database was built up from measurements conducted between 1998 and 2005 in a joint effort by NREA, the Egyptian Meteorological Authority (EMA) and the Danish UNEP research centre Risø. The purpose of the project was to establish a solid meteorological basis for evaluating the country's wind resources.

Particular attention was paid to six promising areas: the northwest coast, the northeast coast, the Gulf of Aqaba, the Gulf of Suez, the Red Sea and the Western Desert. In addition to those data records, the atlas also surveys the Egyptian wind conditions on the basis of wind models and offers detailed, meteorologically founded information on siting requirements for medium-sized and large wind farms.

	WAsP[31]	KAMM[32]
	m/s	
Aswan	9.9	7
Dakhla	5.8	6
Kosseir	7.7	8
Sharm el-Sheikh	13.7	9.5

Tab. 13: Average wind speeds at selected sites in Egypt; m/s[33]

A special wind atlas[34] for the Gulf of Suez was completed in 2003. For this, NREA and the UNEP Risø Research Centre collected data at 13 stations around the Gulf from 1991 to 2001. A potential overall capacity of 20,000 MW for wind power projects was determined for the uninhabited desert regions to the west of the Gulf. Average wind speeds in excess of 7 m/s are encountered there at a height of 10 m. At heights of 50 to 60 m, wind energy densities ranging from 430 to 1,000 W/m^2 can be anticipated.

28 UNEP Risø Centre (United Nations Environment Programme), Prospects for renewable energy technologies in the Middle East and North Africa region, Sami Kamel, UNEP Risø Centre, Denmark, April 2004.
29 Rosetta Branch, Dairout, El Azab, Tamiya.
30 Mortensen et al. (2005), Wind Atlas for Egypt, Measurements and Modelling 1991-2005, and www.windatlas.dk/Egypt/About.html
31 Wind Atlas Analysis and Application Program (wind modelling method with fine spatial resolution, based on measured data).
32 Karlsruhe Atmospheric Mesoscale Model (wind modelling method with medium spatial resolution, based on numerical climate simulation).
33 Source: NREA, OME.
34 Mortensen et al. (2003), Wind Atlas for the Gulf of Suez. Measurements and Modelling 1991-2001.

Region	m/s
Ras Sedr	7.5
Abu Aldarag	8.8
Zafarana	7.5–9.2
St. Paul	8.4
Ras Ghareb	10.0
El-Tour	5.6
El-Zayt	10.3–10.8
Hurghada	6.7

Tab. 14: Average wind speeds at selected locations on the Gulf of Suez; m/s; measured at a height of 25 m[35]

Year	2000	2001	2002	2003	2004	2005	2006
Installed capacity [MW]	5	38	68	98	145	145	230
Annual output [GWh]	n.s.	n.s.	224	214	387	533	552[37]

Tab. 15: The evolution of wind power in Egypt; MW, GWh; 2000–2006[38]

The meteorological data gleaned from ten weather stations situated along the Mediterranean coast were evaluated in a brief study.[36] Three locations – Sidi Barrani, Mersa Matruh and El Dabaa – were found to have average wind speeds of 5 to 6 m/s. As such, they would make suitable sites for wind power plants. The local wind energy density ranges between 180 and 230 W/m^2 at a height of 30 meters, and between 260 and 330 W/m^2 at a height of 50 meters. Model computations for a 1 MW turbine at the El Dabaa site showed an annual yield of over 2.7 GWh.

Hurghada wind farm

Egypt's first wind farm, encompassing 42 turbines from various manufacturers with ratings between 100 and 300 kW, was erected near Hurghada on the Red Sea coast in 1992. This 5.2 MW facility is situated directly adjacent to a wind technology centre with three small test units. Beginning in 1993, the farm's output was successively injected into the local municipal grid.

Zafarana wind farm

This wind project at Zafarana on the Gulf of Suez marked Egypt's initial venture (in 2001) into the use of wind power for feeding electricity into the interconnected power grid. An 80 km^2 area was set aside by decree for NREA wind power projects. The first stage involved the installation of 140 MW of generating capacity by 2004 with German financial and technical assistance. In 2005/06, the farms in Hurghada and Zafarana together produced 552 GWh of electricity.

By 2003, facilities totalling 60 MW were brought online with additional international assistance. The calculated annual output of all these plants comes to approximately 210 GWh, given a capacity factor of 40 %. In parallel with that project, additional plants with cumulative capacities of 33 and 47 MW respectively were installed in March 2001 and June 2004, financed by loans from Germany's Kreditanstalt für Wiederaufbau (KfW). These plants have a total anticipated annual output of 305 GWh for a capacity factor of 43.5 %. Another complex, this one with a capacity of 85 MW, was installed and commissioned in 2006. Here, production for the national grid is supposed to amount to 320 GWh annually. All plants feeding into the interconnected power grid receive remuneration amounting to 1.7 euro cents/kWh (0.12 EGP/kWh). Despite favourable wind conditions, this is unlikely to enable self-supporting operation. A new development stage that will add another 80 MW is presently close to completion and is also being financed with a KfW loan of € 75 million. Commissioning is scheduled for early 2008.

35 Source: NREA.
36 A.S. Ahmed Shata, R. Hanitsch (2005), Evaluation of wind energy potential and electricity generation on the coast of the Mediterranean Sea in Egypt, Faculty of Electrical Engineering and Computer Science, Institute of Energy and Automation Technology, Technical University Berlin.
37 Specific to the 2005/2006 accounting period.
38 Source: Global Wind/2005 Report (Global Wind Energy Council).

This project will be the first in which a private company will operate and maintain the plant for the first five years. Also at the Zafarana site, two more wind power projects rated at 120 MW each are to be installed with initial commissioning set for late 2008. It is planned to part-finance all new facilities through the sale of emission certificates under the CDM. The Egyptian DNA has already approved several wind farms, and contracts for the purchase of certificates have been concluded.

Further extension plans

Another 700 km^2 area bordering on the Gulf of El Zayt on the Red Sea coast has been identified as suitable for wind farms totalling up to 3,000 MW. Mean wind velocities in this area are 10.5 m/s.

With the assistance of KfW Entwicklungsbank (KfW Development Bank), initially an 80 MW wind farm is to be erected there. A feasibility study is currently being prepared, and is scheduled for completion by October 2007.

A corresponding study has already been completed for another complex with a capacity of 200 MW, which is to be built with international assistance.

NREA plans to achieve a total installed capacity of 1,050 MW by 2011. A target of 5,000 MW of wind generating capacity is targeted for 2021/22.

Year	2007/2008			2009		2010
Additional capacity [MW]	120	80	60	60	80	220
Location	Zafarana				Gabal El-Zayt	
Total wind generating capacity [MW]	430		490	630		850
Anticipated power output [GWh]	1,690		1,930	2,480		3,350

Tab. 16: Evolution of wind power at the Zafarana and El Zayt sites up to 2010[39]

Biomass

In the rural areas of Egypt, people obtain 76% of their energy needs from burning plant residue and dry manure. Their traditional stoves are characterised by very poor efficiency (5-10%) in the use of biomass. If the plant residue and farm manure[40] were instead converted to biogas, the available biomass could be used much more efficiently.

The Basaisa Community Development Association (Basaisa-IRTECTAP), the Agricultural Research Centre (ARC) and the technology transfer centre of the National Agricultural Research Project (NARP-TTC) have therefore developed a programme intended to make the merits of biogas known to the rural population. Within the scope of that programme, 18 family size fermenters and two biogas plants for large farms were installed in the late 1990s. Forty people were trained to operate the biogas plants.

Solar energy

Thanks to its location in northern Africa's sunbelt, Egypt enjoys all the best prerequisites for exploiting solar energy. According to a solar atlas dating from 1991, the direct insolation ranges between 2,000 kWh per square meter and year in the north and 3,200 kWh/m^2 a in the south. The sun shines for 9 to 11 hours a day, with only a few cloudy days per year.

Photovoltaics

All in all, PV generating capacities totalling 4-4.5 MW are presently in operation in Egypt at distributed locations. PV technology is being used in various sectors. In 2005, the overall output was distributed as follows: communications 40%, lighting 33%, seawater desalination 12%, advertising 10%, cathodic protection 3% and water pumps 2%.

39 Source: EEHC, NREA.
40 Farm manure consists of organic residue, mainly animal excreta with litter material, in the form of semi-liquid, liquid and solid manure.

In cooperation with the Italian Ministry of the Environment, the New and Renewable Energy Authority (NREA) is planning a solar electrification project for four remote settlements in the Matrouh governorate that have no access to the national power grid. PV systems with a total output of 43 kW are to be installed there. Further information about this project can be found in the section on rural electrification.

Solar thermal hybrid project

An integrated solar combined-cycle system (ISCCS) is under construction in Kuraymat, 90 km south of Cairo. The plant comprises two natural gas-driven turbines rated at 41.5 MW each, two steam generators that utilise the exhaust heat from the gas turbines, and one 68 MW steam turbine. A field of parabolic trough concentrators designed to generate electricity from solar-thermal energy, with a maximum output of 30 MW, is being installed adjacent to the conventional power plant. Solar energy will account for 6.6% of the facility's total annual power output of just under 1,000 GWh. This will save approximately 38,000 t/a CO_2 emissions. The plant is being built as part of a World Bank/GEF programme geared to activating the commercial exploitation of solar-thermal power generation. The GEF is injecting US$ 50 million into this Egyptian project. The designated site has already been developed, and an environmental impact assessment conducted by the Egyptian environmental authorities came to a positive conclusion. Commissioning is planned for mid-2009.

Solar-thermal water heating

According to the New and Renewable Energy Authority (NREA), some 200,000 solar water heating systems are in operation in Egypt. National standards have been drawn up for such systems, and eight local contractors are active in the field of solar-thermal hot water generation. However, since the initial cost exceeds the price of inexpensive gas and electric boilers, the solar systems are not yet particularly popular. Consequently, NREA is campaigning in favour of the technology.

SOLATERM project

The SOLATERM project aims to promote the dissemination of solar-thermal generating systems in the southern Mediterranean area. Eighteen partner organisations in eight southern Mediterranean countries and five European countries intend to improve the prevailing general conditions for the application of solar thermal technology while pressing ahead with relevant research. SOLATERM is being financed with EU funding, with a total budget of € 800,000. The initiative is headed by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). Egypt is represented by NREA and the Centre for the Environment and Development for the Arab Region and Europe (CEDARE). The project was launched in November 2006 with a term of 24 months.[41] According to SOLATERM estimates, Algeria, Egypt, Morocco and Tunisia have a combined installed collector area of only 500,000 m^2, most of which is located in Egypt. The actual potential of this technology, however, is well above that.

Industrial solar thermal pilot plant

With assistance from the African Development Fund, an Egyptian pharmaceuticals company has built a solar steam generator plant in which 1,900 m^2 of collectors generate 1.3 t of steam per hour at a pressure of 8 bar and a temperature of 175 °C. The local component is 70%, including the sealed parabolic trough collectors.

41 See also: GTZ Energy News No. 4, January 2007.

10.6 Rural Electrification

With a countrywide electrification rate of 99 %, most of Egypt's rural population already has access to the public power grid. For the few remaining remote settlements, however, the decentralised use of renewable energy resources is under consideration as an alternative to actual grid access.

Within the scope of a joint project being conducted by NREA and the governorate of North Sinai, the Egyptian environmental authorities, the Rural Electrification Agency (REA) and the Italian Ministry of the Environment, four villages comprising roughly 25 families. Each of them are to be equipped with photovoltaic systems. The project is intended to show how potential electricity users in remote regions can be supplied with electricity at reasonable cost.

Roughly 1,000 people will be affected. Not only the people's homes, but also the schools, mosques, health centres and street lighting are to receive solar electricity. The cost of investment will be about € 500,000. PV modules with a total generating capacity of 43 kW will be installed. The targeted annual power output is 78,000 kWh. The cost will therefore amount to € 0.10/kWh over the next 20 years. Comparable electrification with diesel generators would incur approximately the same cost per kWh.

Exchange rate (as of 19 January 2007):
1 Egyptian pound (EGP) = 0.14 euro (EUR)
1 EUR = 7.31 EGP

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11 Ethiopia

11.1 Electricity Market

Installed capacity

Total installed generating capacity in Ethiopia at the end of 2006 amounted to some 752 MW. Of this, almost 670 MW was installed in hydroelectric power schemes, 7.3 MW in a geothermal plant and roughly 75 MW in diesel generators.

Power generation

98 % of actual electricity production is based on hydropower. The other 2 % is produced by diesel generators, mostly relatively small. In the 2003-2004 financial year the state-owned utility EEPCo (Ethiopian Electric Power Corporation) generated 2,318 GWh of electricity. This was an increase of about 37 % over the year 1999/2000. The lion's share was accounted for by hydropower, at 2,279 GWh.

Year	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
	GWh				
Hydropower	1,645.8	1,789.8	1,991.8	2,023.6	2,279.0
Diesel	23.0	16.9	16.6	40.1	38.8
Geothermal	20	5.1	1	0	0
Total	**1,688.8**	**1,811.8**	**2,009.4**	**2,063.7**	**2,317.8**

Tab. 1: Trends in electricity production according to generation method, GWh/year; Ethiopia; 1999/2000-2003/2004[1]

Power transmission and distribution

On-grid electricity supply is operated by EEPCo. About 98 % of the electricity sold is supplied via the Interconnected System (ICS). The ICS extends across the entire country with the exception of the southeast. Power is not provided in all areas, however. Almost all the large hydropower plants are integrated into the ICS.[2] A further 2 % of the electricity is supplied through several isolated grids in what is called the Self Contained System (SCS), with production from diesel generators and three small hydropower units.

Ethiopia has about 6,000 km of high voltage lines in its transmission grid (230 kV/132 kV/66 kV/45 kV) and 22,000 km of medium and low voltage lines in its distribution grid (15 kV/380V/220V). Various programmes to expand the power grid are currently in progress. Between 2002 and 2006 alone, EEPCo connected about 400 villages to the grid for the first time. By 2010 the degree of electrification across the country is supposed to have reached 50 %.[3]

As well as the expansion measures aimed at the electrification of rural areas, projects are also being advanced to establish grid connections with other countries. As of 2010, Ethiopia would like to be a net exporter of electricity. The construction of a link to Djibouti has made the most progress so far. The African Development Fund granted a loan of US$ 59 million for this in 2005. The scheme is due to be completed by 2009.

The link with the Kenyan grid was decided upon at the end of 2006 and is supposed to be in place by 2014. Financing is to be provided through loans from the African Development Bank, Arab Bank, European Investment Bank and East African Development Bank and through the regional NEPAD programme (New Partnership for Africa's Development).[4] Another link, to Sudan, is at the planning stage.

1 Source: EEPCo 2006.
2 A grid map is available on the internet at swera.unep.net.
3 See also section headed Rural Electrification.
4 NEPAD (The New Partnership for Africa's Development) is an initiative brought into being by the African Union with the aim of promoting the economic and social development of the continent. Among other things it promotes infrastructure projects in the energy sector with ideas and policy inputs (www.nepad.org).

Electricity consumption

Electricity provision in Ethiopia is extremely underdeveloped. With a per-capita electricity consumption of 28 kWh per year, Ethiopia has one of the lowest rates in the world. Only about 15 % of the population has access to the electricity grid. In rural areas, where some 85 % of the 77 million inhabitants of Ethiopia live, the figure is just 1 %. The capital Addis Ababa accounts for roughly 50 % of all consumption, with a further 20 % in the second-largest city Nazareth. In the 2003/2004 financial year electricity consumption totalled 1,846.7 GWh.

1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
GWh				
1,375.8	1,413.0	1,621.4	1,706.8	1,846.7

Tab. 2: Electricity sold by EEPCo, GWh; Ethiopia; 1999/2000-2003/2004[5]

According to its own information, EEPCo supplied over 777,000 end customers in mid-2004. Around 85 % of EEPCo's customers are private households, 14 % belong to the commercial sector and only 1.3 % to industry. Just 0.2 % of consumption is attributable to street lighting.

Between 1992 and 2002 electricity consumption grew at an annual rate of about 3 %. In the wake of expansion of the energy infrastructure, there is expected to be a considerable rise in demand for electricity in the near future.

	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
	Number of consumers				
Households	508,407	534,106	559,205	597,976	667,100
Commerce	78,899	81,794	85,913	90,167	98,837
Street lighting	918	970	1,043	1,207	1,352
Industry	7,926	8,121	8,180	8,444	9,106
Major industry	89	94	99	96	104
EEPCo (internal)	398	411	445	470	508
Total	**596,637**	**625,496**	**654,885**	**698,360**	**777,007**

Tab. 3: Number of consumers, EEPCo; 1999/2000-2003/2004[6]

Electricity price

For many years the average price charged by EEPCo remained stable at about 5 US cents/kWh, and considering the ongoing investment in the energy infrastructure was therefore well below the cost of provision.[7] Foreign advisers and donors, such as the World Bank, have therefore repeatedly recommended increasing the price of electricity. In June 2006 the tariff was raised by 22% to an average of 6.2 US cents/kWh, although this is still not considered sufficient.

Expansion planning

The electricity market in Ethiopia is currently undergoing a process of marked change. Both capacity and the level of electrification across the country are supposed to be massively increased in the coming years, among other things through the construction of several large hydropower plants.

5 Source: EEPCo 2006.
6 Source: EEPCo 2006.
7 Production costs with diesel generators are estimated at between 13 and 25 US cents/kWh. In the case of relatively new hydropower plants the figure is put at between 3 and 4 US cents/kWh. The costs incurred for transmission and distribution of the electricity must be added to this. EEPCo presently has high levels of expenditure because of the expansion of the power grid and investment in energy infrastructure.

11.2 Market Actors

Electricity generation, the electricity grid and the supply of energy are largely under state control in Ethiopia. An important part is also played by international donor organisations in the funding of large-scale projects. The central operator on the market is the EEPCo.

Ethiopian Electric Power Corporation (EEPCo)

The Ethiopian Electric Power Corporation (EEPCo) is a state-owned enterprise. Within the power sector it is responsible for production, transmission, distribution and supply. EEPCo is the key institution for the creation of new grid-coupled power station capacity.

Other Actors

Ministries

Various ministries have either direct or indirect responsibility for the energy sector. The central actor is the Ministry of Mines and Energy. It is responsible for national energy policy and expansion of electricity provision. It has authority over EEPCo and the Ethiopian Electricity Agency (EEA). For matters relating to rural electrification the Ministry of Rural Development also has a role to play. The Ministry of Water Resources is responsible for the protection and utilisation of the nation's water resources. In view of the great significance of hydropower, this ministry is particularly important for the Ethiopian electricity sector.

Ethiopian Electricity Agency (EEA)

The Ethiopian regulatory authority with responsibility for the electricity sector, the EEA, has been in existence since 1997. Its tasks include price regulation, the licensing and supervision of independent power producers, the approval of power purchase agreements (PPAs) and regulating access to the grid by private actors. It is also responsible for organising programmes in the field of rural electrification and establishing the framework conditions for private investors. On account of structural shortcomings and a lack of personnel, however, the EEA is not yet in a position to perform these tasks to the full.[8]

Ethiopian Science and Technology Agency (ESTA)

ESTA is a state institution that answers to the Ministry of Education. Among other things the ESTA has maintained a department for mining, water and energy since 1994, which has run a programme researching into photovoltaics and solar thermal energy in cooperation with Swedish donor organisations.

Ethiopian Rural Energy Development and Promotion Centre (EREDPC)

In the field of rural electrification there are also a number of more recently established institutions, most of which receive assistance from external donors in the form of financial and human resources. EREDPC was founded in 2002. It is answerable to the Ministry of Rural Development, and in collaboration with non-governmental organisations it concerns itself with measures to spread the use of renewable energy sources in rural areas. It also draws up studies into the demand for energy and into the cultural, technical and economic conditions for the electrification of rural regions.[9]

8 Sources: Proclamation No. 86/1997; Rural Electrification Strategy 2002 (Ministry of Infrastructure).
9 Proclamation No. 269/2002.

International institutions

Ethiopia is heavily dependent on international aid. In 2004, development assistance payments accounted for 22.3 % of gross domestic product. In particular, this also relates to financial and technical assistance for infrastructural measures in the energy sector. The most important institutions in this field include the Global Environmental Facility (GEF), the World Bank, the International Monetary Fund, the European Investment Bank and the African Development Bank. Other organisations active in the energy sector include for example the Austrian Development Agency (ADA), Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), the Italian development cooperation organisation DGCS and the British organisation EDS (Energy for Sustainable Development).

11.3 Legal Framework

Laws and other statutory instruments

Since the end of the 1990s the Government of Ethiopia has issued numerous decrees and regulations that are aimed at bringing about a liberalisation of the energy market. The establishment of the regulatory authority, EEA, laid the foundations for the opening of the electricity market. According to Proclamation No. 86/1997, the EEA is responsible among other things for setting the tariffs and regulating access by private operators to the electricity grid. In the same year, Proclamation No. 37/1997 paved the way for private domestic investors to generate electricity and feed it into the grid with plant capacities of up to 25 MW. Only foreign organisations are permitted to invest in power stations with a capacity of over 25 MW. Council of Ministers Regulations No. 7/1996 and No. 36/1998 introduced additional tax relief and improved import regulations as incentives for private investment. Nonetheless, the electricity sector is still controlled by the state. Private investment is subject to numerous restrictions. [10]

Government objectives

For a number of years now energy policy has enjoyed a high priority on Ethiopia's political agenda. The government's declared aim is a huge expansion of the infrastructure in the energy sector. A crucial reference framework for the government's aims and for developments on the electricity market is provided by EEPCo's five-year plans, the power sector development programmes for 2000-2005 and 2005-2010.

Among other things the five-year programme for 2000-2005 envisaged doubling the generating capacity of 327 MW in 2000 by 2005, increasing the number of towns connected to the electricity grid from 458 to 651 and raising the proportion of the population with access to the grid from 13 % to 17 %. At least in terms of the expansion in capacity, which was roughly 750 MW by the end of 2006, these objectives were more than met, which can be seen as an indication of the government's resolve to push through with its intentions.

According to the development objectives set for 2010, 50 % of households are to be connected to the electricity grid. The capacity expansion to allow for this is to be provided in particular by the construction of additional hydropower plants, bringing the total to over 4,000 MW. Electricity consumption is likely to rise from about 2,300 GWh in 2004 to 6,978 GWh in 2010. The government is also aiming to become a net exporter of electricity by 2010. Although in recent years the Government of Ethiopia has proved that it takes the expansion of electricity provision seriously and is pressing ahead with it on a broad scale, doubts must remain whether the highly ambitious targets – particularly with regard to rural electrification – can be achieved within the proposed period.

10 The main disincentives to investment prove to be the inadmissibility of private ownership of land, as enshrined in the constitution, political and social instability, corruption, institutional weaknesses and the relatively low price of electricity.

11.4 Policy Promoting Renewable Energy Sources

To date, Ethiopia has not had a systematic national policy in place targeting the promotion of renewable energy sources. That said, it should be mentioned that the proportion of electricity generated from fossil fuels is only about 2 % anyway, and will fall further in the coming years. Nonetheless, alternative energy sources are often taken into consideration in cooperation with foreign partner organisations and within the framework of the rural electrification programmes. Over and above that, EEPCo is showing greater interest in alternative energy sources as cost-effective alternatives to diesel generators and as a means of diversifying electricity supplies.

Rural Electrification Fund (REF)

Other institutions emerged on the back of the Ethiopian Government's strategic plan for rural electrification in 2002. The Rural Electrification Fund (REF) has been in existence since 2003. The REF receives US$ 15 million in funding from the World Bank and GEF under the Energy Access Program. This allows the granting of loans and the promotion of energy projects in rural areas in collaboration with private actors and local authorities. In formal terms it is administered by the Rural Electrification Board (REB) and the Rural Electrification Executive Secretariat (REES).

The REB determines the criteria for project promotion and coordinates cooperation with other programmes. The Board also decides on whether to proceed with the submitted project proposals. The REB's members are employees of the Ministry of Water Resources, the Ministry of Mines and Energy, the EEA and the EREDPC and representatives of the private sector.[11] The resources available to the REF are used to subsidise 85 % of the cost of rural electrification projects. Renewable energy sources are entitled to a higher subsidy of 95 %. Most of the projects that receive assistance, however, are based on electricity generation with diesel generators.

Clean Development Mechanism

Ethiopia ratified the Kyoto Protocol on 14 April 2005. The institution responsible for the CDM in Ethiopia is the Environmental Protection Authority (EPA). So far, trading in emissions permits has not been used as a promotional tool in the energy sector. No projects have been registered yet with the Executive Board of the UNFCCC. Thanks to the high proportion of emissions-free hydropower in electricity production, the specific emission factor is only 16.92 t CO_2/GWh. The potential for financial promotion within the scope of the CDM is therefore relatively low. It is still possible, though, that the CDM instruments will be used for the planned wind farms in Mesobo-Harena and Ashegoda.

11.5 Status of Renewable Energy Sources

While the intensive use of large-scale hydropower forms the basis for electricity supply across the country, so far renewable energy sources have been used in only a few isolated cases for decentralised power generation.

Hydropower

Hydropower is of paramount importance in Ethiopia, accounting for 98 % of electricity generation. At the end of 2006, total installed capacity amounted to 668.8 MW. The theoretical potential is estimated to be some 30,000 MW, many times the amount presently utilised. Altogether up to 160,000 GWh of electricity could be produced per year. The terrain of the country is considered particularly advantageous, with large differences in altitude. Average annual precipitation ranges between 2,400 mm in the southwest of the country and 150 mm in the north. However, average precipitation is subject to wide fluctuations from year to year, even as far as recurring periods of drought.

11 Proclamation No. 317/2003; ethiopiaref.energyprojects.net.

According to EEPCo's current five-year programme and as part of other projects, it is planned to expand capacity to approximately 4,300 MW by 2013.[12] At present there are several large-scale projects being planned or already under construction.

Power plants

Power plant (*planned or under construction)	Capacity (MW)	Commissioning date (*planned)
Koka	43.2	1960
Awash II	32.0	1966
Awash III	32.0	1971
Finchaa	134.0	1973, 2003
Melka Wakana	153.0	1988
Tis Abay I	11.4	1964
Tis Abay II	73.0	2001
Gilgel Gibe	184.0	2004
3 plants in SCS, total:	6.2	1991, 1992, 1994
Installed capacity, end 2006	**668.8**	
Gilgel Gibe II*	480.0	2008*
Beles*	453.0	2009*
Tekeze*	300.0	2010*
Halale Worbesa*	436.0	2010*
Ficha-Amerti-Neshe*	96.0	2010*
Gilgel Gibe III*	1,870.0	2013*
Planned installed capacity by 2013	**4,303.8**	

Tab. 3: Capacity and date of commissioning of hydroelectric power plants in Ethiopia; MW[13]

The Gilgel Gibe I hydroelectric power plant came on stream in February 2004, and has a capacity of 184 MW. The project was financed by EEPCo, the World Bank, the Austrian Government and the European Investment Bank. Another power plant – Gilgel Gibe II – is currently being built directly adjacent to it, with a planned capacity of 420 MW and annual electricity production of 1,500 GWh. It is due to be completed in 2008. The cost amounts to € 490 million, of which roughly 50 % is being met by the Government of Ethiopia, about one third is being paid by the Italian state and the remaining 16 % is being financed by a loan from the European Investment Bank. A 400 kV transmission line will be built to connect the plant to the EEPCo power grid, to supply the capital, Addis Ababa.

The hydroelectric plant in Beles is due to be completed by the end of 2009. The total cost of the 453-MW scheme is estimated at € 520 million. Part of this, € 400 million, will be funded by the Italian Government in the form of direct payments and loans. Construction of the Tekeze power plant, with a capacity of 300 MW, is scheduled to be completed by 2010. The organisation that has assumed responsibility for building the plant since 2002 is a Chinese joint venture made up of China National Water Resources and Hydropower Engineering Company (CWHEC) and China Gezhouba Water and Power (Group) Ltd.

The Ficha-Amerti-Neshe plant is also being built under Chinese lead management. EEPCo signed an agreement with China Gezhouba Group Corporation (CGGC) in December 2006. The capacity of the plant is expected to be about 96 MW, and work is due to be completed by early 2010. The Chinese Government will cover 85 % of the cost of some € 104 million.

By far the largest project is Gilgel Gibe III, with a capacity of 1,870 MW. This power plant is scheduled to be built by 2013 and will cost about € 1.39 billion. Financing is to be provided by the Ethiopian Government and international donors such as the World Bank.

Other large-scale projects that are planned are Chemoga Yeda (approx. 440 MW), Halale Worbesa (436 MW), Aleltu East (189 MW), Kara Dombe/Blue Nile and Gojeb (150 MW).

12 These are estimates, because many of the projects are still only at the planning stage. Accordingly the details of commissioning dates and anticipated capacity vary, depending on the source.
13 Source: EEPCo 2006, bfai 2006.

Small-scale hydropower

Compared with the major projects described above, the role of small-scale hydropower is relatively modest. Three plants, each rated at less than 5 MW, are connected to the SCS belonging to EEPCo. In principle the huge unused potential for hydropower also opens the way for wide-ranging possible applications for small hydropower plants. Especially in areas remote from the EEPCo electricity grid there are a large number of good sites located close to consumers. Programmes promoting small-scale hydropower are supported by the Austrian Development Agency (ADA), the World Bank, the Global Environmental Facility (GEF)[14] and Irish Aid.

Wind energy

As yet there are no commercial wind power plants used for generating electricity. Since January 2007 a 2.5-kW installation has supplied power to a hospital and other public buildings in the village of Debo. The project was implemented by a church parish in Saxony, Germany. EEPCo is planning to build turbines with a total capacity of 200 MW by 2012. This is intended to reduce dependency on hydropower. Moreover, because of the major grid expansion currently ongoing, there is expected to be a shortage of supply from 2008 onwards. Wind power is considered as a possible alternative to the use of additional diesel generators for increasing electricity generating capacity in the short term. In the long term it is also seen as a possible complement to hydropower in Ethiopia, as these two forms of energy unfold their potential anticyclically: strong winds occur primarily during the dry season.

Wind atlases

The total theoretical potential for wind power in Ethiopia is estimated at 10,000 MW.[15] Good locations for exploiting wind power are mainly to be found in the east and north of the country. The first, imprecise measurements were taken as long ago as the 1970s and 1980s by the NMSA (National Meteorological Services Agency).[16] The SWERA (Solar and Wind Energy Resource Assessment) programme by UNEP is currently working on a wind atlas for Ethiopia.[17] Provisional results indicate that the average wind speed throughout the year ranges between 3.5 m/s in the west of the country and over 5 m/s in the east. The latter region, however, is not connected to the EEPCo power grid. The wind speed figures are only averages, though; suitable locations where local winds are stronger are not identified. The most detailed site-related survey of wind resources to date was conducted as part of GTZ's TERNA wind energy programme. EEPCo is planning further measurements at various locations for the coming years.

GTZ – TERNA wind energy programme

Within the framework of the TERNA wind energy programme, GTZ is cooperating with EEPCo in planning two grid-coupled wind farms with a capacity of 40 to 60 MW each. Preliminary work began in December 2004 and is initially scheduled to end by June 2007. The project covers the selection of suitable sites, wind measurements, the evaluation of wind potential and the drafting of feasibility studies. Training programmes are also being implemented, in cooperation with the Austrian Development Agency (ADA).

14 In 2003 the World Bank in cooperation with the GEF, the European Investment Bank and the Government of Ethiopia launched the Energy Access Project, scheduled to run for five years. The funds made available for this total US$ 183.79 million. The project's objectives include institutional capacity-building measures and expansion of the energy infrastructure. The measures supported by the GEF within this programme are focussed on renewable energy sources.

15 Dalelo, Aklilu, Rural Electrification in Ethiopia: Opportunities and Bottlenecks, Addis Ababa University, Department of Geography and Environmental Education, 2002.

16 The National Meteorological Services Agency (NMSA) is responsible for generating and archiving climate data. This also includes measuring wind data and solar irradiation, although the older data from the NMSA is often not particularly precise.

17 This is expected to be available at www.swera.unep.net from May 2007.

During the first stage of the project ten locations were identified, where wind measurements were taken at a height of ten meters. The measurements began in January 2005 at the following locations: Mesobo-Harena, Ashegoda, Maymekden, Gondar (Bilagig), Harar (Ghiorgis Meda), Nazret (Sire Ababune), Debre Berhan (Beryu Meda), Sululta (Gorodima), Bahir Dar Substation and Nefas Meewcha (for the results of the measurements at seven locations, see chart below).

Monthly Wind Speed in m/s

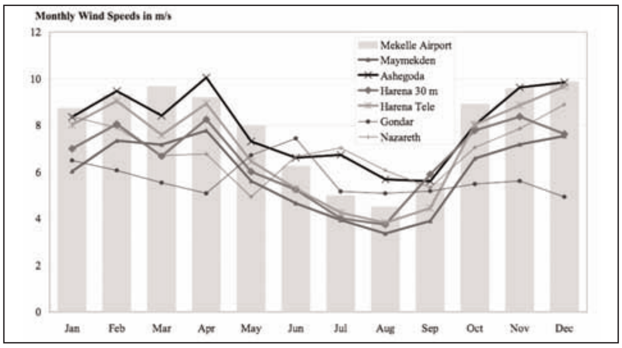

Abb. 1: Average monthly wind speeds in m/s at selected locations – measurements taken as part of the GTZ TERNA wind energy programme in 2005[18]

Further measurements were taken at four selected locations (Mesobo-Harena, Ashegoda, Nazareth and Gondar) over a period of 12 months at a height of 40 metres, with results ranging between 6.9 m/s in Harena and 9.4 m/s in Nazareth. On this basis, GTZ arranged for feasibility studies to be drawn up for Ashegoda and Harena in the course of 2006. Work at Gondar was deferred for the time being on account of the very small space available.

Ashegoda

The site at Ashegoda is situated at 2,400 metres above sea level in the northern highlands of Ethiopia. Measurements at a height of 40 metres revealed an average wind speed of 8.11 m/s. Given a hub height of 57 to 60 metres and an installed capacity of 68.8 to 73.1 MW, it is expected to be possible to generate between 197.4 and 240.0 GWh of electricity per year, depending on the type of turbine used. With an anticipated capacity factor of 31.0 to 37.7 %, the figure is very good considering the thin air at altitude. The connection to the grid is to be provided through a 230 kV line. The calculated production costs have been quoted as being approximately 6 US cents/kWh. Compared with the other forms of energy available as alternatives, the cost is roughly twice as high as hydropower and half the cost of power from diesel generators. The GTZ study recommends that the project be implemented.

Mesobo-Harena and Nazareth

Another feasibility study was conducted in Mesobo-Harena. This location is also in the north of the country, at an altitude of 2,320 to 2,430 metres. In this case the connection to the grid can be provided through a 132 kV line. The results of the study are somewhat poorer than those from Ashegoda. Wind measurements at a height of 40 metres showed a speed of 6.88 m/s. The potential annual yield for this site is given as 85.1 to 99.1 GWh with an installed capacity of 48.8 to 51 MW, depending on the type of turbine. The anticipated capacity factor is between 19.9 and 23.4 %. Accordingly, the production costs for a kilowatt hour have been estimated at between 8.73 and 10.54 US cents. On the basis of these results, the GTZ study is putting forward a guarded recommendation to build the wind farm. It does however advise searching for alternative, more productive locations. EEPCo is currently conducting a third feasibility study itself in Nazareth, with support from GTZ.

18 Source: GTZ, TERNA Wind Energy Programme – Ethiopia, 2006.

EEPCo is presently looking for assistance from international donor organisations to finance the two wind farms it envisages building. The feasibility studies have been made available to all relevant financing institutions.

Biomass

So far biomass has played no part in grid-coupled electricity generation in Ethiopia. Four sugar works have generated electricity for their own use since the 1950s. Since 1998, Finchaa Sugar Factory (FSF) has had the largest and most modern plant, with a capacity of 7 MW. The surplus capacity of 3.6 MW could be fed into the grid. FSF and EEPCo have issued declarations of intent to that effect. All in all the sugar works could make as much as 30 MW available for supply to the grid. To date, however, no such project has been implemented.

Solar energy

Photovoltaics (PV) and solar thermal energy have had only a minor role to play in Ethiopia up to now. The average daily insolation rate across the country is 5.26 kWh/m^2. It varies through the year, from 4.55 kWh/m^2 during the rainy season in July to 5.55 kWh/m^2 in February and March. Geographical differences range between 4.25 kWh/m^2 in the Gambella region in the west of the country and 6.25 kWh/m^2 in the Tigray region in the north.[19]

Photovoltaics

Installed capacity in the photovoltaics sector is estimated at 1.2 MW_p. The majority of this is to be found in installations for telecommunications purposes. As well as this, some non-governmental organisations and international organisations are working with solar home systems (SHS) to electrify households, schools and other public facilities.

The Stiftung Solarenergie (Solar Energy Foundation) has equipped two villages in Ethiopia with solar panels since 2005. In 2006 the Foundation helped to set up the Solar Competence Center in Addis Ababa, which has the aim of advancing the spread of renewable energy.[20]

A US$ 4.93 million World Bank programme, with financial assistance from GEF resources, aimed at promoting renewable energy within the framework of the Energy Access Project also covers the installation of several hundred PV systems with a total capacity of some 400 kW_p. The programme was launched in 2003 and is set to run until 2008, and is also meant to help establish lasting distribution structures for photovoltaic systems.

Solar thermal energy

Until now solar thermal energy has only been used in exceptional cases in hotels and a few non-governmental institutions for heating water. In rural areas, in particular, the population is thought to have insufficient purchasing power to buy such technology. No support is provided.

Geothermal energy

The geothermal energy potential in Ethiopia is estimated at approximately 700 MW. The resources are located in the region of the African Rift Valley. Temperatures of between 50°C and 300°C were measured there at depths of 1,300 to 2,500 metres. The first, and so far only geothermal electricity generating plant is situated in Aluto-Langano and has a capacity of 7.3 MW. It was in operation from 1999 onwards, connected to the EEPCo grid, but since 2002 it has had to be shut down due to a lack of technical maintenance. Apart from this pilot project, geothermal energy has not been used to generate electricity. The German Federal Institute for Geosciences and Natural Resources (BGR) is currently carrying out a project in cooperation with the Ethiopian Geological Survey to investigate geothermal resources in the Afar region.

19 A solar atlas is available online at swera.unep.net.

20 The Stiftung Sonnenenergie is involved in development-policy projects in various African countries targeted at promoting the use of renewable energy. The priority partner country is Ethiopia (www.stiftung-solarenergie.de).

11.6 Rural Electrification

Degree of electrification

One striking characteristic of the Ethiopian energy market is the extremely low degree of electrification, which in rural areas is only about 1 %. The 15 % of the population of Ethiopia who presently have access to electricity are almost entirely restricted to the country's urban centres.[21]

In rural areas, almost all energy provision is based on traditional biomass. Wood is by far the most important fuel, at about 82 %. Apart from wood, dung (9.4 %) and plant residues (8.4 %) are also used. Negative side effects of this form of energy use are large-scale deforestation, declining biodiversity, poor water quality and soil erosion. Heavy dependence on biomass also leads to supply problems, especially in connection with periods of drought.

Diesel generators are commonly used for local electricity supply beyond the reach of the ICS network belonging to EEPCo.

With a view to social and economic development in rural areas, the Government of Ethiopia is pressing ahead with various rural electrification measures in cooperation with international donor organisations. The programmes are an integral part of the Agricultural Development-Led Industrialization Strategy (ADLI) formulated by the Ethiopian Government. Apart from large-scale hydropower, however, renewable energy has only a minor role to play in this.

Sustainable Development and Poverty Reduction Programme (SDPRP)

In July 2002 the Government of Ethiopia presented a programme aimed at reducing poverty in the country, the Sustainable Development and Poverty Reduction Programme (SDPRP), with the Ministry of Finance and Economic Development (MoFED) in overall charge. This programme expressly emphasises the importance of the expansion of rural energy supplies for the development of the country.

Rural Electrification Strategy

Also in 2002, the Ministry of Infrastructure published a strategy paper on rural electrification. This quotes objectives of expanding the power grid, setting up off-grid systems, making use of renewable energy sources and establishing an institutional framework.

The activities of the Rural Electrification Fund (REF) originate from the Rural Electrification Strategy. Within the framework of the World Bank's Energy Access Project, funds amounting to US$ 15 million are available to the REF. The Rural Electrification Board (REB) announced the promotion of specific projects for the first time in 2006. Of the 31 projects submitted by cooperatives, local authorities and private companies, 15 were approved. In 14 of the 15 selected projects it is planned to use diesel generators. Renewable energy plays very little part at all. For the time being it is planned to continue the project until 2009.

Universal Electrification Access Programme (UEAP)

In February 2006 EEPCo, on behalf of the government, launched the Universal Electrification Access Programme (UEAP), the most comprehensive programme to date targeted at the ambitious expansion of electricity provision. The programme is integrated into the government's five-year strategy for the electricity sector for the period up to 2010.

21 15% of Ethiopians are counted as belonging to the urban population. There are about 1,000 places classed as 'urban', each with more than 2,000 households. The other 85% of the population live in village-type structures in the country.

Year	2002	2003	2004	2005	2006
Number of towns with new access to power grid/year	23	66	74	32	227
Total number of towns with access to power grid	492	558	632	664	891

Tab. 4: Number of towns connected to the power grid, new connections and total; Ethiopia; 2002-2006[22]

Under the UEAP, 7,542 towns, villages and public institutions are to be given access to the electricity grid. By 2010 the proportion of the population with a connection to the EEPCo power system is supposed to rise to 50%. The cost of achieving all the objectives envisaged in the context of the UEAP is estimated at US$ 1.3 billion.

By 2009 it is intended that a further 200 rural settlements will be connected to the national power grid. The cost of the investment required for this project phase amounts to some US$ 177 million. A proportion of this (US$ 100 million) was promised by the World Bank as part of the Ethiopian Electricity Access (Rural) Expansion Project in mid-2006, while the other US$ 77 million will be raised by the Ethiopian state.

The World Bank is currently leaving open the possibility of further financial assistance. Although the state-owned utility company EEPCo has proved its potential in realising ambitious goals in recent years, doubts still remain as to the economic feasibility of the set targets. This applies in particular to electricity prices, which are too low given the large-scale expansion of the grid.

The African Development Bank (AfDB) is assisting the Ethiopian electrification programme with a loan of US$ 131 million. The loan was approved in December 2006. The project was launched at the beginning of 2007 and is supposed to run for 48 months. Among other things it is planned to build a 280 km-long high voltage line and several thousand kilometres of low voltage lines. Altogether 235 towns and villages with almost 2 million inhabitants in the Akesta-Alem Ketema and Nekemte-Gendo regions are to be connected to the electricity grid.

Exchange rate (End of January 2007):
1 Ethiopian birr (ETB) = 0.08 euro (EUR)
1 US dollar (USD) = 8.77 ETB

22 Source: World Bank, Electricity Access Expansion, Project Information Document, October 2006.

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12 Jordan

12.1 Electricity Market

Installed capacity

In 2005 the Jordanian interconnected power grid was supplied by an installed power station capacity of 1,873 MW. Compared with the previous year (1,643 MW), this was a capacity increase of 14%. The total power station capacity available nationwide, including the agreed import capacities, amounted to 2,019 MW in the same year (Tab. 1).

In addition to the power stations operated by the two state-dominated power producers, there are also a number of industrial enterprises that generate electricity in their own plants. Some of these also feed excess electricity into the Jordanian interconnected grid. Apart from these power sources, additional capacity can be called up when required from the Egyptian and Syrian grids. The four largest power stations are the station in Aqaba (656-MW steam power plant), the Hussein power station in Zarqa (396-MW steam power plant), the plant in Rehab (353-MW diesel-fired gas turbine) and a new combined-cycle power plant in Al-Risha.

	2001	2002	2003	2004	2005
	MW				
Steam power plants	1,013	1,013	1,013	1,013	1,013
Diesel generators	43	43	43	43	43
Gas turbine (diesel)	353	353	353	353	353
Gas turbine (natural gas)	120	120	120	120	150
CCPS*					300
Hydropower	10	12	12	12	12
Wind	1.4	1.4	1.4	1.4	1.4
Biogas	1	1	1	1	1
Installed capacity (total)	1,541	1,643	1,643	1,643	1,873
Available capacity, incl. imports	n.a.	1,788	1,788	1,789	2,019

* CCPS = combined-cycle power station

Tab. 1: Installed power plant capacity and available capacity (incl. imports) in Jordan; 2001-2005; MW[1]

Power generation

Of the roughly 9,650 GWh of electricity generated in Jordan in 2005[2], 82.5% came from steam power plants. 6.7% was generated in gas-turbine power stations fired with natural gas and a further 3.5% came from diesel-fired power stations and diesel generators. Just under 6% was generated at what is to date the country's only combined-cycle power plant located in Al-Risha.

Renewable energy sources account for only a minimal share of the electricity generated. In 2005, just 0.6% (57 GWh) of the electricity generated was sourced from hydropower. Biogas (5 GWh) and wind power (3 GWh) each accounted for less than 0.1%. The amount of electricity generated throughout the country by diesel generators (73 GWh or 0.7%) exceeds that generated from hydro, wind and biogas together (65 GWh).

	2001	2002	2003	2004	2005
	GWh				
Electricity sector	**7,144**	**7,630**	**7,489**	**8,471**	**9,138**
Steam power plants	6,240	6,771	6,430	7,168	7,524
Diesel generators	1	3	1	1	2
Gas turbines (diesel)	83	115	262	464	341
Gas turbines (natural gas)	769	680	746	776	648
CCPS					558
Hydropower	43	53	41	53	57
Wind	3	3	3	3	3
Biogas	5	5	6	6	5
Industrial sector[3]	405	502	505	496	516
Steam power plants	364	434	428	422	445
Diesel generators	41	68	77	74	71
Total	**7,549**	**8,132**	**7,994**	**8,967**	**9,654**

Tab. 2: Electricity generation in Jordan according to type of generation; 2000-2005; GWh[4]

1 Source: NEPCo.
2 Power generated for the interconnected grid by the power stations of the national power producer plus that generated by self-generators for their own needs plus the excess electricity of self-generators fed into the grid.
3 This covers both power producers from industry who feed electricity into the interconnected grid and pure self-generators.
4 Source: NEPCo.

Since the amount of electricity generated in Jordan has for some years been insufficient to cover the country's needs, additional power is imported from Egypt and Syria. In 2005, 982 GWh was bought in, which was a good 9% of the electricity available in Jordan overall.
Inside the country itself, electricity is generated by the two state-owned power producers, CEGCo and SEPGCo, by industrial self-generators and industrial enterprises. The amounts of electricity imported and generated in Jordan by the various market actors between 2001 and 2005 are listed in the table below.

	2001	2002	2003	2004	2005
	GWh				
Interconnected system – total	**7,616**	**8,150**	**8,651**	**9,483**	**10,314**
CEGCo	7,132	7,615	7,468	8,449	9,086
SEPGCo					30
Potash Co.	115	95	96	96	101
Cement Factory	25	10	10	10	6
Indo-Jordan Chemicals Co.	65	93	84	80	87
King Talal Dam	7	10	15	16	17
Jordan Biogas Company	5	5	6	6	5
Electricity imported from Egypt	267	322	972	788	741
Electricity imported from Syria				38	241
Other industrial enterprises – total	**200**	**304**	**315**	**310**	**322**
Refinery	87	93	92	83	91
Fertilizer Co.	97	153	156	163	166
Hussein Iron Factory	16	15	16	16	15
United Iron & Steal Manufacturing Co.		43	51	48	50
Total	**7,816**	**8,454**	**8,966**	**9,793**	**10,636**
Growth rate	**5.3%**	**8.2%**	**6.1%**	**9.2%**	**8.6%**

Tab. 3: Electricity generated and imported in Jordan; 2001-2005; GWh[5]

Fuel supply

Jordan has not been able to open up any notable oil reserves of its own. Up to the beginning of the third Gulf War (2003), the country purchased fuel oil from Iraq on very favourable terms.[6] Once these preferential terms were no longer available, Jordan was forced to import oil at world market prices. Since 2003, Kuwait and Saudi Arabia have been the main suppliers to Jordan. Since refinery products are still being supplied to the end consumers at subsidised prices, Jordan's national budget is subject to a very heavy burden.[7]

Jordan's only occurrence of natural gas is to be found in Al-Risha in the northeast of the country on the border with Iraq. The gas extracted there (currently approx. 700,000 m^3 per day) is primarily used to fire the neighbouring combined-cycle power station, which went into service in 2005. Since 2003, Egypt has been supplying Jordan with additional natural gas via a pipeline that runs through the Gulf of Aqaba. In the meantime, a large number of the country's power stations previously fired with heavy fuel oil have been converted to natural gas. This is without doubt the main reason why Jordan's consumption of natural gas has risen to around 1.5 billion cubic metres per annum in the period from 2003 to 2005.

The shares taken in 2005 by the three fossil fuels used for electricity generation were as follows: natural gas 58%, heavy fuel oil 32% and diesel 10%. The table below presents the share of Jordan's total consumption of fossil fuels used to generate electricity.

5 Source: NEPCo.
6 Some of these oil imports from Iraq were at very favourable prices, while others were actually free.
7 In 2005, these costs amounted to roughly 7% of gross national product.

	2001	2002	2003	2004	2005
	toe x 1000				
Electricity sector	1,701	1,802	1,845	2,113	2,249
CEGCo	1,701	1,802	1,845	2,113	2,240
SEPGCo					9
Industrial sector (incl. self-generators)	119	145	141	139	144
For electricity generation overall	**1,820**	**1,947**	**1,986**	**2,252**	**2,393**
National fossil fuel consumption	5,150	5,299	5,774	6,489	7,008
Share of total fossil fuel consumption used to generate electricity	35.3%	36.7%	34.4%	34.7%	34.1%

Tab. 4: Fossil fuels combusted to generate electricity; 2000-2005; in toe x 1000[8]

Power transmission and distribution

The Jordanian national interconnected grid transmits electricity from the power stations to the distribution substations and transformer substations in the various regions of the kingdom via 400-kV and 132-kV power lines. The star topography of the grid has a clearly identifiable north-south axis, along which the only 400-kV power line runs, from Aqaba in the south via Amman and up to the Syrian border. The only area in which the grid has a ring-shaped configuration is around the capital city.

In the north, the power grid is connected to the Syrian grid by means of a 230-kV and a 400-kV power line. In the south, there is a 400-kV connection to the Egyptian grid. The interconnected grid feeds the local distribution systems via which almost the entire population of Jordan receives its electricity. The overall length of the installed high voltage power lines (132 kV and 400 kV) is around 3,400 km.

The following table shows the level of expansion of Jordan's transmission network in 2000 and 2005.

Power line ratings	2000	2005
	km	
400 kV	809	871
230 kV	17	17
132 kV	2,200	2,512
66 kV	17	17

Tab. 5: Level of development of Jordan's transmission network; 2000, 2005; km[9]

Table 6 lists the power losses that occur during the generation of power for the Jordanian interconnected grid, during transmission throughout the country and during distribution to the electricity customers (excluding self-generators).

	2000	2005
	GWh	
Generation losses		
Electricity generated	7,125	9,332
Electricity fed from power stations into grid	6,639	8,756
Losses [%]	6.8	6.2
Transmission losses[10]		
Electricity fed into grid (incl. imports)	6,535	9,557
Electricity sold (to distribution companies)	6,321	9,221
Losses [%]	3.3	3.5
Distribution losses[11]		
Electricity supplied	5,646	8,416
Electricity sold (to end customers)	5,038	7,431
Losses [%]	10.8	11.7
Losses throughout the entire grid		
Electricity generated and bought in	7.170	10,314
Electricity used	5,872	8,417
Losses [%]	18.1	18.4

Tab. 6: Losses in the Jordanian electricity sector (interconnected power grid); 2000, 2005; GWh[12]

8 Source: NEPCo; toe = tonne(s) of oil equivalent (1 toe = 41.87 GJ = 11.63 MWh).
9 Source: NEPCo.
10 High voltage lines, 400 kV and 132 kV, including imports.
11 Not including the networks of industrial enterprises.
12 Source: NEPCo.

Electricity consumption and peak load

Peak load in the national grid (including self-generators) in 2005 amounted to 1,751 MW. Compared with the previous year (1,555 MW), this was an increase of 12.6 %. In 2005, Jordan's interconnected grid reached a peak load of 1,710 MW, which corresponds to an increase of just under 13 % compared with the year before (1,515 MW).

In the same year, the load – at the time the peak load in the grid of 1,710 MW was reached – was distributed among the various types of power station as follows: steam power plants 57 %, diesel turbines 22 %, natural gas turbines 4 %, others 2 %, imports from Syria and Egypt 15 %. Between 2000 and 2005, peak load increased by an average of 7.7 % each year.

In 2005, electricity consumption nationwide amounted to 8,712 GWh and was consequently almost 8 % higher than in the year before. The rate of increase the year before that (2003 to 2004) was a good 10 %. Average per capita consumption in 2005 was 1,939 kWh (2004: 1,830 kWh).

Broken down according to sector, the consumption of electricity in the country looks as follows:

	House-holds	Industry	Trades/ crafts	Water pumps	Street lighting	Others	Total
	GWh						
2000	1,981	1,974	805	990	173	210	**6,133**
2001	2,110	2,024	880	981	178	219	**6,392**
2002	2,270	2,193	971	1,045	190	237	**6,906**
2003	2,471	2,294	1,047	1,104	201	213	**7,330**
2004	2,745	2,479	1,190	1,261	213	201	**8,089**
2005	2,989	2,659	1,316	1,298	247	201	**8,712**

Tab. 7: Development of electricity consumption in Jordan according to sector; 2000-2005; GWh[13]

Forecasts by the state power producer NEPCo predict demand for electricity of around 20,700 GWh for 2020, which would equate to double the 2005 level.

	2008	2009	2010	2015	2020
Electricity demanded [GWh]	12,887	13,608	14,299	17,739	20,697
Annual rate of increase [%]	6.2	5.6	5.1	4.4	3.1

Tab. 8: Development of the demand for electricity in the Jordanian power market; estimated; 2008-2020; GWh[14]

Jordan's national power provider, NEPCo, is working on the assumption that the level of demand for electricity will develop roughly as below by 2020:

	2008	2009	2010	2015	2020
Max. demand for electricity [MW]	2,112	2,230	2,339	2,856	3,289
Annual rate of increase	6.0%	5.6%	4.9%	4.1%	2.9%

Tab. 9: Development of the demand for capacity in the Jordanian power market; estimated; MW; 2008-2020[15]

Electricity prices

In June 2002, electricity tariffs in Jordan were raised slightly for the first time since May 1996. 2003 and 2004 saw further moderate price increases. The last adjustment of tariffs took place in July 2005. The price structure is divided roughly into two segments: major customers (large power users) and end customers. The major customers grouping – which, in addition to industrial enterprises, also includes local power providers – pay a demand charge for every kilowatt of their maximum consumption. On top of this is a kilowatt-hour rate, which is lower at night than during the day.

The tariffs for end customers make a distinction between commercial customers and private households. The price of electricity for households rises progressively with the amount of electricity consumed. The two groups of end customers pay two different minimum monthly payments: for households 1.10 euro, for commercial customers 1.37 euro.

13 Source: NEPCo.
14 Ibid.
15 Ibid.

	1996-2002	2002-2003	since 2005
Major customers			
Power providers			
Demand charge (€/kW/month)	2.63	2.63	2.63
Day-time tariff (€/kWh)	0.032	0.034	0.037
Night (off-peak) rate (€/kWh)	0.021	0.023	0.026
Large-scale industry			
Demand charge (€/kW/month)	2.63	2.63	2.63
Day-time tariff (€/kWh)	0.052	0.053	0.053
Night (off-peak) rate (€/kWh)	0.035	0.037	0.037
End customers (excl. major customers)			
Private households			
1-160 kWh (€/kWh)	0.033	0.034	0.034
161-300 kWh (€/kWh)	0.057	0.060	0.065
301-500 kWh (€/kWh)	0.066	0.070	0.073
Over 500 kWh (€/kWh)	0.082	0.088	0.090
Trades and crafts	0.066	0.068	0.069
Light industry	0.040	0.042	0.045
Hotels	0.066	0.066	0.066
Water pumps	0.037	0.042	0.044
Street lighting	0.022	0.027	0.033

Tab. 10: Development of electricity prices in Jordan; 1996-2005; prices in euros[16]

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12.2 Market Actors

In view of the annually increasing demand for electricity[17] and the central role of electricity supply for economic development as a whole, the Jordanian Government decided back in 1997 to embark on a restructuring of the sector. The main objective of this reform was to increase the efficiency and performance capability of Jordan's electricity sector, a goal that was to be achieved by among other things opening up the country's electricity market and enabling private investors to participate in the expansion of the power sector. In the course of these measures, the power generation, transmission and distribution segments went through a process of unbundling. In place of the state authority, JEA[18], which until then had borne responsibility at all levels, separate businesses were formed, each of which operates in just one area.

Power generating companies

Central Electricity Generating Company (CEGCo)

This joint stock company, which has existed in its present form since 1999, operates the majority of Jordan's power stations. In 2005, 94% of the electricity generated inside Jordan came from CEGCo power stations. All of the electricity the company generates is sold to NEPCo, which, alongside the Jordanian Government that itself holds 75% of CEGCo's shares, is the only other shareholder of the national power provider.

Samra Electric Power Generating Company (SEPGCo)

This joint stock company was founded in 2003 and is 100% owned by the Jordanian state. It is responsible for running the combined-cycle power station in Al-Risha. In 2005, the Ministry of Energy and Mineral Resources awarded SEPGCo the contact to build another 100-MW steam power plant. The Jordanian Government is planning to privatise the company as part of an international tendering process.

16 Source: NEPCo.
17 In the period from 1977 to 1997, the amount of electricity generated rose by an annual average of 12%. In 2006, the Ministry of Energy and Mineral Resources (MEMR) was working on the basis of an annual growth rate of more than 5% up to 2010.
18 The Jordan Electricity Authority (JEA) has been the national electricity authority since 1967.

Power transmission companies

National Electric Power Company (NEPCo)

The national power company, National Electric Power Company (NEPCo), is a joint stock corporation whose capital is completely in the hands of the Jordanian state. It is responsible for expanding and operating the nationwide transmission network. NEPCo purchases the electricity from the producers as the sole buyer, in order to sell it on to the operators of the distribution networks. The company operates a national load-dispatching centre to coordinate the demand for and the supply of power.

Distribution companies

Jordan Electric Power Company (JEPCo)

In 2005, the distribution company supplied power to around 739,000 end customers in the four governorates Amman (capital), Zarqa, Madaba and Balqa. This added up to 4,793 GWh or 55 % of the electricity consumed nationwide. The company was founded in 1947 as a joint stock company. The 50-year concession to generate and distribute electricity for the above-mentioned governorates, on which JEPCo's business is based, is due to expire in 2012.

Irbid District Electricity Company (IDECo)

In 2005, this distribution company supplied power to around 251,000 customers in the four governorates Irbid, Mafraq, Jerash and Ajlun in the north of the country (1,210 GWh). Around 14 % of the electricity consumed in Jordan was distributed to end customers via IDECo's network. IDECo's concession runs out sooner than JEPCo's, in 2011. IDECo was established in 1961 as a privately owned power supply (distribution) company. So far, NEPCo still holds 55 % of the shares in the company, but it wants to sell these as part of a further phase of privatisation of the power supply sector.

Electricity Distribution Company (EDCo)

In those regions of the country for which neither JEPCo nor IDECo have a concession, end customers are supplied with their electricity by EDCo. In 2005 this amounted to 139,000 customers, receiving 1,427 GWh or just over 16 % of Jordan's total consumption. EDCo came into being as a power supply company when the Jordanian electricity authority began to be unbundled. The company is state owned and is intended to be sold off within the scope of privatisation of the sector.

Other Actors in the Energy Sector

Ministry of Energy and Mineral Resources (MEMR)

The Ministry of Energy and Mineral Resources (MEMR) lays down the goals and political framework conditions for development of the energy market. Its core task is to facilitate continuing development of the country by ensuring adequate availability of energy. This is meant to be brought about with as little expenditure as possible, but while maintaining high standards. To this end, the ministry also intends inviting foreign investors in the fields of power generation, oil production and the development of other locally available sources of energy.

Electricity Sector Regulatory Commission

This independent institution established in 2001 has a whole range of tasks. On the one hand it fixes the electricity tariffs and the charges for services related to the sale of electricity. On the other hand it awards licences to power providers and distributors and monitors compliance with the terms of the licences. Furthermore, the commission has been set up to arbitrate between operators and electricity customers in order to find solutions that are as amicable as possible. It also has the job of mediating between power generators or operators of distribution networks in the event of disagreement.

The overriding principle to be followed by the commission in all matters relating to the electricity sector is to ensure the interests of the public at large are looked after. To this end, it can both assume an advisory role as well as make public statements.

National Energy Research Center (NERC)

The NERC was established in 1998 with the goal of promoting scientific research in the fields of renewable energy sources and efficient energy use. Furthermore, the centre also has the task of exploring possibilities of using the oil shale that is readily available in Jordan to produce energy. And the final responsibilities of this establishment are in the fields of training and the transfer of technology in the above-mentioned research areas. The NERC cooperates with among others the Ministry of Energy and Mineral Resources (MEMR), the Royal Scientific Society and the Natural Resources Authority. The energy minister also holds the position of chairman of the centre.

12.3 Legal Framework

Development of the electricity sector

Since 1967, the Jordan Electricity Authority (JEA) has been responsible for the generation and transmission of electrical energy throughout Jordan. In those regions whose power supplies were provided by neither of the two power distributors with a concession to supply end customers (JEPCo and IDECo), it was the JEA that also held responsibility for distributing power to end customers.

A lack of financial and administrative independence, autonomy and free-market orientation, as well as an inadequate tariff structure, led to a number of problems. Investment decisions were taken by a government commission and not in accordance with commercial criteria. Personnel policy was dictated by state targets, which did not meet the needs of the electricity sector. Moreover, the state's tariff policy resulted in annual losses, because the electricity prices were too low to cover costs. At the same time, the tariff structure fostered considerable cross-subsidisation between various customer groups. In turn, these subsidies sent out the wrong price signals and led to distortions in the electricity market.

The rapid growth in the demand for power every year meant large-scale investments[19] were necessary to expand the number of power stations and the power grid. The level of these investments, however, would have been a very heavy burden for the Jordanian national budget alone.

Deregulation

Aims

In the mid-1990s, the Government decided to embark on a restructuring of the electricity sector, a process that was to be conducted in several stages, which have not yet been completed. This restructuring has the following aims:

- Efficient and reliable electricity generation, which supports general long-term development of the country by providing electricity at affordable rates.
- The electricity sector is to no longer burden the national budget through annual losses and is to provide or raise the capital necessary to maintain, develop and expand plants and networks itself.
- Operation and regulation of the electricity sector are to be reorganised in such a way that competition is fostered and private investors can be attracted into entering the Jordanian power market.

To achieve these aims, the reform programme has been set up in line with the following principles:

- To give high priority to recruiting private investors willing to participate in the expansion of the electricity sector. These investors are to help satisfy a growing need.
- To restructure and privatise state-owned companies wherever it makes sense, in order to create independent and economically viable facilities.
- To bring independent power producers into the sector.
- To set up a regulatory system that establishes reliable, transparent and comprehensible basic rules for all participants in the electricity sector.
- To promote environmental and safety standards as well as energy efficiency.

19 Studies conducted in 1997 envisaged an investment volume of between US$ 65 m and US$ 156 m per annum up to 2015 depending on the scenario chosen.

Implementation

This restructuring took place in three phases.
In Phase 1 (1994 to 1996), the following measures were implemented: amendment of legislation to enable deregulation of the electricity sector; separation of legislative formation, regulation and operation of the electricity sector; transformation of the electricity authority, JEA, into a joint stock company (NEPCo) that operates according to free-market principles; establishment of the regulatory authority for specifying electricity tariffs; and finally, introduction of a legal framework for independent power producers.

The following measures were implemented in Phase 2 (1996 to 2001): unbundling of NEPCo into separate companies for power generation (CEGCo), transmission (still NEPCo) and distribution (EDCo), whereby NEPCo is still state owned and retains and operates the facilities for transmitting electricity and distributing the load nationwide; extension of the tasks of the regulatory authority to include the issuing of licences to operators of power plants and distribution networks, protection of the rights and interests of electricity customers, the setting-up of quality standards and the approval of investment programmes.

Phase 3 (running since 2001) comprises the privatisation of NEPCo and its power generation and distribution subsidiaries. This is to be achieved either by issuing shares or by selling off stakes to strategic partners.

In March 2004, the Jordanian cabinet passed a resolution under which the state's shares in the distribution companies EDCo and IDECo are also to be sold off, as are 51% of the shares in the national generation company, CEGCo, which has until now been wholly owned by the state. The first attempt in 2005 to sell these shares within the framework of an international tendering process failed due to the lack of a suitable bidder. Following a renewed call for tenders, negotiations were started with investors from Amman (JD Capital), Kuwait (Kharafi National) and Dubai (Abraaj Capital). In January 2007, 64 members of the Jordanian parliament issued a memorandum opposing the sale of CEGCo. Instead, they demanded an increase in the electricity prices of 0.54 euro cents/kWh (5 fils) to bale out the loss-making public corporation.

The Government has being attempting for a long time now to conclude contracts with independent power producers with the aim of expanding the number of power stations in Jordan's electricity generating system, but it is made only very slow progress. A number of potential projects have been abandoned. The Jordanian Government is currently searching for private investors willing to invest in the construction and operation of new power plants up to 2015, plants that together will offer an additional 1,500 MW or so of capacity.

At the end of 2005, Jordan awarded the first concession for a privately funded power plant project. A combined-cycle power station with a planned capacity of 280-400 MW is being built in the vicinity of the capital, Amman. The US$ 280 million project, which is being financed and conducted by AES Oasis headquartered in Dubai[20] and its Japanese partners (Mitsui & Company), is to come on stream in 2008. According to the Government, there are plans for a second project to be conducted by an independent power producer, with another 280-400-MW power station that is to commence generating electricity as of 2010.

As a general rule, the issuing of licences is regulated by the General Electricity Law[21], Article 28 onwards. In conformance with this law, the regulatory authority issues licences to firms that wish to generate, distribute or sell electricity. Generating plants with a capacity of up to one megawatt are allowed to operate without a licence. Local supply networks with a capacity of max. 100 kW can be operated without a licence, in the same way as power plants that are used solely to generate electricity for self-consumption. Power supply companies or middlemen who want to purchase electricity from a power station with a capacity greater than 5 MW may conclude appropriate supply contracts only after competing in a public tendering process (Article 35). These rules apply equally to conventional thermal power stations and stations that generate electricity from renewable energy sources.

20 Subsidiary of the AES Corporation of the United States.
21 Temporary Law No. (64) for the Year 2003/General Electricity Law.

12.4 Policy Promoting Renewable Energy Sources

Responsible institutions

The Jordanian Government has publicly expressed its intention to promote the use of renewable energy sources and has regulated the associated responsibilities in its General Electricity Law passed in 2003. According to Article 3, the Ministry of Energy and Mineral Resources (MEMR) has the task and the necessary powers to promote the use of renewable energy sources for power generation in Jordan. Within the MEMR, the departments for renewable energy sources and for energy conservation and environmental protection are responsible for planning and implementing projects that utilise renewable energy resources at a commercial level.

1998 saw the creation of the National Energy Research Center (NERC), which is responsible for R&D, conducting studies, implementing pilot installations, standardisation, technology transfer and training. The power companies conduct their activities in the field of renewable energy sources autonomously. The same applies to the country's universities.

Long-term planning

In December 2004, the Jordanian Government passed a long-term development plan relating to energy supply for the nation. This plan makes provision for investments of around US$ 3 billion in the energy sector over the period up to 2025. It also envisages greater use of renewable resources in the energy industry, with particular emphasis being given to the use of wind power and solar power as well as the generation of energy from biomass. To achieve the planned share of 2 % for renewable energy sources in the national energy balance, the development plan sees the need for investments to the tune of US$ 480 million. The plan does not specify how big the share private investors are to take is to be and to what extent the Government will contribute funds required.

According to its own information, the Ministry of Energy and Mineral Resources is planning a series of measures intended to speed up the development of renewable energy sources in Jordan. This includes a new law on renewable energy resources, so far unspecified incentive mechanisms and new maps showing where potential lies for wind and solar energy. Also under discussion is a proposal to redesignate a special charge that has until now been levied to promote rural electrification.

Jordanian Law No. 16 (the "Investment Promotion Law") offers a number of concessions for investors who build industrial facilities – such as wind farms – in Jordan. This includes a 100 % exemption of installation components and spare parts from customs duties, charges and taxes. Depending on the location of the facility, tax concessions of between 25 % and 75 % are possible on income tax and social services tax over a period of ten years.[22]

International promotion measures

In 2004, the Jordanian Government submitted an application[23] for a US$ 6 million grant from the Global Environment Facility (GEF/World Bank) for a development project in the field of wind power. Part of the remit of this "Promotion of a Wind Power Market Project" is to eliminate obstacles that stand in the way of the commercial use of wind power in Jordan. The aim on the one hand is to improve the legislative and administrative preconditions for the use of renewable energy resources. On the other hand, the project is also to comprise the construction of a 60-MW wind farm that is to financed by private investors. So far, however, only US$ 350,000 has been approved for feasibility studies.

22 Further information is available on the Internet at www.jordan-explorer.com/Investment/Investment_Promotion_Law1.asp.
23 GEF Council Work Program Submission, Jordan, Promotion of a Wind Power Market, GEFSEC Project Id: 2555.

Since 2005, the Japanese Government, together with the Jordanian Government, has been sponsoring[24] four studies investigating the potentials of renewable energy resources in Jordan within the framework of the "Policy and Human Resources Development Fund" (PHRD) of the World Bank. The Japanese share amounts to US$ 1 million, while Jordan is contributing a further US$ 312,000. One particular focus here too is on the wind power segment. Furthermore, the United States Trade and Development Agency (USTDA) is funding (US$ 180,000) a feasibility study into the expansion of the existing wind farms in Hofa and Al-Ibrahimiya.[25]

Clean Development Mechanism

In January 2003, Jordan became the third Arab country to sign the Kyoto Protocol and declared its responsibility to pay due attention to the prevention of climate change while furthering the social and economic development of the country. By February 2007, Jordan had yet to submit any climate protection projects under the UNFCCC.

The Designated National Authority (DNA) for CDM answers to the Ministry of Environment. The latter is currently looking for investors for two potential CDM projects. In both cases, the goal is to reduce the emission of gases harmful to the climate by converting and upgrading existing power stations to combined-cycle and natural-gas technology, respectively. The extent to which these projects amount to "additional" measures within the meaning of the CDM rules has, however, not been made clear by the ministry.

One indicator of the fact that Jordan has not as yet fully laid down the preconditions for its participation in the international climate protection mechanisms is an additional grant to the tune of US$ 100,000, which Jordan's Ministry of Environment received from GEF funds in 2005. The aim of this grant is to create further capacities so that Jordan is in a position to meet its obligations to notify within the framework of the UNFCCC.

12.5 Status of Renewable Energy Sources

The use in Jordan of renewable energy sources has until now been marginal, accounting for a share of less than 1% of electricity generation. Potentials for generating power from renewable energy resources in the country are to be found primarily in the areas of wind and solar energy.

Hydropower

Jordan has no notable bodies of flowing water suitable for the construction of hydroelectric power stations. The only such plant is at the King Talal dam on the Az Zarqa River, with a capacity of 5 MW. Another hydroelectric generating facility employs a turbine to exploit the head of the cooling water taken from the sea to cool a thermal power station in Aqaba as it flows back to the sea. In 2005, these two stations together generated 57 GWh of electricity and were therefore the source of 0.59% of the electricity generated in the country as a whole.

Wind energy

Wind power potential

Jordan has a number of regions that enjoy wind speeds suitable for generating electricity. Those regions with the greatest potential are located in the north and south of the country. Each region can be placed in one of three categories depending on the wind speeds that prevail: under 4 m/s, between 4 and 6 m/s and above 6 m/s. Particularly attractive locations in the third of these categories can be found in Hofa in the northwest of the country, in Fjeij near Shawbak (Shobak) and in Wadi Araba near Aqaba in the south.

24 Project name: Jordan Sustainable Development of Renewable Energy Resources and Promotion of Energy Efficiency, Project ID: Japanese PHRD Grant/TF052920.

25 Source: REN 21 IAP Actions and Report, Accelerating the Development of Renewable Energy in Jordan, www.ren21.net/iap/commitment2.asp?id=93.

Wind measurements

A wind atlas[26], which was drawn up by the Danish Risø research centre in cooperation with the Jordanian authorities, has been available for Jordan since 1989. According to information provided by the Ministry of Energy and Mineral Resources, this wind atlas is in the process of being updated with results taken from recent measurements. The Jordan Meteorological Department operates fifteen permanently installed weather stations, whose measurements cover wind speeds and directions and are made available online.[27]

The Deutsche Gesellschaft für technische Zusammenarbeit (GTZ) has conducted its own wind measurements at two potential locations for wind farms (Aqaba and Shawbak) in Jordan and published the results of these studies at the end of 2001. Average wind speeds of more than 6.5 m/s at a height of 50 metres were measured at both of these sites.[28] There has also been a CDM baseline study[29] (conducted on behalf of GTZ) available since 2002 for a privately financed wind farm at Aqaba with a capacity of 25 MW. GTZ has also commissioned another study[30] for the Shawbak location, which investigates the suitability of the facility planned for there with respect to the CDM. Here, too, the plans are for a privately financed 25-MW wind farm.

A Swiss company, interwind, has been conducting wind measurements at fourteen locations in rural regions of Jordan since June 2003. These studies are being carried out on behalf of a Canadian company, RSW International, and are aimed at determining the extent to which wind power is suitable for providing decentralised power supplies in rural regions. 50 metre-high masts are being used to take these measurements. The results[31] of wind measurements conducted in Tafila were published in 2004. Average wind speeds of only 4.4 m/s[32] were measured here.

Wind farms

So far, two wind farms have been built and come on stream in Jordan, both of which feed into the national grid. The first of these farms has a generating capacity of 320 kW (4 x 80 kW) and was constructed in 1998, in cooperation with a Danish company, in Ibrahimyya near Hofa, as a pilot project. The second was completed in 1996 in Hofa (financed with funds from the German Eldorado programme) and has a capacity of 1.2 MW (5 x 225 kW). Both wind farms are operated by CEGCo and together they generated around 3 GWh of electricity in 2005.

Expansion plans

The Ministry of Energy and Mineral Resources has been searching since 2002 for investors for the two highly promising locations in Fjeij near Shawbak and Wadi Araba near Aqaba. The intention is for these projects to be built and operated by independent power producers (IPPs) on the basis of BOO (Build-Own-Operate) contracts. A wind farm with a capacity of 25 to 30 MW to be fed into the interconnected power grid is to be built at each of these two locations. The level of capital expenditure is estimated at US$ 60-70 million. The projects were put out to public tender in 2005, but have so far attracted no potential investor.

26 Højstrup, J. (1989): Wind Atlas for Jordan. Risø National Laboratory, Ministry of Energy and Mineral Resources, Jordan Electrical Authority, and Jordan Meteorological Department.
27 See: met.jometeo.gov.jo.
28 However, due to the indefinite nature of the data measured, the authors of the report recommended further studies be carried out before a final decision on locations can be made.
29 Wartmann 2002, "TERNA Wind Energy Project, Jordan – Wind Park Aqaba".
30 Wartmann 2002, "TERNA Wind Energy Project, Jordan – Wind Park Shawbak".
31 Eyad S. Hrayshat, Wind availability and its potentials for electricity generation in Tafila, Jordan, Al-Balqa Applied University, Tafila, Jordan.
32 No reference was made in the source to the height at which these wind speeds were measured.

Biomass

Due to the arid climate, there is not a great deal of vegetation in Jordan. This obviously limits the potential use of vegetable biomass. The burning of vegetable biomass serves to a limited extent in rural regions for cooking and heating and is the main source of energy of the Bedouin in the desert. Great energy potential is to be found in household wastes (municipal solid wastes), which has an organic content of roughly 60 %, and is estimated to add up to an annual total of 1.1 million tonnes. This equates to a daily per capita figure of between 0.35 and 0.95 kg of waste with a gross calorific value of 7-11 MJ/kg. The figures vary depending on the time of year and also differ between urban and rural regions.

Biogas

In cooperation with the United Nations Development Programme (UNDP), a project has been developed for utilising the methane gas that arises at the municipal waste disposal site in Amman. With the aid of the Global Environmental Facility (US$ 2.5 million) and the Danish development agency DANIDA (US$1.5 million), a biogas facility has been financed that captures the gases that arise at the landfill and uses a 1-MW generator to generate electricity for the interconnected power grid. The facility has been in service since 2000 and generates some 5 GWh of electricity annually. The installation is run by the Jordan Biogas Company, a joint stock company that is owned by the Central Electricity Generation Company (CEGCo) and the Greater Amman Municipality (GAM).

Solar energy

Jordan is a very sunny country. Average daily solar irradiation is 5.5 kWh/m^2, while the sun shines approximately 2,900 hours per annum. Despite this, apart from for heating water for some households, solar energy is scarcely being used.

Photovoltaics

According to the Jordanian Ministry of Environment, there is a multitude of potential applications – such as for supplying electricity to small settlements and tourist facilities, as well as in agriculture – in which, thanks to the high level of solar irradiation, PV systems could be employed as an economically viable alternative to connecting to the grid. Despite this, very little use is being made of photovoltaics in Jordan. Across the country, there are only around 100 PV systems installed as stand-alone systems in remote areas. These are used to power water pumps or supply electricity for telecommunication systems, schools and other facilities. All in all, these systems have a total capacity of 184 kW_p.

Solar thermal energy

Jordan has a fully developed market for solar water heaters. The majority of solar systems in use function according to the thermosyphon principle and are manufactured locally by more than 20 companies. A typical system comprises three solar panels with a surface area of three to four square metres and storage tanks with a capacity of between 150 and 1,000 litres. Roughly a quarter of Jordanian homes (around 220,000 units) are fitted out with a solar thermal water heating system. According to estimates of the Ministry of Energy and Mineral Resources, the total surface area of solar panels in use in the country amounts to approximately 1 million square metres, a large proportion of which was installed back in the 1980s. Around 10,000 square metres are being added every year. A national plan to further develop solar thermal energy – which has been formulated within the framework of the Euro-Mediterranean Partnership (MEDA Programme) – envisages an annual increase in new solar panels installed of 44,000 square metres. Included in this plan is the increased use in future of solar thermal energy to assist in the heating of buildings.

Geothermal energy

Geothermal resources in Jordan have been identified mainly in two regions. That said, both the sources on the eastern banks of the Jordan Valley and those on the plateau to the east of Madaba offer comparatively low temperatures below 100 °C. This means they cannot be used to generate electricity and will continue to be used for thermal purposes only, such as for heating swimming pools and greenhouses.

Desalination of seawater with renewable energy

In 2003, the National Renewable Energy Laboratory (NREL) of the US Department of Energy, together with the Jordanian Ministry of Water and Irrigation, the Palestinian Water Authority (PWA) and the Israeli institute of technology, Technion, implemented a pilot scheme for mobile seawater desalination. Two systems that consist of a mobile trailer with a membrane filter and storage tanks mounted on it were put into service. These systems can be supplied with power either from the grid, by a diesel generator or via a 16-kW photovoltaic system specifically adapted for this purpose.

12.6 Rural Electrification

Degree of electrification

The well developed supply network in the country also supplies a large proportion of the population in rural regions with electricity. There are now only a few remote settlements that still do not enjoy the benefits of a grid connection.

Year	Total population [x 1000 inhabitants]		Population with power connection [x 1000 inhabitants]		Share of population with power connection [%]	
	Nation-wide	Rural regions	Nation-wide	Rural regions	Nation-wide	Rural regions
2000	4,820	1,743	4,815	1,736	99.9	99.6
2001	4,940	1,737	4,935	1,732	99.9	99.7
2002	5,070	1,854	5,065	1,850	99.9	99.8
2003	5,200	1,908	5,195	1,904	99.9	99.8
2004	5,350	1,970	5,345	1,966	99.9	99.8
2005	5,485	2,019	5,480	2,015	99.9	99.8

Tab. 11: Development of electrification in rural Jordan; 2000-2005[33]

Programme for rural electrification

The Rural Electrification Project (REP) is a department of the Ministry of Energy and Mineral Resources and was set up in 1992. At that time, the Government had decided to introduce an additional charge of 0.11 euro cents (1 fils) on every kilowatt-hour consumed. In 1997, this charge was increased to 0.22 euro cents (2 fils). The money levied through this charge is being used for rural electrification.

A programme aimed at promoting the provision of power to those people who live in remote regions far from the national power grid with the aid of PV systems has been running since 2002. In particular, low-income population groups living in the countryside are to be given access to electricity through this programme. Within the scope of this programme, nine PV systems (solar home systems) have been installed in a small village, which are used to provide lighting and power radios and televisions in the households taking part.

Exchange rate (August 2007)
1 Jordanian dinar (JOD) = 1.03 euro (EUR)
1 EUR = 0.975 JOD

33 Source: NEPCo 2006.

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13 Morocco

13.1 Electricity Market

Installed capacity

At the end of 2005 the power generating capacity installed in Morocco was capable of producing a total output of 5,252 MW. Of this, thermal power stations accounted for 3,469 MW (66 %). The installed capacity available from hydropower is 1,729 MW (33 %). Wind generation plants provide the remaining 54 MW (1 %).

The Jorf Lasfar Power Station is particularly significant for the country's power supply. This is a coal-fired plant owned by a Swiss-American consortium. With a power rating of 1,356 MW, it is the largest privately owned and operated power plant in Africa. 9,936 GWh of electricity was produced there in 2004, which was 60 % of all the electricity generated in Morocco, while its share of total installed capacity was about 29 %. Most of the coal used in Jorf Lasfar is imported from South Africa. Morocco itself has barely any coal reserves worthy of note. Yields from the country's only coal mine in Jerada are declining.

The installed capacity connected to the grid belonging to the national power utility, Office National de l'Electricité (ONE), has changed as follows in recent years:

	2000	2001	2002	2003	2004	2005
	MW					
Thermal	3,168	3,168	3,168	3,189	3,096	3,469
Hydropower	1,167	1,167	1,167	1,167	1,498	1,729
Wind	54	54	54	54	54	54
Total	**4,389**	**4,389**	**4,389**	**4,410**	**4,648**	**5,252**

Tab. 1: Installed capacity by energy source; ONE and independent power producers; Morocco; 2000-2005; MW[1]

In addition to the capacity installed on its own territory, Morocco can also call upon a further 700 MW via a subsea cable to Spain if the need arises.

Power generation

In 2004 the amount of electricity produced by the public utility ONE and two independent power producers totalled 16,383 GWh. Thermal power generation is based largely (86 %) on the burning of imported coal, with the rest (14 %) coming from oil (imported from Saudi Arabia, Iran, Iraq and Nigeria). Hydropower accounted for 10 % of electricity supplies, and wind power 1%. In addition to the electricity produced within the country, a further 1,555 GWh was imported from Spain.

	2000	2001	2002	2003	2004
	GWh				
Thermal	10,771	12,091	13,068	13.657	14,584
Hydropower	705	856	842	1,441	1,600
Wind	65	207	194	187	199
Imported	2,363	1,564	1,392	1,455	1,555
Total	**13,904**	**14,718**	**15,496**	**16,752**	**17,938**

Tab. 2: Gross electricity generation by energy source; Morocco; 2002-2004; GWh[2]

Power transmission and distribution

In 2004 the transmission grid belonging to the state power utility ONE consisted of 17,532 km of high voltage power lines. It covers the entire country, and is connected to the Algerian[3] and Spanish power grids via regional links. The capacity of the subsea cable between Morocco and Spain has been 700 MW up to now. A € 117 million project to double this capacity to 1,400 MW is nearing completion. This will then contribute to a growing link-up between the European and North African electricity markets beyond just these two countries, Morocco and Spain.

1 Source: ONE.
2 Source: ONE.
3 Two 400 kV power lines; a third is at the planning stage.

The distribution network was made up of 40,560 km of medium voltage lines and 112,017 km of low voltage lines. Depending on the region, the supply of electricity to ultimate consumers is the responsibility of either ONE itself, or one of seven local municipal authorities or one of four private companies (as in the cities of Casablanca, Agadir, Tangier and Rabat). In 2004 the electricity sold through these eleven distribution enterprises to end customers accounted for 49 % of the total.

Since 2004 a three-year action plan has been running which is meant to improve the quality of the Moroccan electricity grid. In the first year of the programme alone it proved possible to reduce the down time per customer by 22 %. Transmission losses were 5.5 % in 2004. Together with distribution losses, the total losses for the national power utility ONE were almost 11 %.

Electricity consumption

The amount of electricity sold by the Moroccan state-owned power utility ONE reached 17,627 GWh in 2005, compared with 16,288 GWh in 2004. Against the background of economic growth and rising living standards in Morocco, demand for electricity rose at an average annual rate of 6.5 % from 1995 to 2005. For the period through to 2015 the Government of Morocco is expecting the annual growth rate to be as much as 7.5 %. According to estimates by ONE, national demand for electricity in 2015 will be 35-40 TWh.

	2001	2002	2003	2004	2005
	GWh				
Direct sale to households	no data	1,630	1,846	2,041	2,316
Services	410	436	821	881	no data
Industry	3,062	3,213	3,578	3,894	
Agriculture	695	676	817	943	
Administration	167	166	504	546	
Sale through local power providers	6,908	7,228	7,646	7,984	8,474
Total	**13,452**	**14,085**	**15,214**	**16,288**	**17,627**

Tab. 3: Electricity sales from production by ONE and imports, according to end user; Morocco; 2001-2005; GWh[4]

Electricity prices

The price of electricity for ultimate consumers, apart from customers obtaining their electricity from private power supply companies, is fixed by decree from the Prime Minister of Morocco. Different tariffs apply in the low voltage sector depending on the type of use[5] and the amount purchased. In 2004 the kilowatt-hour rates for private households started at 0.08 euro/kWh (DH 0.84/kWh) for the first 100 kWh and then rose progressively with increasing electricity use to 0.12 euro/kWh (DH 1.35/kWh) for consumption above 500 kWh. The prices for rural regions are graduated according to maximum connected load, and are somewhat higher. The electricity tariffs for private consumers have remained constant in nominal terms since 1996.

The prices for medium voltage power depend on the time of day at which the electricity is required. For medium voltage customers the kilowatt-hour (unit rate, net) costs between 0.04 euro (DH 0.42) at times of low electricity demand (after 11 p.m.) and 0.08 euro (DH 0.92) at peak load times. There is a separate preferential tariff for farmers, which also varies according to the time of year.

4 Source: ONE.
5 Households, commerce, administration, street lighting, motor drives.

In the high voltage sector three tariff options allow customers to choose the lowest-priced combination of demand charge and unit rate. The demand charges per kW range between 18.36 euro (DH 204) and 102.69 euro (DH 1,141) depending on the period of consumption. The unit rates for high voltage customers are also dependent on the time of consumption, with the net price per kWh ranging between 0.03 euro (DH 0.35) and 0.11 euro (DH 1.19) at peak load times.

Between 1997 and 2004, net electricity prices fell by 44 % in the medium voltage sector and by 36 % for high voltage customers. The Government of Morocco made these price reductions possible by introducing a reform of the tax system, which came into force on 1 January 2004. The lower electricity tariffs reduced the burden on the Moroccan economy by € 80 million (DH 890 million) in 2004 alone.

The degree to which the long-term macroeconomic marginal costs of power supply are covered has shown a declining tendency in recent years, and is currently estimated to be approximately 80 %. By regional standards the electricity tariffs are high.

13.2 Market Actors

Office National de l'Electricité (ONE)

Office National de l'Electricité (ONE) is a state-owned power utility and is the dominant enterprise in the Moroccan electricity sector. It operates in the fields of power generation, transmission and distribution and has 9,000 employees. In 2005 ONE achieved sales of € 1.08 billion (DH 12 billion). The number of customers was around 3,000,000, growing at an average annual rate of 10 %.

On the list of Moroccan companies with the highest turnover in 2006, ONE occupies fourth place. Other companies from the energy sector occupy places 13 (Lydec), 30 (Redal) and 40 (Amendis) in this ranking. All three are local utility companies, which in addition to supplying drinking water also sell electricity from ONE's grid to their end customers in the cities of Casablanca, Rabat, Tangier and Tétouan.

ONE supplies roughly 50 % of the electricity consumed in Morocco directly to final users. The other half is sold by public and private local power providers, although they for their part obtain their electricity from ONE. Distribution is organised in such a way that ONE is more likely to supply electricity directly to customers in rural regions while the municipal and private distributors primarily operate in the cities. Although the liberalisation of the electricity market offers opportunities both on the supply side and in sales, opening the way for independent power producers and the supply of electricity to end users by independent power providers, as yet it is always necessary to deal with ONE in its role as a single buyer and operator of the transmission network.

In respect of renewable energy sources, ONE is mainly active in the areas of hydropower (it owns all 26 hydroelectric power plants) and wind energy. The construction of new hydropower plants and two new wind farms is at the planning stage.

Apart from ONE, there are two private companies in Morocco that operate as independent power producers, each having their own power plant or wind farm. These are described below.

Jorf Lasfar Electricity Company (JLEC)

A consortium made up of the Swiss group ABB and CMS Energy Corporation from the USA operates the 1.3 GW coal-fired power station in Jorf Lasfar, an industrial port on Morocco's Atlantic coast, 15 km south of Jadida. About 60 % of the electricity produced in Morocco originates from this consortium's plant.

Compagnie Eolienne de Détroit (CED)

Compagnie Eolienne de Détroit (CED) owns and operates the Al Koudia wind farm in Tetouan, which has a rated output of 50 MW. CED is owned by Electricité de France (EDF, 49 %), Paribas Merchant Bank (35.5 %) and Germa Consulting (the initiator of the project; 15.5 %).

Other Actors

Actors in the renewable energy sector

La Compagnie Du Vent

This French wind power service provider was responsible for building the first and so far only sizeable grid-connected wind farm in Morocco (Al Koudia near Tetouan, 50 MW).[6] A second major wind power project, rated at 10.2 MW, for the cement works belonging to Lafarge Ciments in Laayoune is also being implemented by Compagnie Du Vent. The company has been in existence since 1991 and now has 55 employees. Apart from Morocco, most of its wind power projects have been located in France. The services offered include wind measurements and location studies, planning and developing wind farms and also operating and maintaining wind farms.

L'Association Marocaine des Industries Solaires et Eoliennes (AMISOLE)

The association of solar and wind power enterprises is an umbrella organisation representing the interests of companies and individuals with a professional involvement in the field of renewable energy. Founded in 1987, the association now represents about 40 companies with several hundred employees. AMISOLE is open to all interested parties whose activities are primarily focused on the use of renewable energy sources in Morocco.

Individual companies

The market survey by the industry association AMISOLE[7] lists 26 Moroccan companies that are active in the field of photovoltaics. There are 14 companies in the solar thermal sector. The list also includes two wind power companies and a planning office. According to information from AMISOLE, about twenty companies assemble simple PV systems from imported components. There are also several companies that import complete solar systems and sell them on the Moroccan market.

One established local company in the solar business is Afrisol SA (a member of the BP Solar group). Established in 1987, Afrisol sells solar energy systems under the Solarex brand (USA). Since 1998 Afrisol has been operating in the Maghreb/West Africa region and other African countries as Solarex's master distributor. Since 2003 Afrisol has supplied Sun Box solar home systems to future solar power customers of ONE within the framework of the rural electrification programme (PERG). Other major solar enterprises in Morocco include SunLight Power Maroc (SPM), Noor Web and Total Energie Maroc.

6 On completion the wind farm was transferred to Compagnie Eolienne de Détroit (CED) for operation.
7 Guide du marché, December 2006, http://www.amisole.com/.

Centre d'Information sur l'Energie Durable et l'Environnement (CIEDE)

CIEDE is a project run by the Environment Ministry. Its work complements the activities of the administration in the fields of energy and climate change. Its primary tasks are to acquire, collect and disseminate information about the sustainable use of energy and about the impacts of energy generation on the environment. The Centre provides information about developments relating to climate change mitigation and sustainable development. It is also meant to advise on new opportunities for cooperation and funding available to actors in the fields of environment, energy and development and promote technology transfer.

Centre de Développement des Energies Renouvelables (CDER)

Established in 1982, the Centre for the Development of Renewable Energy Sources (Centre de Développement des Energies Renouvelables, CDER) is directly subordinate to the Ministry of Energy and Mining. CDER's activities include conducting studies, disseminating knowledge, performing quality-control checks on equipment (PV systems in particular), and training specialists in the renewable energy sector.

Maisons de l'Energie et de l'Environnement

The Government of Morocco is promoting the establishment of what it calls Maisons de l'Energie et de l'Environnement, in cooperation with ONE. These 'maisons' (French for 'house') are small rural enterprises that help local residents plan their own energy supplies. CDER and the United Nations Development Programme (UNDP) provide technical and financial assistance in the setting up of these advisory centres. So far almost 100 such enterprises have been established.

13.3 Legal Framework

Opening of the electricity market

ONE is a public law company answering to the Ministry of Energy and Mining and has been responsible for the generation and transmission of electricity in Morocco since 1963. It operates as a single buyer. Since 1994, however, power plants with ratings above 10 MW can also be built and operated by private enterprises, on condition that the project was subject to open tendering and all power produced is sold to ONE. This opening of the electricity market is governed by law no. 2-94-503 dated 23 September 1994.

Planned liberalisation

Morocco intends to offer electricity to consumers in the country at internationally competitive prices as soon as possible. The prices charged by European power providers, and in particular those on the Spanish market, are taken as the benchmark. In a policy decision in 2001, the management of ONE determined that this objective was to be achieved by further opening of the Moroccan electricity market in several stages.

It is aimed to divide the Moroccan electricity market into two parts, an open market segment and a regulated one. On the open market independent power producers will be able to produce electricity and sell it directly to 'eligible end customers'. Initially, customers shall be considered eligible if electricity is of particular economic importance to them and they can benefit from more flexible, competition-oriented electricity prices. The terms can then be negotiated directly between the producer and the customer. Such 'eligible end customers' would therefore be free to choose their electricity suppliers on the open market. It is planned to set up an energy exchange for this open market, where electricity is to be traded according to the laws of supply and demand.

Eligible companies are also supposed to be able to obtain their electricity from intermediaries acting solely as wholesalers or from international suppliers from other countries, provided this is possible within the framework of the coupling to neighbouring grids. The quota of 'eligible end customers' with access to the open market segment is to be raised in stages.

Those not belonging to the category of eligible customers shall continue to purchase their electricity from the regulated market at officially determined prices. Over the long term this is meant to secure the supply of power to private households with a low voltage connection at prices set by the state. Ensuring that if possible everyone in Morocco has access to affordable electricity is a common social concern for which the Moroccan state intends to continue to bear responsibility.

The liberalisation of the Moroccan electricity market does not constitute a radical upheaval of existing structures but rather a movement towards long-term strategic objectives,[8] and in the opinion of those responsible it contributes to achieving these more quickly.

In April 2006 the Government of Morocco applied for a loan[9] of US$ 100 million from the World Bank/International Bank for Reconstruction and Development (IBRD) to assist it with the reform of the entire energy sector, including liberalisation of the electricity sector.

13.4 Policy Promoting Renewable Energy Sources

Action plan for renewable energies

The Ministry of Energy and Mines (Ministère de l'Energie et des Mines) has aggregated its efforts in the field of renewable energies in an action plan for the period up to 2015. The four primary goals of the plan are: security of supply, improved access to energy by the population, greater competitiveness within the production sector, and protection of the environment.

One aim of the action plan is that by 2015 wind farms with a total capacity of 600 MW are supposed to be on stream. 400,000 m^2 of solar collectors are to be installed for producing hot water, and 150,000 households in rural areas are to be provided with decentralised energy from renewable sources. All in all the action plan is meant to save the energy equivalent of about 500,000 t of oil (5.8 TWh).

The rural electrification programme is just as much part of the action plan as the efforts to use more energy-efficient technology in households, public buildings and industry. A further component is the creation of establishments dubbed 'energy houses', local advice centres which provide citizens with information and offers relating to energy saving.

Wheeling of electricity from renewable energy sources

Since September 2006, companies which generate their own electricity from renewable energy sources can transmit the electricity via ONE's national high voltage grid from the location of the power plant to their production facilities. Up to 2011 the grid operator will impose a wheeling charge of 0.5 euro cents/kWh (6 cDH/kWh). After 2011 the charge will rise to 0.7 euro cents/kWh (8 cDH/kWh). Surplus electricity which the self-generators do not need can be sold to the public grid; the price paid is 20 % higher than the usual purchase prices.

8 Reduction of electricity costs for end customers, electrification of the entire country by 2008, opening of the market for international investors, diversification of energy sources.

9 Project ID P099618.

The first Moroccan company to enter into an agreement with ONE on the basis of this provision was the Ciments du Maroc group in November 2006. Ciments du Maroc will generate power from its own planned wind farm (10 MW) in Tetouan for use in the neighbouring cement works; in future it intends to transmit any electricity not consumed there to its other production sites elsewhere in the country, via the ONE grid.

Other fiscal incentives

Foreign investment in the environment sector in Morocco is basically not subject to any restrictions. Morocco has substantially reduced (from 10 % to 2.5 %) its import duties on certain components for use in harnessing renewable energy sources. However, this only applies if the imported goods are not also manufactured in Morocco itself.

International promotion measures

Morocco is a priority partner country of German Development Cooperation. Since 1961 a total of € 1.2 billion of German promotion funds has flowed to Morocco. In the 1970s and 1980s, financial cooperation by Kreditanstalt für Wiederaufbau (KfW) in the energy sector was initially focused on developing hydropower potential. Today, promotion is additionally directed towards the wind power and photovoltaic sectors. KfW's Tangier wind farm project was the first donor-financed wind energy scheme in Morocco. It paved the way for further wind power projects. Preparatory wind measurements for it were carried out in 1992-1994 in northern Morocco as part of GTZ's Special Energy Programme. KfW also promoted PV projects to bring about rural electrification, in which private companies were involved at an early stage in order to maintain the systems.

During a visit to Morocco by the German Minister for Development, an agreement was reached in Rabat in September 2006 to promote a 33 MW hydropower plant in Tilougguit (High Atlas) through the provision of € 35 million.

Other international assistance organisations are also active in Morocco. The World Bank, for example, is promoting modernisation of the energy sector with a loan of US$ 100 million. Since January 2007 the Deutsche Gesellschaft für technische Zusammenarbeit (GTZ) has been advising CDER and the Ministry of Energy in Morocco on developing a law on renewable energy. The consultancy work by GTZ should also be seen as the result of donor coordination and as part of the Development Policy loan from the World Bank. The consultancy work starts out from the draft of a law that was presented by the World Bank in October 2006, dealing in particular with the wind sector; the other fields such as solar thermal energy, biogas etc. will be covered by the GTZ consultancy services. The results of the study were due to be available in May 2007. From 2008 onwards GTZ is also scheduled to advise the new organisation that is to be set up to promote the use of renewable energy in Morocco and will provide backup as it becomes established; it will do this in the course of a three-year capacity-development project. The World Bank together with the African Development Bank are also involved in the financing of a solar thermal combined-cycle power plant.

Clean Development Mechanism

After Morocco ratified the Kyoto Protocol in 2002, the country quickly succeeded in creating smoothly functioning administrative frameworks for implementing CDM projects. A national CDM strategy was developed in the course of an internationally promoted project[10] that was completed in 2005. The Moroccan Designated National Authority (DNA) was established as soon as September 2002, and is accommodated within the Ministry for Territorial Planning, Water and Environment (Ministère de l'Aménagement du Territoire, de l'Eau et de l'Environnement – MATEE). According to the DNA there are also a further eleven consulting companies or independent consultants specialising in providing support to CDM projects and preparing the documentation. In April 2006 the Moroccan DNA had 40 projects in its portfolio, which taken together would enable total savings of five million tonnes of CO_2 to be made each year.

10 UNDP Project ID number: MOR/02/M08.

This, though, by no means exhausts the country's CDM potential. On the supply side Morocco still has considerable reserves of unutilised renewable energy sources.[11]

By December 2006, three Moroccan CDM projects had been registered with the CDM Executive Board (EB): two wind farms and a rural electrification project.

Two other renewables energy projects have so far been approved by the responsible Moroccan authority (DNA) on the basis of the Project Design Document (PDD). By the end of 2006, however, they had not been submitted to the UNFCCC for registration. The projects concerned are a wind power station (10 MW) in Tan Tan for powering a seawater desalination plant belonging to the Office National d'Eau Potable (ONEP) and a landfill gas plant for the city of Rabat.

Registered	Project	Commissioned	Construction costs	DOE[12]	Annual saving
23.09.2005	10.2-MW wind farm in Tétouan for supplying energy to a cement works belonging to the French company Lafarge	2005	approx. US$ 10 million	DNV	28,600 t CO_2e
29.10.2005	60-MW wind power plant in Essaouira belonging to the state utility company ONE	2008 (planned)	approx. US$ 90 million	DNV	150,000 t CO_2e
28.04.2006	Rural electrification programme run by ONE with off-grid photovoltaic systems (approx. 105,000 solar home systems)	2004 (first of four parts)	approx. € 208 million	TÜV Süd	39,000 t CO_2e

Tab. 4: Registered Moroccan CDM projects; 2004-2006[13]

The website of the Moroccan DNA[14] lists a further 16 projects which have successfully presented a Project Idea Note (PIN) and are being further expedited by the investors. These include several wind farms, two hydroelectric power plants, a biodiesel project, several biogas facilities in the waste management sector and a project to improve efficiency in public lighting.

11 Cf. section headed: Status of Renewable Energy Sources
12 The Designated Operational Entity (DOE) is the independent test and certification organisation responsible for the project.
13 Source: UNFCCC, as at: 12/2006.
14 See: www.mdpmaroc.com, as at: 12/2006.

13.5 Status of Renewable Energy Sources

The greatest potential for harnessing renewable energy sources in Morocco is to be found in wind power, hydropower and solar energy. Whereas hydropower already accounts for a share of 10 % of national power generation and the first wind farms have been built, the use of solar energy is still in its infancy.

Hydropower

Morocco's technically exploitable hydroelectric power potential is estimated at 2,500 MW, giving annual electricity production of 4,600 GWh; only some 40 % of this has been developed to date. The degree of exploitation is supposed to be increased to 68 % by 2015. Due to severe fluctuations in precipitation rates, hydropower's overall contribution to annual national power production varies between 5 % and 10 %.

At the end of 2005 the state-owned power utility ONE operated a total of 26 hydroelectric plants, which together have an installed capacity of 1,265 MW. As well as those there is the pumped-storage power plant at Afourer, which can supply an additional 470 MW to the grid at peak load times. With the aid of a low-interest KfW loan of € 27 million, the obsolete control technology for at least ten elderly hydropower plants is set to be renewed. This is meant to allow centralised remote control of the plants.

ONE is constantly expanding the number of power plants at hydroelectric schemes. Two new power plants are planned to be commissioned in the Khénifra region in 2007. The plant in Tanafnit on the Oum-Er-Rbia river will be equipped with a generator capacity of 2 x 9 MW. The El Borj power plant lies directly below this on the same river and will have an installed capacity of 2 x 13 MW. The power generation complex as a whole, with its total capacity of 44 MW, is supposed to produce 212 GWh of electricity per year. The cost, € 8.5 million (DH 95 million), is being financed jointly by ONE and the German organisation KfW.

Another scheme at the planning stage is a run-of-river plant in Tilougguit on the upper reaches of the Assif Ahancal river, with a final installed capacity of 33 MW with diurnal storage. KfW is providing assistance for the project amounting to € 35 million. The plans ready for public tendering and the tender documents themselves were prepared by the French consulting engineers Coyne et Bellier. There is also a feasibility study containing the results of the initial investigations into the anticipated environmental impacts of the project. As about three years will be needed for construction, the plant will not be able to be commissioned until 2009 at the earliest.

Small-scale hydropower

Morocco also has considerable potential in the category of micro hydropower (up to 300 kW). As part of the programme to employ small hydropower schemes for rural electrification, ONE commissioned the 220 kW Oum Er Rbia generating plant in 2004. It is supposed to produce 2,000 MWh of electricity per year and thus supply an isolated grid serving 18 villages (556 households). Previously a small hydropower plant with a capacity of 200 kW had been commissioned in Askaw in 2002. In this programme the investment costs are borne jointly by the newly electrified households, the local municipal authorities and ONE. Further such systems are planned, and ONE and CDER are in the process of evaluating the economic efficiency of various locations.

Pumped-storage power plant

A 470-MW pumped-storage power plant for peak load coverage has been in operation near Beni Mellal/Afourer since the end of 2004. The project received financial assistance from the European Investment Bank (EIB) and the Arab Fund for Economic and Social Development (FADES). The plant was built by Alstom (France/Morocco) and SGTM (Morocco).

Wind energy

Morocco has good to very good wind conditions, with mean wind speeds exceeding 11 m/s in some places, so the country's exploitable wind potential is substantial. CDER estimates Morocco's total wind power potential at 6,000 MW. The Government of Morocco is planning to increase the share of electricity generated with wind power to 4 % by the year 2010.

Wind power potential

Between 1991 and 1994, in the course of a wind energy evaluation programme, CDER conducted measurements to determine the wind potential along the Atlantic coast and in the northeast of the country, with financial assistance from GTZ.[15] Then, in a second phase from 1997 to 2000, the wind potential of selected sites along the Atlantic coast was investigated. The third phase – from 2001 to 2010 – is geared to evaluation of the mountainous Atlas and Rif regions.

The data gathered to date confirms that Morocco has several areas with excellent potential for exploiting wind energy, particularly in the greater Tangier, Ksar Sghir and Tétouan areas (where average annual wind speeds at a height of 10 m range from 8 m/s to 11 m/s) and in the Dakhla, Laâyoune, Tarfaya and Essaouira areas (with average annual wind speeds at a height of 10 m ranging from 7 m/s to 8.5 m/s). The Sahara Wind Project, which is looking at developing wind potential in Northwest Africa in order to supply energy to Europe, has conducted wind surveys and investigated the possibility of laying a high voltage power transmission line between Morocco and Western Europe.[16]

The InWEnt study[17] 'Wind Regimes of Africa' published in May 2004 includes an extensive chapter on the wind conditions in Morocco.

Wind farms

Wind-farm	Capacity [MW]	Com-missioned	Average annual-production [GWh]	Financing	Operator
Al Koudia	3.5	03/2001	no data	KfW	ONE
Al Koudia	50	08/2000	226	European Investment Bank	CED
Tétouan	10.2	09/2005	38	Lafarge Ciments	Lafarge Ciments[18]
Tanger	140	End of 2008	510	European Investment Bank und KfW	ONE
Essaouira	60	2008	210	KfW	ONE

Tab. 5: Installed and planned wind farms; Morocco

A 3.5 MW wind farm was erected at the Al Koudia Al Baïda site (Tlat Taghramt in Tétouan Province, 40 km east of Tangier) in late 2000 at a cost of approximately € 6 million. KfW provided a low-interest loan of € 4.35 million for this scheme, which uses German turbine technology (Enercon). The wind farm is being operated by ONE.

Another wind farm at the same location, this one with a rating of 50 MW, entered service in August 2000 with the help of a € 24.4 million loan from the European Investment Bank. The cost of generating the electricity was calculated at 3.7 to 5.5 euro cents/kWh (0.4-0.6 DH/kWh). Eighty-four wind turbines from Vestas, each rated at 600 kW, were erected on behalf of Compagnie Eolienne de Détroit (CED) for approximately € 45.7 million. This scheme is a purely private project based on a BOT contract with ONE; ownership of the wind farm will be transferred entirely to ONE after 20 years.

15 CDER published the initial findings in a report entitled 'Le Gisement Eolien du Maroc' in March 1995.
16 For further information see: www.saharawind.com.
17 Benjamin Jargstorf, Wind Regimes of Africa – Comparative Evaluation of Wind Data from Selected Countries, 05/2004, Factor 4 Energy Projects GmbH.
18 Only generating to meet the company's own needs.

Expansion plans

Other wind farms with capacity totalling 200 MW are planned, and are intended to exploit wind potentials in the greater Tangier area in the north of Morocco and in an Atlantic coast region near the town of Essaouira.

The planned Tangier wind farm will comprise two sites: Sendouk, with 65 MW, and Dhar Saadane, with 75 MW. In the wake of a fruitless international tendering process, ONE decided in February 2003 to erect the Tangier wind farm on its own account. The project is being financed by loans from the European Investment Bank (€ 80 million) and KfW (€ 50 million).

A second 60 MW wind farm is to be installed some 15 km south of Essaouira on the Atlantic coast. The € 83 million project will be receiving assistance from several sources, including a € 50 million loan from KfW. The wind farm is expected to produce 210 GWh of electricity per year, and likewise is intended to be operated by ONE.

ONE has already conducted wind measurements for a 60-MW wind farm near Taza, which is about 100 km east of Fez, and has completed a study into the potential environmental impacts. Plans to build an additional 60-MW wind farm in the south of Morocco, near the town of Tarfaya, have been temporarily shelved by ONE.

Decentralised exploitation of wind energy

To a lesser extent wind energy is also being exploited for the purposes of distributed rural electrification. For example, a pair of 25 kW wind generating systems and a 15 kW unit were installed in the province of Essaouira. Together, these systems supply electricity to 123 households. According to CDER, Morocco presently has towards 300 off-grid wind power plants and roughly 5,000 wind-driven pumps.

Industrial companies are also beginning to make use of wind energy on a decentralised basis. A shrimp-processing factory in Tangier, for example, is using two second-hand 80 kW turbines to a cover part of its own electricity needs. The reconditioned turbines were supplied and installed by a Dutch company in June 2005. Thanks to average wind speeds of 6.5 m/s at the site, the two systems are likely to provide 386,000 kWh of electricity per year. Any surplus energy produced there will be fed into the public grid.

Biomass

Nearly one-third of Morocco's total energy requirement is met by biomass, mostly in traditional form, i.e. through the use of biomass in the form of fuel wood or charcoal for heating and cooking purposes. Morocco has approximately 5 million hectares of forested area. The country's rapid consumption of wood as a source of energy (approx. 11 million tonnes annually) is not indefinitely sustainable, however, and is contributing to the loss of more than 30,000 hectares of forest each year. The Government of Morocco is therefore promoting the introduction of technologies for the efficient use of fuel wood and for its substitution by other energy sources.

Biogas

Every day, Morocco produces approximately 8,000 tonnes of domestic waste and 1.1 million cubic metres of wastewater that could be put to use for generating landfill gas/sewage gas. Animal and vegetable wastes from the agricultural sector could also be utilised. Appropriate biogas plants have been developed with GTZ assistance in the past, and the potential of the planned large-scale sewage treatment plant for the city of Agadir is being examined by RAMSA with help from GTZ (measurement programme). The EIB has put forward the prospect of financing the feasibility study for a biogas plant. The industry association AMISOLE estimates the number of biogas plants presently installed in Morocco to be about 20 small units. There are also plans to produce biogas from domestic waste in Rabat and Fez.

Solar energy

Despite excellent solar irradiation conditions – average daily irradiation is 5 kWh/m^2 and there are over 300 days of sunshine per year – the use of solar energy for grid-coupled electricity generation is still at an early stage of development in Morocco. The only installation connected to the grid is a 1 kW_p photovoltaic system serving as a pilot plant and model project.

PERG Solaire

The electrification campaign with solar home systems (SHS), which is part of the Moroccan rural electrification programme (PERG), is making good progress. The first phase of the programme, during which 16,000 households were fitted with SHSs, was completed in 2005. A further 37,000 households are to be equipped with their own PV systems in the second phase, which will run until 2008. The contract for the second phase of the programme was again awarded to Temasol, an enterprise jointly owned by Total Energie and Electricité de France (EDF).

Photovoltaic Market Transformation Initiative (PVMTI)

The Photovoltaic Market Transformation Initiative (PVMTI), an important solar energy programme devoted to developing national markets for PV systems in India, Kenya and Morocco, was launched by the GEF and the International Finance Corporation (IFC) in 1998.[19] The programme envisages an investment volume of US$ 5 million for Morocco. Some of these funds have already been allocated to two companies. One is the Moroccan financing company Salafin SA, which in June 2002 received US$ 1 million for a lending programme designed to promote solar energy systems. The systems are supplied, installed and maintained by Afrisol SA. The second scheme is a microfinance project by Association Al Amana, for which the IFC is making US$ 720,000 available in the form of guarantees and loans. The project intends to offer microloans for the purchase of solar energy systems in the Taroudant region. In this case the Moroccan PV enterprise Noor Web is supplying the solar energy equipment.

Solar thermal energy

The Promasol programme for promoting thermosolar systems for water heating has helped to boost the number of installed units from 21,700 in 1997 to 111,300 in 2004. An initiative by the Italian Environment Ministry (MEDREP) is promoting the development of a market for solar water heaters in Morocco.

Solar thermal power plant

Assisted by a GEF subsidy of € 43 million and a loan of € 136 million from the African Development Bank, a power plant is to be built in the eastern part of Morocco near Aïn Beni Mathar, some 90 km south of Oujda, which combines a conventional combined-cycle gas turbine with a thermal parabolic trough solar generating system. Over 200,000 m^2 of reflector area shall capture the sunlight and use it to generate thermal energy. The total design capacity is 240 MW, of which approximately 30 MW is to be produced from solar energy. In the course of a year the power plant will generate 1,590 GWh of electricity. According to calculations, 55 GWh will be attributable to the solar generating system, which will therefore account for almost 3.5 % of total production.

The fuel for the gas turbine is to be taken from the pipeline between Algeria and Europe. According to a feasibility study that was completed in 1998 and financed by the European Investment Bank (EIB), the project is expected to cost € 213 million. The difference between the promised loan and the total costs will be borne by ONE, which will then also run the power plant. According to ONE, tendering for the project began in 2004, and the plant is scheduled to be completed in 2009.

Geothermal energy

Morocco's geothermal potential is still largely unexplored. The country's geothermal resources are confined to the north-eastern region and parts of the Sahara. The resources are relatively minor in magnitude but, according to the International Geothermal Association (IGA), could be used for heating purposes.

19 For further information see www.pvmti.com.

Desalination of seawater with renewable energy

The Moroccan water authority, Office National d'Eau Potable (ONEP), is planning to build a seawater desalination plant to supply Tan Tan, a town on the Atlantic coast in the south of the country; the plant is to be powered by electricity from a 10 MW wind farm. The project is due to be completed in 2007, when initially it is supposed to supply 6,000 m^3 of desalinated water per day, rising in stages to a capacity of 11.000 m^3 by 2015. The bidding procedure for the plant was in preparation in April 2006. Operation and maintenance will be the responsibility of a separate company, which will be given purchase guarantees for the water it produces by ONEP. The project is to be registered under the Clean Development Mechanism (CDM). The Moroccan DNA has already given its approval for this, but so far no application has been made to the UNFCCC for registration.

13.6 Rural Electrification

Degree of electrification

In recent years Morocco has made great progress in providing grid power to its population. ONE presented a national electrification programme – Programme pour l'Electrification Rurale Global (PERG) – to the Moroccan governing council in 1995, and launched it in 1996. The degree of rural electrification was only 18% in 1995 before the programme started, but this rose steadily to 82% by the end of 2005. Even villages situated long distances from the power grid now have at least a basic decentralised electricity supply, with the aid of renewable energy sources.

According to data provided by ONE, 21,689 villages, or 1,392,954 households, had been provided with an electricity supply by the end of 2005 within the scope of the PERG programme. The Government of Morocco aims to achieve full electrification of the country by 2007.

Programme for rural electrification

ONE is responsible for rural electrification in cooperation with the relevant local authorities. International donors, ONE and the users jointly finance the electrification measures.

The role of the private sector in decentralised rural electrification has continued to grow in recent years. Private companies are responsible for the procurement, installation and maintenance of the solar energy systems. In return, after the systems have entered service the companies collect charges from the users at regular intervals. The only help provided by ONE to the future electricity customers is with the financing of their systems. Within the framework of its new fee-for-service model, ONE has now completely surrendered the technical side of rural electrification to privately owned enterprises.

Solar home systems and fee-for-service contracts

ONE provides a financial subsidy for each installed solar home system, with contributions ranging from € 389 to € 1,598 (DH 4,320 to 17,760). The precondition is that the implementing solar energy company must enter into a contract with ONE. Solar home systems rated at 50, 75, 100 and 200 watts are being promoted. The household in which the SHS is installed then repays the remainder to the implementing contractor in instalments over a period of 10 years. The SHS itself remains the property of ONE for that 10-year period, after which its ownership passes to the household in question. The solar contractor is responsible for installing and servicing the solar home system.

One subsidiary project within the rural electrification campaign that operates according to this principle is the TEMASOL programme, which is supposed to supply electricity from PV systems to 370,000 people in 53,000 households in 24 Moroccan provinces. It is based on cooperation between ONE and two companies (Electricité de France and Total Energie), and is co-financed by German Financial Cooperation (KfW), the French development agency AFD and the French Global Environment Facility (FFEM).

The costs to be borne by the households under this programme are made up of a once-only connection cost of € 63-360 (DH 700-4,000) and a monthly fee of € 5.85-13.50 (DH 65-150), depending on the output of the installed system.

Decentralised rural electrification with renewable energy sources

In contrast with its predecessor programme (PNER), which came to an end in 1996, PERG also includes the off-grid electrification of communities and villages situated away from the existing distribution networks. The part of the programme targeting decentralised electrification began in 2000 and primarily promotes the use of SHSs, but also micro hydropower plants and small wind energy conversion systems.

Hybrid isolated grids have been installed at two locations in the province of Essaouira. These involve the use of wind generating systems in combination with diesel generators. In Sidi Kaouiki, two wind turbines each produce 25 kW and a diesel generator 30 kW. In Moulay Bouzerktoun there is 15 kW of wind power and 15 kW from diesel. According to estimates from the Centre de Développement des Energies Renouvelables (CDER), there are about 300 off-grid wind turbine systems in Morocco.

Exchange rate (December 2006):
1 Moroccan dirham (DH) = 0.09 euro (EUR)

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14 Namibia

14.1 Electricity market

Installed capacity

The national power grid in Namibia is fed by three domestic power plants and inputs from neighbouring countries into the interconnected system. With a rating of 249 MW, the Ruacana hydroelectric power station is the largest contributor in terms of domestic capacity. Namibia also has two thermal power stations: the coal-fired Van Eck plant near Windhoek with 120 MW, and the 24 MW Paratus plant near Walvis Bay, which has four diesel generators.

The two thermal power plants were only installed as an interim solution, because the hydropower plant at Ruacana was not completed until much later than planned. Originally it was assumed that Ruacana would be able to provide enough electricity for the entire country. However, since demand for electricity has increased rapidly since then, not only are all three plants still in operation, but roughly half[1] of all electricity consumed in Namibia now has to be purchased from neighbouring countries.

Since the bought-in power from South Africa is less expensive than that generated by the country's own thermal power plants, the latter are only depended on for periods of particularly high demand. The maximum capacity for importing electricity from neighbouring interconnected grids amounts to 600 MW. The capacity available within the country has remained unchanged since 1999, and comprises the following elements:

Ruacana, hydropower	249 MW
Van Eck, coal-fired, Windhoek	120 MW
Paratus, diesel generators, Walvis Bay	24 MW
Interconnection with neighbouring grids	600 MW
Total	**993 MW**

Tab. 1: Available capacity, by source; Namibia; 1999–2006; MW[2]

Power generation

No data is available on the proportions of domestically produced and imported electricity with regard to type of plant or source of energy. According to information provided by the national power utility NamPower for 2006, both thermal power plants are kept in standby mode and only actually utilised in exceptional cases to help cope with peak loads. Consequently, it must be assumed that most of the electricity produced in Namibia comes from Ruacana Power Station.

Namibia is a member of the Southern African Power Pool (SAPP), an international, interconnected electrical system representing member countries of the Southern African Development Community (SADC). Power providers in Zambia (ZESCO), Zimbabwe (ZESA), Botswana (STEM), Angola and South Africa (Eskom) all share their generated power with one another. The table below provides an overview of the electricity produced in and for Namibia.

Power production	2001	2002	2003	2004	2005
			GWh		
NamPower (Namibia)	1,211	1,429	1,421	1,379	1,660
Zesco (Zambia)	21	21	21	9	23
Eskom (South Africa)	1,045	921	988	1,423	1,514
Zesa (Zimbabwe)	–	–	–	87	158
STEM (Botswana)	–	–	36	47	8
Total	**2,277**	**2,371**	**2,466**	**2,945**	**3,363**

Tab. 2: Power production for the Namibian grid; 2001–2005; GWh[3]

1 2005: 1703 GWh electricity imported, and 1660 GWh produced domestically.
2 Source: NamPower.
3 Source: NamPower.

Power transmission and distribution

Namibia has a well-developed network of transmission lines radiating out from the capital city of Windhoek to reach all populated areas of the country. The main transmission line extends from north to south, because one of the two main power sources is situated near the northern border (Ruacana Hydro Power Station) and the other is located at the southern border, i.e. the point at which the Namibian grid merges with the South African grid.

Transmission and distribution lines	2001	2002	2003	2004	2005
	km				
400 kV	735	988	988	988	988
330 kV	521	521	521	521	521
220 kV	1,664	1,664	1,958	1,958	1,958
132 kV	1,166	1,388	1,462	1,588	1,656
66 kV and below	13,223	14,194	16,357	20,762	22,072

Tab. 3: Development of the Namibian power transmission and distribution network; 2001–2005; km[4]

In the five-year period between 2000 and 2004, Namibia managed to reduce its power transmission losses from 9.8% to 5.1%.

Power consumption

Demand for electricity in Namibia has increased markedly in recent years. The main contributory factors to this was the commissioning of the Scorpion zinc mine in 2004 in the southwest of the country. Together with the associated ore processing facilities, that mine alone accounts for roughly 25% of Namibia's overall power consumption.

Electricity sold	2001	2002	2003	2004	2005
	GWh				
Namibian users	1,981	2,082	2,117	2,301	2,349
Scorpion zinc mine	–	–	76	471	596
Botswana	2	4	7	8	12
Angola	5	6	10	12	16
Eskom (South Africa)	62	44	36	3	3
Total	**2,050**	**2,136**	**2,246**	**2,795**	**2,976**

Tab. 4: Quantities of electricity sold; Namibia; 2001–2005; GWh[5]

The upward trend in peak loads is attributable to a combination of increasing customer count and, above all, the Scorpion mine commencing operation in 2004.

Peak load	2001	2002	2003	2004	2005
	MW				
Without Scorpion mine	332	348	371	389	400
With Scorpion mine	332	348	371	461	491

Tab. 5: Peak load; Namibia; 2001–2005; MW[6]

4 Ibid.
5 Source: NamPower.
6 Source: NamPower.

Electricity prices

Electricity prices for ultimate consumers in Namibia vary slightly from region to region. The total price comprises a demand rate and an energy rate (unit rate). Some regional providers also levy a monthly service charge, and each purchased kWh of electricity also carries a fee equivalent to 0.048 euro cent (N$ 0.0045) that goes toward financing the Namibian regulatory authority, the Electricity Control Board.

	City of Windhoek	Grootfontein (CENO-RED)	Lüderitz city government
	€		
Private households, 220 V			
Base rate per ampere	0.544	0.259	0.270
Energy rate per kWh	0.037	0.083	0.062
Service charge	–	5.400	–
Industrial users			
Demand rate per kVA	7.559	9.719	9.499
Energy rate per kWh	0.037	0.075	0.045
Base rate	–	32.397	–

Tab. 6: Electricity prices for ultimate consumers, in euros; Namibia; 2006/2007[7]

Local providers set their own prices for their respective service areas but must have them approved by the Electricity Control Board. Once the prices have been approved, they can be viewed at the Board's website.[8]

To date, all providers obtain all their electricity from NamPower, the national power utility, which charges them the equivalent of 0.021 euro/kWh.[9] The last price increase (+ 9.5 %) took effect in July 2005.

Future development and expansion planning

By 2011 the national power utility NamPower is anticipating the peak load to have risen to approximately 600 MW. The South African power producer Eskom, which in the past has supplied a major share of Namibia's electricity needs, has announced that, due to rising domestic demand, its capacities will no longer be available in the future. With that in mind, the Government of Namibia is striving to become less dependent on imported electricity by securing enough generating capacity of its own to satisfy the country's needs. Aiming for an accordingly higher level of self sufficiency, the Government of Namibia had the Ministry of Mines and Energy investigate various options for expanding the domestic generation of power.

It emerged that the first option, building two large dams, would take too long, because it would mean negotiating agreements with neighbouring countries affected by the schemes. Consequently, according to NamPower, it was decided to develop the Kudu natural gas field, which is situated about 130 km off the coast of Namibia. A 170 km-long pipeline will bring the collected gas to Oranjemund, where two 400-MW gas-fired power plants are to be constructed in stages. With that much additional capacity, Namibia would even be able to export electricity to the Southern African Power Pool (SAPP). In December 2006, NamPower announced that construction of the two gas-fired power plants could begin as early as 2007. The first plant is supposed to be up and running by the end of 2010.

7 Source: Electricity Control Board.
8 www.ecb.org.na
9 Source: NamPower price list 2006/2007.

14.2 Market Actors

NamPower

Established in 1964[10], Namibia's national power utility is now a corporation wholly owned by the Government of Namibia. With a staff of roughly 900, NamPower operates the country's three power plants and the national power grid. The company also (still) supplies electricity directly to a number of customers who are situated beyond the reach of local power providers.[11] As a member of SAPP, NamPower buys and sells electricity abroad. The company has set up a special division for that field of business.

Regional Electricity Distributors (REDs)

In the past, Namibia's various municipal authorities organised the local supply of electricity to ultimate users. The respective local governments purchased electricity from NamPower and passed it on to the citizens. Tariffing was left to the local authorities, who sometimes availed themselves of the opportunity to cross-subsidise other public services at the cost of the electricity customers.

Now, however, the Namibian power sector is being restructured – a process that began in 2000 and is to be completed in 2007 - and the municipal power providers are being grouped into five large utility companies. In their respective regions, the utilities have the status of independent enterprises managed according to market-economy principles. They are regulated by the Electricity Control Board, which among other things is responsible for approving ultimate-user prices and setting electricity supply standards.

The old municipal power providers will share ownership of the new REDs in the same proportions as their prior participation in the distribution of power within their respective districts. For the time being, NamPower will hold an average of 28% ownership of all five new companies.[12] Three of the five REDs have already gone into business (NORED in 2002, Erongo RED and CENORED in 2005). In the regions belonging to the two remaining REDs (Southern RED and Central RED) in the southern part of the country, amalgamation of the municipal providers into regional companies is well under way.

Other Actors

Electricity Control Board (ECB)

The Namibian regulatory authority was established in accordance with the provisions of the Electricity Act (Act 2 of 2000) for the purpose of regulating the electricity sector enterprises (licensees) and ensuring that the electricity market develops in a manner to reflect the interests of all concerned.

The ECB is responsible for issuing the prescribed licenses to all actors engaged in the generation, transmission, distribution, sale and importing/exporting of electricity in Namibia. The requisite awarding procedures were established within the ECB and are being successfully applied. To date, NamPower and the five REDs are still the most important licensees following restructuring of the electricity sector.

10 Until 1993 the company's name was South West African Water and Electricity Corporation (SWAWEC). Originally, SWAWEC was a full subsidiary of the Industrial Development Corporation of South Africa.

11 Presumably, NamPower will relinquish these direct customers to the still-to-be-established REDs sometime within the next two years in order to withdraw completely from the power distribution sector.

12 No information is available regarding further holdings.

The ECB's independence is limited by the fact that the Ministry of Mines and Energy is responsible for finalising the granting of all licenses. The ECB merely makes recommendations after having examined and evaluated the incoming license applications. The further fact that the ministry has in several cases disagreed with the ECB experts' recommendations[13] leaves room for conjecture that the views of the ministry and the ECB are liable to diverge on issues regarding developments in the electricity sector.

The ECB is headed by a five-member board of directors appointed to four-year terms by the Minister of Mines and Energy. The technical secretariat attends to routine duties assigned to the ECB in pursuance of its statutes. This includes issuing licenses, approving tariffs, ensuring the quality of supply, settling disputes and helping restructure the Namibian energy sector.

14.3 Legal Framework

Fundamental statutory regulations

In 1998 the Ministry of Mines and Energy issued a White Paper on Energy Policy that defined the boundary conditions for the future development of the electricity sector. A study[14] conducted on the basis of that paper and published in 2000 now serves as the foundation for the administrative Electricity Act (Act 2 of 2000) which likewise was adopted in 2000. Restructuring of the electricity sector is also based on that same 1998 White Paper, which therefore also still serves as the foundation for Namibia's energy policy.

The Ministry of Mines and Energy is also responsible for establishing the outline policy stipulations that provide a working basis for the ECB's activities. The ministry exercises power of decision over recommendations made by the ECB.

Restructuring of the electricity sector

In the year 2000 the national power utility NamPower began to restructure its business operations, a process that will be concluded with the establishment of the two remaining REDs in the southern part of the country in 2007. Now, the once vertically integrated enterprise comprises three clearly delimited core areas: power production, power transmission and power trading.

Power trading remains an independent division of the public enterprise and is closely interlinked with the power transmission business area. As such, NamPower has the function of a single buyer for the Namibian electricity market.

Exactly what a single buyer for the Namibian electricity sector is supposed to do, however, is still a matter of dispute between the Ministry of Mines and Energy and the ECB. The latter regards the single-buyer model as a transition towards a further liberalised electricity market in which producers and providers can conclude contracts of supply directly with one another.

NamPower, however, believes that the single-buyer model is unsuitable for the Namibian electricity market. How that market actually does develop in the future is a matter that remains to be seen. Presently, the close linkage between power trading and NamPower's other two divisions (production and transmission) makes this state-owned enterprise the dominant player on the electricity market.

When the restructuring has been concluded, NamPower will no longer be a power provider. The plants and customers will pass to the new regional electricity distributors (REDs).

As things stand, there are no present plans either for splitting off any further NamPower parts or divisions into independent enterprises or for privatising the company.

13 For example, the licenses that the ministry has issued to some REDs have longer terms than those recommended by the ECB.
14 Study of the Restructuring of the Namibian Electricity Supply Industry (ESI) (2000).

Opportunities for independent power producers

In more than one policy statement, the Ministry of Mines and Energy has come out openly in favour of an unfettered, market-oriented, transparent electricity market offering an attractive environment for private investment. Thanks to the licensing model that is being implemented by the ECB, independent actors enjoy open access to the Namibian electricity market. Independent power producers are able to inject their outputs into the NamPower-operated power grid. However, the public utility is providing just as little concrete information about the associated transmission fees as it is about remuneration for purchased power.

There are no political or legal barriers to prevent participation in the Namibian electricity market. The absence of a genuinely independent single buyer, however, makes it difficult for independent power producers to calculate their chances of making a profit. Potential providers are still too dependent both on which electricity prices NamPower deems appropriate and on which conditions NamPower attaches to the purchase of electricity. Since NamPower operates power plants, too, the company could fall into a conflict of interest as a power trader, since it would be only natural for the company to keep the profitable utilisation of its own generating capacities first in mind.

14.4 Policy Promoting Renewable Energy Sources

Promotion programmes

The outline stipulations on policy for the promotion of renewable energy sources are contained in the aforementioned 1998 White Paper on Energy Policy. This deals with the planning and institutional promotion of the utilisation of renewable energy sources and the rational use of energy, albeit without mention of any concrete implementing regulations.

In 2001, within the scope of a project entitled Namibia Renewable Energy Programme and with assistance provided by UNEP, the government planned and developed a national framework programme for the promotion of renewable energies. The programme is supposed to incorporate the objectives of the government as well as the measures that need to be implemented in order to achieve those objectives. However, the government has yet to adopt a corresponding programme.

In July 2006, NamPower set up a new subdivision concerned with the promotion of renewable energies. The new subdivision is tasked with developing strategies for cooperation with producers of renewable energy within the scope of joint ventures, but also has the role of concluding power purchase agreements with such producers. Developers and investors involved in projects based on renewable energies are invited to present their plans there.

With a view to promoting the use of renewable energies, particularly in rural areas, the Ministry of Mines and Energy began in 1996 to allocate money for what it called a Solar Revolving Fund, by way of which solar home systems[15] can be financed. The loans are repayable over five years at an interest rate of 5 %. Since 2005 the revolving fund has been administered by the Windhoek-based company Konga Investment (Pty) Ltd.

International promotion measures

The Namibian government launched its UNDP/GEF-assisted Barrier Removal to Namibian Renewable Energy Programme (NAMREP) in 2004. The programme pursues two main objectives: to improve, with the aid of photovoltaic systems, access to electricity in rural areas without connection to the national power grid, and to help conserve fossil sources of energy while reducing Namibia's dependence on imported energy by expanding the use of solar thermal water heating systems. The project consists of two phases. Phase 1, which was very largely completed in 2006, was devoted to eliminating organisational and technical barriers to the dissemination of solar technologies.

15 Since 2005 it has also been possible to finance solar-thermal hot water heating systems via this fund.

The main barrier was a lack of both technical expertise and market opportunities for solar technology. That satisfied the prerequisites for the second phase, the purpose of which is to accelerate the dissemination of solar technologies by better accommodating the available equipment and financing options to the actual needs of potential users.

Several different components are intended to help make the NAMREP programme successful: training and upgrading; elimination of institutional, financial and technical barriers; promotion of public awareness and social acceptance; and development of demonstration and pilot facilities. The programme was promoted with US$ 2.7 million in its first phase, and US$ 2.6 million is earmarked for the second phase.

The Danish development assistance organisation DANIDA is also cooperating with Namibia within the scope of a bilateral Special Environmental Assistance programme, the goals of which include the sustainable production and use of energy. In 2004, DANIDA launched its three-year Namibian Renewable Energy and Energy Efficiency Capacity Building Project (REECAP), which has a volume of some 1.1 million euros and is geared to informing the urban and rural populations about the opportunities offered by renewable energies while raising their awareness in connection with the rational use of energy.

Clean Development Mechanism

Namibia ratified the Kyoto Protocol on 4 September 2003, although as yet no designated national authority (DNA) has been set up. Consequently, for the time being no CDM projects can be implemented in Namibia, nor have any plans been laid for CDM projects involving renewable energies.

14.5 Status of Renewable Energy Sources

The huge Ruacana hydroelectric power station is the main component of Namibia's national power generating capacity. The exploitation of existing wind, solar and biomass potentials for the domestic generation of electricity is still marginal.

Hydropower

Namibia obtains most of its electricity from the 249 MW Ruacana hydropower plant on the Kunene River, which forms the border to Angola. In view of dwindling power supply capacity reserves, the government commissioned a "hydropower master plan" within the scope of a detailed study designed to yield insight into the country's existing hydropower potential. The plan lists twelve possible sites for additional hydropower plants. Counted together, the sites in question could yield a maximum annual output of 6,932 GWh, some 5,500 GWh of which could, according to the cost structure laid out in the master plan, be produced for less than 0.027 euro/kWh.

Name of project	Rating [MW]	Output [GWh]
Ondurusu	58	225
Zebra	30	115
Epupa	340	1,724
Baynes	225	1,120
Marien	230	1,170
Hartman	125	630
Hombolo	170	855
Mcha	80	410
Divundu A	19	150
Onseep B	29	151
Vioolsdrift	44	227
Aussenkehr	30	155

Tab. 7: Hydropower potentials in MW and GWh; Namibia[16]

16 Source: Ministry of Mines and Energy – Directorate of Energy.

NamPower has conducted in-depth studies and drawn up plans for two such large-scale projects (Epupa and Baynes). However, since it was decided in 2006 to implement the Kudu natural gas project, NamPower is no longer pursuing any major hydropower projects. Even the small Popa Falls run-of-river project (Divundu A, 19 MW) envisaged for the Okavango River in the northeast corner of the country is not being implemented by NamPower for the time being. Technical studies and an environmental report providing for construction of a 9.75 m-high weir already exist for Popa Falls. Construction would take about three years and cost approximately 33 million euros. According to NamPower, the project could be implemented by an independent power producer if sufficient international funding and/or private investment capital were to be made available.

Wind energy

Wind potential

The wind conditions prevailing in Namibia were investigated within the scope of a GTZ promotion programme entitled Promotion of the Use of Renewable Energy Sources in Namibia, which was launched in 1993.

Then, in a 1996 study commissioned by GTZ and executed in cooperation with the national power utility NamPower, detailed wind measurements were performed at two promising locations on the Namibian Atlantic coast (Walvis Bay and Lüderitz). The purpose of the studies was to clarify whether or not the selected sites would be suitable for hosting wind farms. Meteorological and technical aspects as well as economic considerations and infrastructural matters were all given due consideration.

Site	Annual average wind speed [m/s]	Energy density [kWh/m^2a]	Weibull parameters, A,k
Walvis Bay "Saltworks"	6.8	3,047	A=7.73 k=2.17
Lüderitz "Golf Course"	7.5	4,936	A=8.4 k=1.70

Tab. 8: Wind potential at height of 50 meters for two sites in Namibia[17]

The Namibian wind regime is dealt with in one chapter of the InWEnt publication Wind Regimes of Africa[18], where the measured data from both site studies are evaluated. The results show that Namibia has some excellent wind potentials at sites situated along its Atlantic coast.

Wind power plants

The first wind energy conversion system installed in Namibia was a now twelve-year-old, second-hand 220-kW turbine which, with technical assistance rendered by the Danish development assistance organisation DANIDA, was erected in late 2005 eleven kilometres east of Walvis Bay, i.e. in the desert. Its output is fed into the power grid operated by the regional provider ErongoRED.

Planned wind farms

Judging on the basis of the obtained measured data, the site studies and an environmental report, the national power utility NamPower decided in favour of constructing a wind farm near Lüderitz. Within the scope of a pilot project, a plant was planned with an initial rating of 3 MW and an eventual full rating of 20 MW. In December 2001, however, the Namibian Electricity Control Board refused, on economic grounds, to issue the requisite license for the project. In March 2003, the Namibian government appointed a project development team to help them define clear-cut directives regarding the production of wind-generated electricity.

17 Source: Ministry of Mines and Energy – Directorate of Energy.
18 Jargstorf, Benjamin, Wind Regimes of Africa – Comparative Evaluation of Wind Data from Selected Countries, InWEnt Division Environment, Energy and Water, Berlin, 2004.

The team is also tasked with spurring on the wind farm construction project in Lüderitz. If and when that plant is ever actually commissioned is another matter that remains to be seen.

It became known in early 2007 that a Danish investor is planning wind parks with a total output of 92 MW. Seventy turbines are supposed to be installed around Big Bay outside Lüderitz, and 16 each near Oranjemund and at Walvis Bay. The total investment is put at towards 100 million euros, and the Danish Government, among other donors, is expected to contribute some of the funds. An application for a power generating license has already been submitted to the ECB. Power generation is expected to cost 2.6 euro cents/kWh (N$ 0.24/kWh), and the operator is expecting NamPower to pay 3.8 euro cents/kWh (N$ 0.35/kWh). The first turbines are supposed to be installed in October 2007, and the full capacity is expected to come on-line by 2009.

Biomass

According to information provided by the Namibian Ministry of Mines and Energy, some 80 % of the rural population use biomass as their principal source of energy – almost exclusively in the form of firewood for cooking and heating. Countrywide, between 15 % and 20 % of all primary energy consumed comes from wood. A national steering committee[19] established in 1998 is drawing up plans for the sustainable utilisation of existing biomass resources.

Biogas

The National Biogas Programme launched in June of 2000 is being jointly administrated by the Ministry of Mines and Energy and the Ministry of Agriculture. With the aid of technical assistance rendered by the Government of India, ten small biogas digesters (3-5 m^3) have been installed in Namibia as part of a model project. However, the systems are not producing any electricity at the moment.

Solar energy

In large parts of Namibia the daily insolation rate exceeds 6 kWh/m^2. Even in the less sunny coastal regions, rates of the order of 5.5 kWh/m^2d can be expected. Thanks to the fact that nearly the whole country enjoys more than 300 sunny days a year, the average daily sunshine duration ranges between nine and ten hours. This gives Namibia excellent meteorological prerequisites for the utilisation of solar energy.

In connection with the aforementioned NAMREP programme, the Government of Namibia has taken measures to improve the conditions for harnessing solar energy within the country. Efforts are focussed on three technologies: solar home systems (SHS), photovoltaic water pumps for wells, and solar thermal water heaters. Market analyses, application scenarios, feasibility studies and technical guidelines have been developed for all three principal applications of solar energy within the scope of the NAMREP programme.

Photovoltaics

In the course of the government's "Home Power!" programme, which expired in 2003, some 600 to 700 rural households with no access to the public power grid received small solar systems. Such systems are still being financed via small, low-interest loans from the aforementioned Solar Revolving Fund. According to information from the Ministry of Mines and Energy, more than 1000 solar home systems had been installed in Namibia by July of 2006. An on-grid photovoltaic plant with a rating of 5 kW_P was installed at the Habitat Research and Development Centre of Namibia in 2004. It is now feeding electricity into the grid operated by the local power provider. No information is available on remuneration or feed-in terms.

19 National Steering Committee on the National Biomass Energy Conservation Programme under the direction of the Ministry of Mines and Energy.

Solar thermal systems

In 2005 there were approximately 3,200 solar thermal water heating systems installed in Namibia, two-thirds of which, some 2,100 systems, were in use in private households. Hence, about 2.3 % of all Namibian households with any kind of hot-water system had solar thermal equipment. The remaining one-third of the systems were serving either commercial/industrial buildings or public facilities. Between 2000 and 2005 the sale of solar thermal systems increased at an annual average rate of 16 %. Now, some 200 new systems are being installed each year.

The domestic market, however, is still too small to sustain domestic production. Five different companies import solar thermal equipment from abroad, and six contractors have specialised in the installation of such systems. The main impediment to the further dissemination of solar thermal systems is a combination of low electricity rates and the high initial cost of the equipment. Since 2005, though, not only photovoltaic systems but also solar thermal systems can be financed via the Solar Revolving Fund that the Ministry of Mines and Energy set up to help promote renewable energies.

14.6 Rural Electrification

Degree of electrification

Just under 1.5 million people, or 72 % of the Namibian population, live in rural areas. Of the 2,855 villages to be found in Namibia, roughly 2,400 still have no link to the national power grid. One hundred and thirty-one villages are situated in officially declared off-grid areas, but the Ministry of Mines and Energy plans to get the remainder connected to the grid within the next 20 years. Since Namibia gained independence from South Africa in 1990, rural electrification has added approximately 8,330 households in 400 settlements to the public power grid.

Rural electrification programme

Namibia launched a rural electrification programme in 1990. The Rural Electricity Distribution Master Plan from the year 2000 covers all future electricity customers in the country that have not yet gained access to electricity. The Master Plan includes provision for both grid-connected power and decentralised electrification with the aid of renewable energy. In the past, various different organisational approaches have been taken to rural electrification with solar energy systems. Most PV systems have been purchased by the owners themselves with funds secured via the Home Power! programme as a developmental measure of the aforementioned Solar Revolving Fund.

A fee-for-service model was tested in the village of Ovitoto in 2002. There, some 100 households were equipped with solar systems, and only the electricity actually consumed was paid for, according to a prepayment system. In such a thinly populated area of Namibia, however, system maintenance and accounting proved uneconomical. Consequently, the systems were transformed into “normal” solar home systems in 2004, and the users now pay a monthly fixed rate until the respective system is paid for in full and they assume ownership.

Isolated grids

In addition to individual solar home systems, Namibia also has a number of off-grid regions that are suitable for electrification in the form of small isolated solar networks.[20] Combinations with other sources of electricity, such as wind power or diesel generators, present themselves as a supplementary alternative. In 2004, the Gobabeb Desert Research Station in Namib Naukluft Park commissioned a PV-diesel hybrid facility with a rating of 26 kWp to serve a small network of 25 consumers.

Exchange rate (15 February 2007):
1 Namibian dollar (NAD) = 0.10799 euro (EUR)
1 EUR = 9.25983 NAD

20 See also: Ministry Of Mines And Energy – Directorate of Energy, Baseline Study: Barrier Removal To Namibian Renewable Energy Programme (NAMREP) Final Report, Namibia, 2005, page 50.

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15 South Africa

15.1 Electricity Market

Installed capacity

In 2006 South Africa's total installed power generation capacity amounted to approximately 43 GW. The South African utility company Eskom is one of the world's largest electricity providers, with an installed net capacity of 39,810 MW (2006).[1] Of this, 90 % is accounted for by coal-fired power stations (35,607 MW), 4 % by nuclear power stations (1,800 MW) and 6 % by hydroelectric power stations (2,000 MW) and gas turbines (342 MW). Additional generating capacities are provided by private electricity producers (approx. 1,390 MW licensed at the end of 2004, chiefly industrial owner-operators) and local government utilities (1,825 MW licensed at the end of 2004). Eskom also has a stake in the Cahora Bassa hydroelectric power scheme in Mozambique, with a capacity of 1,600 MW.

Peak demand in Eskom's integrated network reached 33,461 MW in 2005/2006. Thanks to a new gas pipeline from Mozambique to South Africa, natural gas will also increasingly become established as an important energy source for generating electricity. The first gas-fired combined heat and power station was commissioned in July 2006 in Richards Bay.[2] Another plant in Newcastle was due to begin generating power in the first quarter of 2007.

Power generation

In 2005/2006[3] net electricity generation by Eskom amounted to 221 TWh, of which 205.8 TWh was from coal-fired power stations, 1.1 TWh from run-of-river power plants, 2.9 TWh from pumped storage plants and 11.3 TWh from nuclear generation.

	2000	2001	2002	2003	2004	2005/06
	GWh					
Coal	172,362	175,223	181,651	194,046	202,171	205,837
Hydropower	1,343	2,061	2,357	777	720	1,141
Pumped storage plants	2,591	1,587	1,738	2,732	2,981	2,867
Nuclear power stations	13,010	10,719	11,991	12,663	14,280	11,293
Gas turbines	0	0	0	0	0	78

Tab. 1: Net electricity generation by Eskom; South Africa; 2000–2006, GWh[4]

Eskom produces electricity for the domestic market and for some neighbouring countries. In recent years, however, power imports from neighbouring countries (mainly Mozambique) have grown considerably faster than exports, to the extent that in 2005 there was already an almost exact balance (9,200 GWh was imported and about 12,900 GWh exported). For the future it is planned to make greater use of imports to meet the growing demand for electricity.

In 2004, national (public) gross power generation was 230 TWh, of which 3.2 % was from private generators (7.4 TWh) and a further 0.8 % from local government utilities (1.2 TWh), while the rest came from Eskom power stations. Some 363 GWh was consumed by private self-generators for their own needs.

1 The nominal capacity of all power stations is 42 GW.
2 This industrial combined-cycle power plant with an electrical output of 27.5 MW supplies electricity and heat to a paper mill.
3 1.4.2005–31.3.2006; statistics from before this period always relate to the calendar year.
4 Source: Eskom, Annual Report 2006. The figure for 2005/2006 covers the period 1.4.2005 to 31.3.2006.

Power transmission and distribution

Eskom both owns and operates the transmission grid. The transmission grid encompasses voltage levels between 132 and 785 kV and for the most part is over 60 years old, which means that considerable investment in maintenance will be necessary in the near future. In addition to the domestic grid, the grid infrastructure for interchanging electricity with neighbouring countries is also to be expanded in future. South Africa is an important member of the Southern African Power Pool (SAPP) and thus has access to relatively inexpensive and secure sources of supply beyond its borders.[5] Transmission losses in the reporting period of 2005/2005 were comparatively low at 8.2%.

Degree of electrification

While only one third of households had an electricity supply in 1994, by the end of March 2006 the proportion had already risen to about 72%. At present there are still some 3.4 million South African households without access to electricity. Eight provinces have an electrification rate of over 70%, while only two provinces are below that figure.[6]

Electricity consumption

The consumption of electricity sold by Eskom reached 208.3 TWh in the 2005/2006 accounting year. Between 2000 and 2005/06 the average rate of growth in electricity demand was 3.1%. Almost 40% of the electricity was supplied to distributing companies, with the rest being sold directly to end users. Altogether more than 8 million customers are currently supplied with electricity, roughly half of them directly by Eskom and the other half by municipal or other distribution companies. The largest sectors in terms of power consumption are industry, in particular aluminium producers and mining.

The promising outlook for the economy suggests that as a long-term trend demand for electricity will grow by 4.2% per year, or about 1,500 MW.

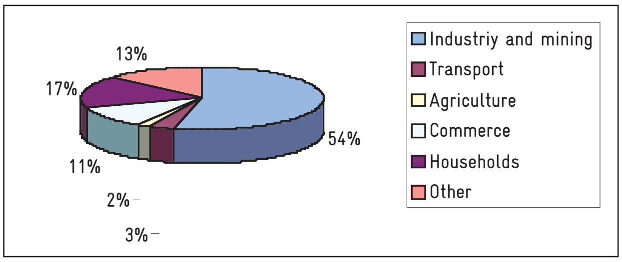

Fig. 1: Electricity consumption by sector; South Africa; 2004; GWh[7]

Electricity prices

Even if electricity generating costs are among the lowest in the world at less than 1.5 euro cents/kWh thanks to the low-cost domestic coal resources available, there are still substantial differences in tariffs between the distribution companies and the various consumer groups.

Eskom and the municipal utilities charged the following average prices to their customers in 2004 and 2005/2006 (Eskom only):

	Power distributors incl. Eskom 2004		Eskom only, 2005/2006	
	ZAR-ct/kWh	€-ct/kWh	ZAR-ct/kWh	€-ct/kWh
Agriculture	31.13	3.42	32.86	3.61
Households	28.82	3.17	40.08	4.41
Commerce	28.45	3.13	22.69	2.50
Transport	22.13	2.43	20.25	2.23
Industry	18.31	2.01	14.75	1.62
Mining	15.37	1.69	16.19	1.78
Others[8]	23.45	2.58		
Other distrib.			16.13	1.77
Average (volume-weighted)	21.82	2.40	17.05	1.88

Tab. 2: Average electricity prices (net); South Africa; 2004 and 2005/06; ZAR cents/kWh, € cents/kwh [9]

5 Eskom and other African electricity suppliers plan to build hydroelectric power stations on the River Congo. This river, which has the largest water volume in Africa, has an estimated energy potential of 100 GW. The project includes a 3,000 km-long power transmission line through to South Africa.
6 These provinces are KwaZulu-Natal, at 64%, and Eastern Cape, at 55%.
7 Source: Digest of South African Energy Statistics, 2005. Department of Minerals and Energy.
8 Among other things this category includes street lighting and exports by the distribution companies.
9 Source: National Electricity Regulator: Electricity Supply Statistics 2004.

Altogether there are more than 2,000 different tariffs in force in South Africa, with prices varying between 2.1 euro cents/kWh (ZAR 0.19/kWh) and 7.8 euro cents/kWh (ZAR 0.71/kWh).

In 2005 the regulator approved a tariff increase for Eskom above the inflation rate. The average electricity price (including levy) for other distributors thus rose from 1.76 to 1.87 euro cents/kWh (16.04 to 17.05 ZAR cents/kWh) on 1 April 2006. This increase is the first step in a three-stage annual price increase, in increments averaging about 5 % per annum. This is the first time that the regulatory authority has approved an annual price adjustment over three years for Eskom. The reason given for this longer-term tariff rise was the need for stable and predictable prices in the light of the investment required for the expansion of power stations.

Eskom has introduced free basic electricity provision for households with very low incomes, with an allowance of 50 kWh per month. This entails entering into a contract with the local authorities, which for their part have to check the neediness of the applicants. In 2004 more than three million households were able to take advantage of this service. That said, at the beginning of 2006 it was estimated that only 27 % of all needy households had been given the free basic tariff.

Expansion planning

Despite growing demand for electricity, Eskom has not brought any new power generating capacity on stream in recent years. In view of anticipated supply shortages from 2007 onwards, Eskom announced in 2004 that three decommissioned coal-fired power stations with a total capacity of 3,800 MW would be put back into service in stages through to 2011. Forecasts indicate that power demand will grow by 4.2 % per year in the long term, giving rise to a need for additional power generating capacity of more than 1,500 MW per year. To date there are definite plans for new coal-fired power stations amounting to 6,000 MW. It is also assumed that about 1,000 MW of capacity could be built in the period 2007-2009 in the form of combined heat and power plants based on renewable energy and waste incineration.

15.2 Market Actors

Eskom

Eskom is the dominant electricity supply company on the African continent. It is responsible for almost all electricity generation in South Africa, for all electricity transmission, and (still) for a considerable proportion of electricity distribution.

Independent power producers

Independent power producers still operate on the sidelines at present. Their share in total electricity generation amounts to only about 3 %. Producers using renewable energy sources in particular have hardly made any headway in the past due to Eskom's low electricity prices and the lack of any government support. However, the South African Government has announced greater support in the coming years, especially for those private producers which generate electricity from renewable energy.

Distribution sector

The distribution sector, which comprises Eskom and municipal utilities, has so far been characterised by a large number of actors. However, many of the 185 municipal and other distribution companies (2004) are unable to operate efficiently and cover costs due to the fact that they have only small numbers of customers[10] and low tariffs.

Restructuring at the distribution level was introduced following a decision taken by the national cabinet in May 2001, with the effect that in future only six urban distributors and one nationwide rural distributor (Regional Electricity Distributors – REDs), each with a standardised tariff structure, will distribute electricity to final customers. To achieve this, the municipal distribution companies will be merged with the distribution network belonging to Eskom. In the wake of the Electricity Distribution Industry Restructuring Act, a state holding company (Electricity Distribution Industry Holdings – EDIH) was formed to implement the reform.

10 Numerous distributors have only between a few hundred and a few thousand customers.

The first distribution company within EDIH, regional electricity distributor RED One, began operation in Cape Town on 1 July 2005. The restructuring process in the distribution sector is supposed to be completed by about 2009.

Other Actors

Department of Minerals and Energy (DME)

The Department of Minerals and Energy (DME) is the ministry responsible for the electricity sector and therefore the most important political institution. It is responsible for energy planning, develops guidelines on energy policy and introduces programmes to develop the energy sector. It also has a significant role to play in the competitive tendering process for electricity generation projects involving independent power producers.

Department of Public Enterprises (DPE)

The Department of Public Enterprises (DPE) has oversight responsibilities for all state-owned enterprises. This includes the largest such entity, the electricity supply company Eskom. In this role the DPE works closely with the DME, which is responsible for energy policy, and the regulatory authority, to ensure optimum conditions for the state-owned enterprises and the economy as a whole.

National Energy Regulator of South Africa (NERSA)

Since July 2006 the former National Electricity Regulator (NER)[11] as set out in the Energy Regulator Act, 2004[12] has been responsible not only for the electricity sector but also for all piped and grid-linked energy sources, i.e. also for oil and gas, and was renamed as the National Energy Regulator of South Africa (NERSA).[13] The managing board is appointed by the DME but it operates independently. The core task of the NERSA is to issue licenses for electricity transmission, distribution and generation and to monitor and authorise tariffs. The authority is financed by a levy that has to be paid by the power producers and which can be passed on to all power consumers as a cost factor.

Since the new Electricity Regulation Act[14] came into force in August 2006, all power generating facilities require a licence. The only exceptions are electricity generation for the producer's own use and non-commercial electricity generation with no connection to the grid.

Up to 2004, NER had granted a total of 15 licences for electricity generation: one for Eskom, nine for municipal authorities and five for private producers (mainly sugar companies using bagasse). All in all these licences covered 51 power plants. Of the 17 coal-fired power stations, 10 belong to Eskom, four to municipal authorities and three to private producers. There are ten hydroelectric power stations, six of which are owned by Eskom and three by municipal authorities, while one plant is privately run. Of seven gas turbines, two belong to Eskom and five to municipal authorities.

11 Until 1 April 1995 its name was the Electricity Control Board.
12 Act No. 40 of 2004, in force since 15 Sept. 2005.
13 Formally the amalgamation took place earlier, on 1 Oct. 2005.
14 Act No. 4 of 2006.

15.3 Legal Framework

White Paper on Energy Policy

The White Paper on Energy Policy presented by the government in December 1998 sets out the most important energy policy goals and is at the same time the fundamental strategy paper for liberalising and privatising the electricity sector. Its core points are the free choice of electricity supplier by customers, the introduction of competition, especially in the generating sector, greater participation of the private sector, and open, non-discriminating access to the transmission system.

Reform of Eskom

The privatisation and unbundling of Eskom is set out in a legal framework plan by the Department of Public Enterprises.[15] Since July 2002 Eskom has been operating as a joint stock company, in which electricity generation, transmission and distribution form separate business divisions. In view of the anticipated electricity shortages, the original plan that Eskom should dispose of 30% of its generating capacity by 2006 and not add any new capacity itself for the time being has initially been put back.[16] Even without the part-privatisation of Eskom, however, the government is keeping to the plan to surrender 30% of the electricity market to independent producers in future. In the long term the transmission grid, too, is supposed to be transferred to a separate company in the ownership of the state.

Energy Act

The draft of a framework law for the energy sector (Energy Bill) was presented in 2004. This law, which has not yet been enacted, provides for the establishment of a National Energy Council, the preparation of systematic energy statistics, the introduction of regularly updated integrated energy planning, and programmes on energy efficiency, renewable energy and energy research.

In addition, the national energy efficiency strategy of 2004 targeted a reduction in total final energy demand of 12% by 2015. There are now signs, however, that such a reduction in consumption will not be achieved.

15.4 Policy Promoting Renewable Energy Sources

White Paper on Renewable Energy

According to the 1998 White Paper on Energy Policy, the South African Government aims to introduce focused promotion for the development, demonstration and implementation of renewable sources of energy for applications on a small and a large scale. A first strategy paper on the use of renewable energy was presented in 2000.[17] The approach was given a concrete form in the White Paper on Renewable Energy, which was adopted in November 2003.

With the adoption of this Paper the Government committed itself to a step-by-step expansion of the use of renewable energy to 10 TWh (or 0.8 Mtoe[18]) by 2013. This encompasses electricity generation from wind, solar, biomass and small-scale hydropower, along with solar thermal water heating and the use of biofuels. In addition to announcing financial incentives to be provided by national and international programmes, the Paper calls for the establishment of a comprehensive regulatory framework including appropriate tariff structures. A strategy paper on implementation was most recently announced for September 2005 but has not as yet been published. Also under discussion is the introduction of an electricity feed law which would lay down arrangements for paying for electricity supplied to the grid from renewable energy sources.

15 'Policy Framework: An Accelerated Agenda towards the Restructuring of State-Owned Enterprises', August 2000.
15 10% of the generating capacity is to go to enterprises owned by black South Africans as part of the Black Economic Empowerment strategy.
17 Department of Minerals and Energy, Implementation Strategy for Renewable Energy in South Africa, Draft 2, February 2000, and Strategy for Renewable Energy in South Africa, Consensus Draft, 19 March 2001.
18 Mtoe: Million tons of oil equivalent

National promotion programmes

Significant promotion of renewable energy sources for electricity generation has been provided since 1994, chiefly within the framework of electrification programmes for rural areas in conjunction with off-grid applications.[19]

At present there are no special rules for supplying and paying for electricity from renewable energy sources. The White Paper on Renewable Energy envisages a tendering model with long-term power purchase agreements. The NERSA has the task of devising the specific framework. In the course of further strategy development, however, it is also planned to consider alternative remuneration models. Given the current electricity prices of 1.6 to 4.4 euro cents/kWh (Eskom), though, at present there is little scope for electricity generation on the basis of renewable energy. In the longer term, however, it is expected that average generating costs will rise because of the building of additional power stations, so the competitive position of renewable electricity generation will improve.

A dedicated programme designed to promote renewable energy was first launched by the Department of Minerals and Energy for the 2005/2006 financial year, and is set to be continued through to 2007/2008 with a total budget of €1.6 million (14.2 million rand). For administrative reasons, however, it proved impossible to distribute the €0.5 million (4.5 million rand) available in the first year, apart from a very small amount. It is a requirement that the projects must have a minimum output of 1 MW (or an equivalent amount in the annual production of liquid fuels). The Renewable Energy Finance and Subsidy Office (REFSO) was set up within the DME to handle the programme.

SABRE-Gen Programme

In 1998 Eskom launched a programme to investigate the potential applications of renewable energy sources for grid-coupled electricity generation on a large scale and to test these in demonstration projects. The South African Bulk Renewable Energy Generation (SABRE-Gen) programme has four components:

- Use of biomass (SABRE-Gen BioEnergy)
- Generation of solar thermal electricity (SABRE-Gen Solar Thermal Electric)
- Use of offshore wave energy (SABRE-Gen Wave)
- Use of wind energy (SABRE-Gen Wind)

Central Energy Fund and other national finance providers

The particular objectives of the Central Energy Fund (CEF), set up in 1997, are to establish universal access to modern forms of energy, to increase the use of renewable energies, and to develop a local gas market.[20] In order to provide assistance and cover risks in the development and demonstration of new energy technologies, the Energy Development Corporation (EDC) was included as part of the CEF in January 2004.

One of the first major projects to receive assistance is the investment stake in the Darling wind farm.[21] The CEF (or EDC) is also the executing institution for an ongoing solar thermal project supported by the GEF. In the hydropower sector the EDC has entered into an agreement with the private investor NuPlanet to establish an independent power producer to exploit hydro energy. The joint subsidiary, Bethlehem Hydro, will build and operate a hydroelectric power plant with a total capacity of 3.9 MW.[22]

19 See section headed Rural Electrification.
20 For further information see www.cef.org.za.
21 See section headed Wind energy.
22 This project has also been registered as a CDM project.

The CEF group also includes the South African National Energy Research Institute (SANERI), which was founded by Ministerial Directive in October 2004. The Institute arranges for research to be conducted (mainly by third parties) in the energy sector – including on renewable energy – and in 2006/07 had a budget equivalent to € 4.2 million.

Further financial assistance is offered by the Development Bank of Southern Africa (DBSA), the Industrial Development Corporation and the Department of Trade and Industry.

Danish-South African programme

The four-year Capacity Building Project in Energy Efficiency and Renewable Energy (CaBEERE) was launched in August 2001 in cooperation between the South African and Danish governments. In addition to developing strategies for disseminating renewable energies and possible implementation measures on a policy level, the programme focused on implementing specific projects, building up a database with service enterprises and preparing fundamental sector studies.[23]

Prospects of a World Bank project

A project entitled Renewable Energy Market Transformation (REMT) is still in the preparation phase; it is supported by the GEF. In addition to institutional empowerment, this focuses on grid-coupled electricity generation and electricity production in the sugar and paper industries for in-plant use. A large proportion of the financial resources is to come from the Prototype Carbon Fund (PCF).[24]

Clean Development Mechanism

South Africa joined the Kyoto Protocol in July 2002. Because electricity generation has until now been based almost entirely on burning coal, South Africa has relatively high CO_2 emissions by international comparison at over 9 t per capita, and thus presents a good starting point for CDM projects.[25] In particular there are considered to be promising potential applications in small-scale projects in the field of power generation from renewable energy.

The Department of Environmental Affairs and Tourism (DEAT) is responsible for climate policy. A Designated National Authority (DNA) was set up within the DME at the end of 2004 to approve CDM projects at the national level.

Up to mid-2006, 20 projects had been submitted to the DNA for provisional assessment and 12 projects for approval. Six of the projects are concerned with the utilisation of methane gas on landfill sites, three with the use of biogas and four with the use of other forms of renewable energy for generating electricity. Three projects have been registered as CDM projects by the Executive Board of the UNFCCC in the meantime.

Project title	Date of UNFCCC registration	Equivalent CO_2 reduction per year
Kuyasa low-cost urban housing energy upgrade project, Khayelitsha (Cape Town; South Africa)	27.08.2005	Depends on project implementation
PetroSA Biogas to Energy Project	29.09.2006	29,310
Durban Landfill-gas-to-electricity project – Mariannhill and La Mercy Landfills	15.12.2006	68,833

Tab. 3: CDM projects registered with the UNFCCC in South Africa[26]

23 Further information is available from the DME at www.dme.gov.za.
24 The total funding amounts to US$ 165 million. Of this, US$ 103 million is to be provided by private sources, US$ 6 million each by the GEF and the South African Government, and US$ 50 million by the PCF.
25 According to Eskom's 2006 annual report, in the reporting period 920g of CO_2 were emitted per kilowatt-hour of electricity generated.
26 Source: UNFCCC 2006.

15.5 Status of Renewable Energy Sources

Renewable energies currently account for approximately 9% of South Africa's primary energy production. The most significant element within this is the traditional use of biomass (for example firewood) for cooking and heating.

Renewable forms of energy (mainly hydropower) only contribute just under one per cent to the country's electricity generation. In South Africa renewable energy sources are used primarily in off-grid installations. A lack of promotion and the low cost of generating electricity from coal are proving to be the main obstacles to the use of grid-coupled systems.

Hydropower

In 2005 the installed (nominal) capacity of run-of-river power plants amounted to 668 MW, of which Eskom produced 661 MW, mainly in two large hydropower plants. Of the six small hydropower plants (< 10 MW) with a total capacity of 15 MW, two were owned by Eskom and three by municipal utilities. The only private small hydroelectric power plant has a capacity of 3 MW.[27] The total installed capacity of micro hydropower systems is estimated at 0.4 MW.

Hydropower potential

Low precipitation, often only seasonal watercourses and frequent droughts and flooding restrict the potential for hydropower.[28] The realisable potential for hydroelectric power plants with a capacity of less than 50 MW is approximately 9.9 TWh. There are said to be between 3,500 and 5,000 potential locations for micro-hydro-power systems, chiefly located on the Eastern Escarpment.[29]

In isolated cases small plants are promoted within the context of rural electrification. It remains to be seen to what extent the announced strategy to promote renewable energy contains specific hydropower components.

Wind energy

The potential for wind energy is good, especially in the area of the long coastal strip and inland escarpments. The DME published a wind atlas for the first time in 1995. Measurements were conducted in Eastern Cape Province with EU support at the end of the 1990s. An average wind velocity of 6 m/s was measured at a number of different locations. At Cape Point average peak wind speeds of 9 m/s were recorded. A new wind atlas based on detailed data is being drawn up by Eskom within the framework of the SABRE-Gen programme. The annual wind energy potential is estimated at 26 TWh.[30]

Installed and planned wind farms

At present there is only one wind farm feeding electricity into the interconnected grid: a pilot wind farm belonging to Eskom in Klipheuwel, 50 km from Cape Town, consisting of three wind turbines from different manufacturers (rated at 660, 750 and 1,750 kW). The wind conditions at this location, however, are not favourable. Otherwise wind power plants are used to generate electricity in small village grids (totalling approximately 45 kW) and standalone off-grid systems (altogether roughly 500 kW).[31]

27 This private plant is located in Nelspruit in the province of Mpurnalanga and has proved to be a cost-effective, profitable project.
28 Further information on potentials and resources is available in the South African Renewable Energy Resource Database (SARERD): www.csir.co.za/environmentek/sarerd/index.html.
29 Source: DME: Green Power – Business Opportunities in South Africa for Renewable Energy Independent Power Producers. 2003. In the White Paper on Renewable Energy the potential is stated as 11 TWh.
30 Source: SARERD database.
31 Traditionally wind energy is mainly used in windmills for pumping water. Currently over 20,000 such installations are in operation, and with approx. 12 MW account for three-quarters of the installed capacity. See DME – Department of Minerals and Energy: Baseline Study on Wind Energy in South Africa; Final Report; Capacity Building in Energy Efficiency and Renewable Energy Program; February 2003.

A first relatively large, privately implemented wind power project near Darling (on the west coast) with a capacity of 5.2 MW is now set to be brought to fruition in 2007 after a lengthy planning period (the location was chosen as long ago as 1997). With a mean wind speed of 7.5 m/s at an elevation of 50 m and a capacity factor of 30 %, annual electricity production is estimated to be 13.3 GWh.

Under a long-term power purchase agreement (20 years) the city of Cape Town will buy the electricity and pay for it with an added premium on top of the normal purchase costs. In so doing the city intends to meet the commitment that it set itself to increase the share of electricity from renewable sources to 20 % by 2020. The city's own distribution company will transmit the wind-generated electricity to interested consumers as 'green electricity', with the price conditions set accordingly. Because of its status as a demonstration scheme, the Energy Development Corporation (a division of the Central Energy Fund) is also participating in the project, contributing € 2.1 million (19.3 million rand). If operation is successful and there is appropriate demand for 'green' electricity, the wind farm is to be expanded to 13 MW with a further six turbines.

Preliminary investigations are also being conducted at a former military base on Langefontain Farm. It is being considered whether to install 50 turbines of the 2.3-MW class there.[32] In addition to these major projects there are also investigations into the use of small wind power facilities in mini grids, often in hybrid operation with PV or diesel systems.[33]

With regard to the government's objective of supplying 10,000 GWh from renewable energy by 2013, however, wind energy has only a small role to play.

UNDP/GEF wind energy programme

The use of wind power in South Africa is accordingly still at the pilot or demonstration stage. A promotion framework for grid-coupled wind power plants is now supposed to be developed with the aid of international organisations. One such case is the programme launched in August 2001, the UNDP/GEF's South Africa Wind Energy Programme (SAWEP), which is being implemented in cooperation with the Danish organisation DANCED (Danish Cooperation for Environment and Development). The total costs are US$ 10.9 million, with a GEF subsidy of US$ 2.3 million.

The first phase, which ended in December 2006, focused on policy consultancy in respect of a regulatory environment for independent electricity generation, the development of financing mechanisms and support for local project developers. In this connection successful negotiations were held with Eskom on a power wheeling agreement which specifies the conditions for transmitting wind-generated electricity via the Eskom power grid. Contributions were also made to wind measurements, the performance of environmental studies, financing and grid access. The programme is now to be continued in a three-year second phase and then contribute to the construction of wind farms with a total capacity of about 45 MW.

32 See among others: DME, Baseline Study on Wind Energy in South Africa. Final Report. Capacity Building in Energy Efficiency and Renewable Energy Program. February 2003. Or also Winkler, Harald; Renewable energy policy in South Africa: Policy options for renewable electricity; Energy Policy; online version 2003.

33 This includes the Lubisi Dam Community Project, in which two imported 2.2-kW small wind power systems were installed in combination with PV systems. In the Hluleka Nature Reserve two 2.5-kW wind power installations together with PV systems and diesel generators support the electricity and water supplies to a small settlement.

Biomass

Measured against total primary energy production, biomass in the form of fuel wood, wood wastes, dung, bagasse and charcoal ranks very high. These energy sources cover 60 % of the energy consumption of private households.

So far only sugarcane bagasse is of any relevance in power generation. In 2004 it accounted for 414 GWh or about 0.2 % of all the electricity generated. Bagasse is used directly in the sugar factories to fuel combined heat and power stations. At present the electricity produced there is largely used within the plants (221 GWh) and only a smaller proportion is fed into the grid (192 GWh). In 2004 five bagasse-fired plants with a total capacity of 105 MW had licences; all were owned by independent power producers.

Biomass potential

At present (latest figures: 2004) only about a quarter of the electricity generation potential of bagasse is exploited.[34] In addition, wastes from sawmills and paper mills could contribute 7,600 and 4,500 GWh respectively to electricity supplies each year. The annual energy potential of harvest residues is 341 GJ, and residues from livestock breeding could contribute some 5,600 GWh to electricity production.[35]

Biogas

So far there has been hardly any production of biogas from sewage or solid wastes, but this option certainly has potential. The energy content of the domestic and industrial solid wastes generated in 1990 amounted to 40.5 PJ. Methane obtained from sewage could contribute 36 MWh annually to electricity supplies.

The portfolio of the World Bank's Prototype Carbon Fund (PCF) includes a South African landfill gas project. In the city of Durban,[36] CO_2 certificates will be earned following successful implementation of a project converting methane gas from two landfill sites into electricity, and sale of the certificates to the PCF has been contractually agreed. Initially the captured gas is to be converted into electricity in generators rated at 0.5 MW each. If the yield is good, the possibility of a subsequent doubling of capacity is not ruled out.

Solar energy

With average daily solar irradiation of 4.5 to 6.5 kWh/m^2, South Africa has excellent conditions for solar energy applications. The solar radiation values were recorded in a database and published on a map.[37]

Use of solar energy for electricity generation

The total installed PV capacity is approximately 12 MW$_p$, of which only about 150 kW is attributable to grid-connected systems. In addition to solar home systems (SHS), distributed facilities are used for telecommunications and water pumps as well as for schools and hospitals.

Eskom planned to carry out non-grid-coupled electrification of 16,400 schools and some 2,000 hospitals by 2005. The schools were to be equipped with an average PV rating of 500 W, while larger systems were planned for rural hospitals.[38] Financing was made available through national and international promotion schemes. KfW (KfW development bank) participated in this part of the programme with a contribution of € 9.5 million.

34 Every year some 7 million tonnes of bagasse are produced. Given an output of 200 kWh/t achieved using modern combined-cycle power plants, the calculated potential would be 1,400 GWh.
35 See SARERD database.
36 New name: eThikwini.
37 See SARERD database.
38 The electrification programme for rural hospitals with renewable sources of energy is being headed by the Independent Development Trust (IDT).

Concession programme for 350,000 solar home systems

The provision of small PV systems for isolated supply units in areas that cannot be cost-effectively connected to the national grid is an essential element of the promotion programme for the electrification of rural regions.[39]

At the beginning of 1999 a promotion programme was launched to install a total of 350,000 SHSs, each rated at about 50 W_p. In each of seven regions, 50,000 systems are being installed and looked after by a private concessionaire for each region. The concessions are to be obtained through competitive tendering, and the SHSs are owned by the concessionaires. Between 60 and 80 % of the capital costs are covered by subsidies amounting to ZAR 3,500. Whereas in Eastern Cape Province the remaining costs have to be borne in full by the users (ZAR 58 per month) through fees (fee-for-service model), in other provinces an additional ZAR 40 per user is paid from a government funding pot. Despite this considerable assistance, because of bad experience in some cases in the past SHSs are only installed in households with regular incomes. The monthly fee is usually paid in advance, and this is required in order to activate the power supply.

To date, concessions have been granted in the following regions:

- Solar Vision Ltd. (northern Limpopo)
- Nuon-Raps Utility Ltd.[40] in northern KwaZulu-Natal (8,000 systems 2005-2006)
- KES KwaZulu Energy Services Company (65 % EDF, 35 % Total Fina Elf) in the interior of KwaZulu-Natal: 15,000 households by the end of 2006; about 10,000 households had been equipped by the end of 2005.
- Shell-Eskom in the northern part of Eastern Cape and in southern KwaZulu-Natal
- Renewable Energy Africa (central Eastern Cape)

One of the first concessionaires was the Shell-Eskom joint venture. In its first phase this joint venture tackled the electrification of 6,000 households in Eastern Cape Province during 1999 and 2000. Of the 6,000 systems, only 4,700 were still in operation in 2002. The systems, known as Powerhouse systems, were provided to the households for a one-off payment of € 16.50 (ZAR 150). The users have to buy a magnetic card costing about € 7 to activate the system. The credit on the card is used up after about 30 days and the card has to be recharged. The fees include full maintenance of the system, including battery changing. However, socio-economic and technical factors have prevented the programme from running smoothly.[41]

KfW is contributing € 15.9 million to the investment costs for 27,000 SHSs in two areas, Eastern Cape and North West Province. As yet, though, no contract has been signed with a concession partner.

Use of solar thermal energy

Despite high daily solar irradiation rates averaging between 4.5 and 6 kWh/m^2, the use of solar thermal energy to date has been marginal. The primary cause of this has been the very low and partly subsidised electricity prices, which promote the use of electricity for heating water. On the other hand there is growing interest in reducing the peak loads caused at certain times of day by electric water heaters, among other things by replacing them with solar heaters. Until now almost the only types to have been used are unglazed solar absorbers for heating swimming pools, while the market for glazed collectors for heating water for domestic use is dormant.

39 See section headed Rural Electrification.
40 A joint venture between the Dutch power utility Nuon and the South African company Rural Area Power Solutions Ltd. (RAPS).
41 The many thefts and a lack of willingness to pay have proved problematic. Furthermore, the prepaid card technique proved to be complicated and liable to faults. Shell is considering a new distribution model (Neue Energie, 09/2003, p. 110).

A project with the title Solar Water Heaters (SWHs) for Low-Income Housing in Peri-Urban Areas is currently being implemented, with subsidies from the GEF.[42] This project was preceded by pilot schemes with 100 low-cost solar hot water systems in townships of Durban and Johannesburg. In addition to expanding the solar thermal market, the purpose of the ongoing project, which is being implemented by the Central Energy Fund, is also to raise standards in manufacture and installation and to put appropriate financing mechanisms in place.

A market analysis was performed as the first step. Furthermore, new standards were developed for collector manufacture and for the training of installation engineers, and a test bed was acquired on which to carry out quality assurance and certification of collectors. 500 solar systems are now to be installed in a first project phase, primarily on newly built houses. A second phase is planned in which 9,000 systems are to be installed. The project is being handled in close collaboration with the FINESSE programme (Financing Energy Services for Small Scale Energy Use).

It is also aimed to equip houses with solar thermal systems in low-income townships of Cape Town through a CDM project that has already been registered. This involves both retrofitting to existing buildings and installation in – potentially – several thousand new homes. Some 2,300 systems are supposed to be fitted in the first stage. In mid-2007 it is expected that a directive will come into force in Cape Town which would make it obligatory to fit new buildings with solar hot water heaters.

ESKOM is also investigating the benefits of solar hot water heating in a research project, and is looking to a demand-side management project for the domestic sector to reduce electric peak load.

15.6 Rural Electrification

The proportion of rural households with an electricity supply rose from 21 % in 1995 to 54 % in 2005. Most of the non-electrified households are in the provinces of KwaZulu-Natal and Eastern Cape.

Integrated National Electrification Programme

The Integrated National Electrification Programme (INEP) unites the formerly separate electrification measures that were carried out by NER and Eskom. It has been running since 2001, with the DME taking over responsibility for it in April 2002. The aim is for all households to be provided with an electricity supply by 2012. The electrification programme is being financed by international donors and via the National Electrification Fund, which is fed directly from the national budget and is watched over by the DME.

In the 2004/2005 financial year more than € 110 million (ZAR 1 billion) was available from this programme, which enabled over 217,000 households and around 2,300 schools and health centres to be electrified. Only a very small part of this (ZAR 22.4 million = € 2.5 million) was used for solar home systems in private households (see above). In 2004 some 170,000 new connections were installed by Eskom alone, more than 74 % of them for rural households.

42 Total cost € 5.43 million, GEF subsidy € 0.73 million.

In the 2005/2006 financial year the budget amounted to almost € 130 million (ZAR 1.2 billion). This was enough to connect over 151,300 households, almost 500 schools and 28 health centres to the electricity grid. Nearly € 6.6 million (ZAR 60 million) was used for the provision of non-grid-coupled supply to households in the provinces of KwaZulu-Natal and Limpopo. The budget of almost € 8.8 million (ZAR 80 million) originally intended for these purposes could not be fully utilised, among other things because there were not enough solar modules available on the world market.

Almost € 154 million (ZAR 1.4 billion) was available for electrification for the 2006/07 financial year, including € 43 million (ZAR 391 million) for direct transfers to municipal authorities.

Exchange rate (December 2006):
1 South African rand (ZAR) = 0.11 euro (EUR)

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16 Tunisia

16.1 Electricity Market

Installed capacity

In 2005 the installed power plant capacity in Tunisia totalled roughly 3,300 MW. Of this, 3,170 MW (97 %) was provided by thermal power stations, 62 MW (2 %) by hydroelectric power and 20 MW (less than 1 %) by wind generating plants.

Type of power plant	2002	2003	2004	2005
	MW			
Thermal (steam) power plant	1,145	1,145	1,145	1,145
Combined-cycle gas turbine	364	364	364	364
Gas turbine	804	804	922	1,163
Hydropower	62	62	62	62
Wind power	10	19	19	19
STEG[1] total	2,385	2,394	2,512	2,753
IPPs[2]	471	498	498	498
Total capacity, national	**2,856**	**2,892**	**3,010**	**3,251**

Tab. 1: Installed power plant capacity; Tunisia; 2002–2005; MW[3]

For some years now the state-owned power utility Société Tunisienne d'Electricité et du Gaz (STEG) has primarily relied on gas-fired power plants for generating electricity, fuelled by natural gas from the country's own reserves and by imports from Algeria.[4] 11 % of the installed capacity comprises combined-cycle gas turbine (CCGT) power plants. Independent power producers feeding electricity into the public grid account for approximately 500 MW (15%) of the nationally available capacity.

In 2005 the peak load in public supply was 2,172 MW. This has risen by about 100 MW per year since 2001.

By 2011 the total power generating capacity is supposed to be expanded to 4,400 MW in order to meet the growing demand for electricity. As well as adding new thermal power plants, the government envisages promoting renewable energy to play a part in the provision of the requisite production capacity.

Power generation

Annual electricity production in Tunisia amounted to approximately 13,300 MW in 2005. Of this, about 7 % was produced by self-generators for their own purposes. The remainder came from power stations on the public grid, including independent power producers (IPPs). 80 % of Tunisia's electricity was generated from natural gas in 2005, and 20 % from heavy oil.[5] 76 % of the natural gas consumed in Tunisia in 2005 went into the production of electricity, with 24 % being used by industry and households.

	2001	2002	2003	2004	2005
Production (GWh)	10,853	11,281	11,830	12,454	13,006
Consumption (GWh)	8,751	9,085	9,542	9,991	10,353

Tab. 2: Electricity production (incl. IPPs and self-generation) and consumption; Tunisia; 2001–2005; GWh[6]

Power transmission and distribution

Tunisia has a well developed electricity grid, to which more than 99 % of households in the country are connected. In 2005 the transmission system operated by STEG consisted of some 5,300 km of high voltage power lines, 46,000 km of medium voltage lines and 84,000 km of low voltage lines. It is connected to the European power grid via the grids in Algeria and Morocco. To the east, the Tunisian power grid is linked with Libya. The aim is to establish a North African interconnected grid that would extend through Egypt and Jordan as far as Syria.

1 Société Tunisienne d'Electricité et du Gaz (STEG).
2 Independent power producers (IPPs).
3 Source: STEG Annual Report 2005.
4 The natural gas occurring in the country is exploited by international companies under contract, and its price is dependent on the exchange rate with the dollar. The price is linked to oil prices on the international market, with a reduction of 15 %. Until now the petroleum and natural gas used in the thermal power stations has mostly originated from Tunisian sources. All in all, however, Tunisia has to import 60 % of the crude oil and derivates that it requires.
5 Source: L'Energie No. 68, October/November 2006.
6 Source: Tunisian Statistical Office 2006.

Electricity consumption

Almost all of STEG's 2.7 million electricity customers are connected to low voltage lines, with only 14,000 customers using medium voltage and just 18 customers a high voltage connection. Altogether they used 10,353 GWh of electricity in 2005. Almost 57 % of this (5,948 GWh) was supplied as high or medium voltage to business customers in various sectors: industry (3,714 GWh), agriculture (350 GWh), infrastructure (420 GWh), transport (237 GWh), tourism (607 GWh) and services (620 GWh). The remaining 43 % was low voltage power sold to end consumers primarily in commerce and the domestic sector.

Higher living standards have led to a considerable rise in consumption by private households, which grew by 30 % in the period from 2000 to 2005. Ninety per cent of households have TV sets. Refrigerators are now to be found in 82 % of all households, and account for about 40 % of private electricity consumption. The targeted promotion of energy-saving measures through energy audits in industry and the spread of energy-efficient domestic appliances enabled electricity consumption to be reduced by about 370 GWh in 2005. In the course of implementation of the 11th five-year plan, these savings are supposed to rise to 2,300 GWh per year by 2011, equivalent to almost 18 % of the forecast power consumption of 13,000 GWh for that year.

Electricity prices

Electricity prices are set by the Ministry of Industry, Energy and Small and Medium-sized Enterprises on the basis of proposals submitted by STEG. By international standards, the electricity tariffs are low. They are broken down in two ways: firstly according to voltage level and type of use[7], and secondly according to the time of use. In the low voltage sector the tariff structure has a progressive component.[8]

	Daytime tariff €-ct/kWh	Night-time tariff €-ct/kWh
High voltage sector	3.41	2.66
Medium voltage sector	4.96	4.96
Low voltage sector		
0–50 kWh/month	4.01	4.01
› 50 kWh/month	6.72	6.72

Tab. 3: Standard electricity tariffs, unit rate (not including taxes); Tunisia; 2006; € cents/kWh [9]

The Tunisian Government manages to keep electricity prices low by subsidising the price of natural gas to the tune of twenty per cent. For a number of years now the cost of this state subsidy has risen sharply along with global market prices for crude oil, and is an increasing burden on the Tunisian budget. In 2005 for example, about € 930 million (1.5 billion Tunisian dinars) was spent on compensatory payments to stabilise energy prices, accounting for roughly 15 % of state expenditure or 4 % of gross domestic product.

7 For example domestic, agriculture, irrigation, air conditioning.
8 A detailed overview of the current tariffs is provided on the website of the Tunisian state energy supply company. See: www.steg.com.tn.
9 Source: STEG 2006.

16.2 Market Actors

STEG – Société Tunisienne d'Electricité et du Gaz

The electricity supply business in Tunisia is dominated by the state-owned enterprise STEG, which is answerable to the Ministry of Industry and Energy. It is still responsible for supplying electricity and gas to all Tunisian customers, apart from the autonomous electricity suppliers. As well as the power grids, STEG operates most of the Tunisian power stations and extracts the natural gas itself from four of the country's five gas fields.

In view of the high rates of growth in demand for electricity, STEG lost its state monopoly in power generation in 1996, with the market being opened for independent power producers (IPPs). IPP projects have been permitted since Decree 96-1125 was issued, although they must be awarded within the framework of an international tendering process. Since 1999 it has also been permitted for gas extraction companies to operate gas-fired power plants without a preceding bidding procedure and to sell the generated electricity to STEG.[10] Despite the opening of the generating market, even in 2005 it was still the case that 85 % of national electricity generating capacity belonged to STEG, while only 15 % was operated by independent producers.

Other Actors

Ministry of Industry and Energy; CSPIE and CIPIE

The Ministry of Industry and Energy, or its Directorate General for Energy, draws up plans for expanding the energy infrastructure and implements the energy policy adopted by the government. Most of the state actors in the energy sector are answerable to the ministry. These also include two commissions: the 'Commission Supérieure de la Production Indépendante d'Electricité' (CSPIE) and the 'Commission Interdépartementale de la Production Indépendante d'Electricité' (CIPIE), which were both set up in 1996. The Ministry of Agriculture, Environment and Water Resources is responsible for the exploitation of hydropower.

The CSPIE decides on the procedures and selection criteria for public tender processes and awards contracts to independent power producers. It also passes rulings on the granting of tax incentives for investors. The interministerial CIPIE carries out preliminary work for the CSPIE by selecting projects for tendering, preparing bidding procedures, evaluating offers, flanking the contractual negotiations between the independent producers and the Energy Ministry, and securing the granting of public subsidies on a case-by-case basis.

National Energy Agency (ANME)

The former Tunisian agency for renewable energies, the Agence Nationale des Energies Renouvelables (ANER), was founded in 1985. Under Law No. 2004-72 of 2 August 2004, the national Tunisian energy agency, the Agence Nationale pour la Maîtrise de l'Energie (ANME), succeeded the ANER and took over all its functions. The ANME is answerable to the Ministry of Industry and Energy and is tasked with translating its policy directives into practice. These include securing Tunisian energy supplies in the long term. The agency is meant to approach this in two ways: on the one hand by working towards a wide-ranging increase in energy efficiency, and on the other by helping to develop new energy sources. Its activities extend from scientific research and the preparation of studies to training experts and raising awareness among the population, and also embrace engagement in international cooperation. Renewable forms of energy are a focal area of its work. The agency employs roughly 100 people, and is funded partly from the Tunisian national budget and partly from donations and external lenders. Since 2003 the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) has worked with the ANME within the framework of a project on the promotion of renewable energies and rational energy use, providing support in the fields of planning, project management and quality assurance and on matters relating to innovative energy-saving technologies and the harnessing of renewable energy sources.

10 Law No. 99-93 of 17.8.1999: Portant promulgation du code des hydricarbures.

Tunis International Centre for Environmental Technologies (CITET)

1996 saw the founding of the Centre International de Technologies de l'Environnement de Tunis (CITET), which has the task of disseminating and promoting environmental technologies. It is answerable to the Tunisian Ministry of the Environment. In addition to providing a range of advisory and training services, it also has laboratory and development capacity at its disposal. A library and an extensive online presence serve the purpose of documenting and disseminating information relating to environmental matters. The CITET is involved in numerous cooperation projects, including international projects. Together with the CITET and two other German partners, the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) is running the IHK/GTZ Company Pool on Environmental Technology in Tunis, which has set itself the goal of supporting small and medium-sized European companies from the environmental technology sector in gaining access to the market in Tunisia and other Maghreb countries. The target group comprises companies with at least a medium-term interest in the promotion of further-reaching cooperation with Tunisian partners (for example in the form of licensing, technology cooperation or joint ventures).[11]

16.3 Legal Framework

Since the early 1980s the Tunisian Government has contributed to the promotion of rapid economic and social development in the country by adopting legislation implementing appropriate energy policy. In the year 2000, for the first time the country's own oil and gas deposits were no longer sufficient to meet the higher demand for energy that was rising along with economic growth. Instead of potential additional funding of economic growth in Tunisia from income generated by energy exports, the country found itself dependent on the international crude oil price. As a consequence, from 2001 onwards the government increasingly developed strategies aimed at the rational use of energy and diversification of energy supplies. In addition to adopting new legislation and Presidential decrees, the government also made considerable improvements to the institutional, financial and organisational framework for sustainable energy use. The two most important components are described in the following.

Law No. 2004-72

Law No. 2004-72 on the rational use of energy defines the sensible use of energy as a national priority and as the most important element of a sustainable development policy. It states three principal goals: energy saving, the promotion of renewable energy and the substitution of forms of energy previously used, wherever this offers technical, economic and ecological benefits.

Article 14 lists four areas in the field of renewable energy which are to be treated as priority areas of a national promotion programme:

1. Expansion of wind power for electricity generation
2. Introduction of incentives for the use of solar thermal energy
3. Use of solar energy for further electrification of rural areas, irrigation and seawater desalination
4. Encouragement of the greater use of production residues for energy generation and of geothermal springs and small-scale hydropower plants.

11 Contact: Dipl.-Ing. Mohamed Cherif, Company Pool Manager, eco-forum@citet.nat.tn.

Law No. 96-27

The door to private-sector involvement in the electricity sector was opened with the adoption of the law on demonopolisation of the state-owned power utility STEG of 1996 (No. 96-27). Fundamentally this allows private companies to generate electricity if they are successful in a bidding process, and to sell that electricity to STEG as a single buyer. The detailed terms and procedures for the granting of concessions to private generating companies were laid down in ordinance no. 9661125 of 20 June 1996.

Despite these initial steps in the direction of opening of the market, the electricity sector in Tunisia is still largely subject to state control and only geared to competition to a limited extent. To date, as is the case with conventional power stations, electricity from renewable energy sources can only be fed into the STEG grid on the basis of tendering processes and individual contracts between the private producers and STEG.

As yet there are no standardised arrangements governing the terms and tariffs according to which independent power producers are able to feed their electricity into the STEG grid. Private operators have to arrange these matters on a case-by-case basis through a contract with STEG. As a general rule, STEG is prepared to purchase surplus electricity from companies for which power generation is merely an ancillary activity, not their primary business. If electricity generation is a company's main activity, STEG is not obliged to purchase the electricity, although it can do in the context of an individual contractual arrangement.

16.4 Policy Promoting Renewable Energy Sources

The Tunisian energy agency ANME states that its work on promoting renewable energy focuses on two areas: solar thermal energy for water heating, and wind power for electricity generation. In the solar thermal sector the government target is an installed collector area of 500,000 m^2 by 2009. Towards this aim, the PROSOL promotion programme has been running since 2005. In the case of wind power, the existing capacity (20 MW) is supposed to be increased to 155 MW by 2009. The government is relying on private investors and international promotion, for which it also intends to create favourable conditions within the context of the CDM.

Fiscal and other incentives

As yet there is no specific legislation in place in Tunisia to promote electricity production from renewable energy sources. Investors can, however, generally benefit from tax and customs duty relief. Customs duties can be reduced from a general rate of 18 % to the minimum rate of 10 %. Value-added tax can be reclaimed entirely for imported goods if they cannot be manufactured in Tunisia, and for locally produced capital goods. As well as this, in specific cases income taxes can be remitted for up to five years and investment subsidies can be granted.

The Tunisian state can also contribute to the costs of expanding the infrastructure. If a project is considered to be particularly important on account of the magnitude of the amount invested or the number of jobs created in Tunisia, the state can also make the required land available at a symbolic price. Decisions on concessions of this nature are taken by CSPIE.

Clean Development Mechanism

Although Tunisia can be considered a model for other African countries in terms of its environmental and energy policy, the CDM sector is still in its infancy. To date there are only two landfill gas projects that have been successfully registered with the CDM Executive Board; these are being implemented with Italy as the partner country.[12]

The Tunisian authorities have recognised the opportunities presented by the CDM, however, and are planning a huge expansion of such activities. In the period up to 2011 the plans envisage projects that, taken together, are supposed to achieve savings of 12.7 million tonnes of CO_2 equivalents. The planned reductions in greenhouse gases are supposed to be shared roughly equally between the energy and waste sectors. According to the government's CDM strategy, it is intended to develop about 360 projects by 2011, equivalent to an average of 60 new projects per year. Efforts are to be focused on the following areas: waste management, wind power, combined heat and power, energy efficiency for bulk consumers, fuel switch, industrial process technology, and optimisation of oil and gas extraction.[13]

The Tunisian Designated National Authority (DNA) for the CDM has been set up within the Ministry of the Environment, and has had official statutes and rules of procedure in place since mid-2006. So far there is no information available on approval procedures for project developers or certificate buyers.

The Tunisian energy agency ANME is a competent point of contact for CDM projects, and is also able to provide financial support for the development of CDM projects.

GTZ has advised Tunisia on building up capacity for implementing CDM activities since early 2006. Important project executing agencies such as the national energy supply company STEG, the state-owned Groupe Chimique Tunisien and the oil company Entreprise Tunisienne d'Activités Pétrolières (ETAP), likewise state-owned, are also to be brought in as part of this initiative.

Most of the future CDM projects in Tunisia are likely to be implemented in cooperation with one of these three principal actors in Tunisia's industrial and energy sector.

16.5 Status of Renewable Energy Sources

Apart from centralised electricity generation from hydropower, the use of renewable energy to produce electricity is still at an early stage of development in Tunisia. One focus of attention is currently wind energy, although the utilisation of solar energy for thermal purposes is also gaining in importance.

Hydropower

145 GWh of electricity was generated from hydropower in 2005, or 1.6% of the total produced by the state-owned energy supplier STEG. At 62 MW, hydropower accounts for about 2% of the country's installed capacity.

The Sidi Salem dam is the most important hydroelectric power installation in Tunisia, and has been in operation since 1982. With an installed capacity of 36 MW, it produces 40 GWh of electricity per year.

In future, with the planned expansion of renewable energy, particular emphasis is to be placed on the use of small-scale hydropower schemes. Nine sites for such plants have been identified in the course of a development programme: Barbara (3 MW), Sidi Saad (1.750 kW), Siliana (850 kW), Bejaoua (750 kW), Medjez el Bab (250 kW), Nebhana (500 kW), Sejnane (1 MW), Bouhertma (1,2 MW) and Khanguet Zezia (650 kW). The total capacity of the programme is supposed to be 10 MW (60 GWh/a). According to a study from 1993, the total potential for hydropower in Tunisia is some 1,000 GWh per year, although realistically only about a quarter of this is technically utilisable.[14]

12 As at: December 2006, http://cdm.unfccc.int/Projects.

13 Amous, Samir, Strategie nationale pour la mise en oeuvre du mecanisme pour le developpement propre en tunisie, Rapport final, Ministere de l'environnement et du developpement durable, Tunisia 2005.

14 Source: International Small-Hydro Atlas.

Wind energy

Greater use of wind energy has been a declared primary goal of Tunisia's energy development programme since 2001. There is still no nationwide wind atlas for the country, however, although one is currently being drawn up, and measuring stations have already been installed for that purpose. The national energy agency ANME has conducted a series of pilot measurements with international support. These attest that the conditions for harnessing wind energy in Tunisia are good. The total on-shore potential is estimated at approximately 1,000 MW.[15]

Site analyses in the north and northeast of the country revealed potentials of 300 MW in regions with wind speeds between 7 and 10 m/s.[16]

Although initial experience with small turbines was gathered in Tunisia as long ago as the early 1980s, the commercial use of wind power for electricity generation has only just begun. In the past, wind energy has mainly been used on a decentralised basis, for example for pumping water as part of field irrigation schemes in remote regions.

Sidi Daoud wind farm

Until now only one wind farm has been built, in Sidi Daoud (Gouvernement Nabeul) near Cap Bon. It has been in operation since 2000. Average annual wind velocity at this location is 8.4 m/s at a height of 30 m. The systems were partly (20 %) financed from STEG's own funds, with 80 % coming from a Spanish loan. The contract for the turnkey erection of the turbines, valued at US$ 9.7 million, was awarded to the Spanish manufacturer MADE. The wind farm is operated by STEG, and with 32 turbines each rated at 330 kW it initially had a generating capacity totalling 10.6 MW. In 2002 this was used to generate 30 GWh of electricity. In 2003 the wind farm was expanded by the addition of twelve turbines with a capacity of 8.7 MW for US$ 8.2 million. It now has a total generating capacity of almost 20 MW, thus representing about 0.6 % of the country's installed capacity.

In 2005 the wind farm generated 42.4 GWh of electricity, which was almost 0.5 % of Tunisia's total production. STEG is planning a second expansion, by 34 MW, for 2007. At the end of this third project stage the total installed capacity at the wind farm will be 55 MW. Since it first entered service, the wind farm has enjoyed a proven technical availability of over 95 %.

Site analyses

Various organisations (STEG, GTZ, private companies) have conducted, financed or promoted measurements to investigate further possible locations for wind farms in Tunisia, and are continuing to do so.[17] GTZ together with ANER has examined three locations in more detail to determine their suitability for siting wind farms. The locations in question are Enfida on the east coast, Zargis south of the island of Djerba, and Cap Negro on the north coast. With support from UNDP, locations were evaluated on the Cap Bon peninsula, a plateau south of Thala in the centre of the country, and a site near to Kebeli in southern Tunisia. Preparations are also being made by large-scale industrial consumers to use wind generators to produce their own electricity. The first step involves eight cement works, where the necessary measurements are being taken so that the companies' own needs of 60 to 80 MW can be met by wind generators on or near the premises.

15 Source: Global Environment Facility: Development of On-grid Wind Electricity in Tunisia for the 10th Plan.
16 Source: African Wind Energy Association – AfriWEA.
17 For example at the Jebel Sidi Abderrahmane location in the region of Cap Bon, where STEG measured average wind velocities of over 10 m/s at a height of 45 m, and at Métline in the region of Bizerte, with an average of 9 m/s at a height of 30 m.

International projects

A project with international partners aimed at strengthening technical capacities in the wind power sector was launched in Tunisia in 2001. The purpose of the project was to develop grid-coupled and off-grid wind power installations (including a partial investigation of wind potentials) and to throw light on the regulatory framework conditions. In this connection, the Canadian consulting company Hélimax together with a local partner completed a strategic study into the expansion of wind power in 2003. Before that, too, Hélimax also compiled an economic study into the possible establishment of a wind industry in Tunisia, a training manual on wind energy and a baseline study for a CDM project in the wind sector. Subsequent to this initiative an official GEF promotion project[18] was agreed upon in 2003.

UNDP/GEF project in cooperation with GTZ

In November 2003, UNDP decided to implement a project with GEF assistance under the title 'Development of On-Grid Wind Electricity in Tunisia for the 10th Plan', which was designed to run for eight years. The project began in 2004 and is being executed in cooperation with GTZ. Within the framework of this project, which targets the large-scale exploitation of wind energy, it is planned that private investment of more than US$ 100 million should be funnelled into the wind sector. The funds provided by the GEF amount to US$ 10.25 million.

The institutional, regulatory and operational capacities of the key institutions are to be strengthened through technical assistance. The 100 MW of additional capacity that is to be built in the coming years is to be supported by production-dependent financial assistance in the first five years of operation. Based on avoided costs of 0.037 TD/kWh and 35 % availability of the wind farm, at present the additional costs are expected to be 2 to 3 US cents/kWh, about a quarter of which are to be covered by GEF funds.

The Tunisian Government anticipates that private investors will be in a position to finance the remaining additional costs through subsidised export credits or emissions certificates. The government intends to provide only tax concessions as its own contribution to meet the funding shortfall.

The share of assistance contributed by GTZ within the project as a whole consists of site analysis, consultancy services to the Tunisian Government on matters relating to grid integration, tariff structuring and preparation of and backup support for the bidding procedure. In addition, GTZ aims to help ensure that a high quota of local value added is achieved by providing technical assistance to domestic manufacturers.

Future wind power plans

As part of its 10th development plan (2003-2007) the Tunisian Government is planning the construction of wind farms with a capacity of about 120 MW. The construction of a further 200 MW by private investors on a purely competitive basis is envisaged for the period from 2008 to 2011 under the 11th development plan.

A strategic study into the development of renewable energy in Tunisia conducted on behalf of ANER in 2004 provides an assessment of the potential seen in wind energy.[19]

18 GEF Project ID 967, UNDP PMIS ID 2129.

19 ANER Groupement ALCOR-Axenne: Etude Stratégique sur le Développement des Energies Renouvelables en Tunisie Aux Horizons 2010-2020-2030, Tunis 2004.

Wind power	2010	2020	2030
Installed capacity [MW]	310	1130	1840
Production [TWh/a]		2.8	4.6
Primary energy saved [TWh/a]		8.1	14.0
Resultant saving of CO_2 [mill. t CO_2e]		1.5	2.8
Primary energy saved (aggregated) [TWh]	10.5	64.0	186.0
Resultant saving of CO_2 (aggregated) [mill. t CO_2e]	2	13	37

Tab. 4: Estimation of wind energy potential; Tunisia[20]

Tendering for three new wind farms

The deadline for an international call for tenders (N° 2006 E 4025) from STEG for three new wind farms in Métline, Kochbate and Ben Aouf expired in December 2006. Altogether the capacity of these wind farms is supposed to be 120 MW. The object of the tendering process is firstly the turnkey construction of the installations and secondly a five-year operator contract.

Biomass

There are hardly any plants in Tunisia for the direct conversion of biomass into electricity. In Hammam Sousse a plant has been run since July 2000 under Tunisian-Chinese cooperation which produces biogas from waste from poultry breeding on an industrial scale, and converts the gas into electricity. The plant can process three tonnes of poultry manure per day, and from this it produces approximately 200 m^3 of biogas, which it converts into 300 kWh of electricity. A small biogas plant was set up at a cattle breeding farm in Sidi Thabet for training purposes. The national energy agency's biogas programme also mentions 50 small plants producing biogas in the northwest of the country.

Solar energy

Solar irradiation in Tunisia ranges between 1,500 and 1,900 kWh/m^2 annually. The length of sunshine is 2,800 to 3,200 hours/year or 255 days/year. The conditions for utilising solar energy are therefore good.

Photovoltaics

There has been a national programme aimed at rural electrification with photovoltaic systems since the 8th development plan (1992-1996). Since then, 11,000 remote farms have been electrified and 200 rural schools supplied with solar electricity. Solar-powered surface wells and public lighting systems have also been installed.[21] A further 2,000 settlements are to be equipped with PV systems in the future. Other applications for solar-generated electricity are also supposed to be developed in the fields of water supply and desalination.

Solar thermal energy

Solar thermal systems for heating water have been installed in Tunisia since 1982. By the mid-1990s the total collector area had reached 30,000 m^2. Problems with quality and a lack of competition led to a tailing-off of demand. Of the existing capacity, 80 % is installed in private households, with the remainder in public buildings such as hotels, hospitals and barracks.

20 Quelle ANER, 2004.

21 More details about these PV projects are given in the section on rural electrification. Future prospects: in the 10th development plan, state expenditure of roughly € 19.3 million has been set aside for the promotion and utilisation of renewable forms of energy and the development of an energy-efficiency programme.

According to Law No. 2004-72[22] expanding the use of solar thermal energy is one of the two principal development goals of the national energy programme. Since 2005 there has been a national promotional loan programme in place under the name of PROSOL, which is meant to help Tunisia achieve an installed collector area of 700,000 m^2 by 2011. The state provides a direct subsidy for solar thermal installations at a rate of 59 euro/m^2 (TD 100/m^2), up to a maximum of 236 euro/m^2 (TD 400). The remaining amount can be covered by credit finance at preferential rates, to be paid back over five years. Collection is taken care of by the state-owned utility company STEG in conjunction with the electricity bill. As an accompanying measure provided by the state, no value-added tax is payable on installation of the systems. In 2005, thanks to this programme, 23,000 m^2 of new collector area was installed in the residential sector. The target for 2006 was 45,000 m^2. The PROSOL lending programme is part of the Mediterranean Renewable Energy Programme (MEDREP), which has received US$ 7 million from the Italian Government. The United Nations Environment Programme (UNEP) is contributing US$ 2 million, thanks to which the interest rate for borrowing can be reduced from the usual 14 % to 7 % for financing solar thermal systems. Thanks to repayment guarantees provided by STEG, local banks were able to grant the equivalent of US$ 5.7 million in small loans for solar thermal installations in 2005.

Geothermal energy

The geothermal springs in the south of the country in the Kebili region have a relatively low temperature of between 30 °C and 80 °C. Up to 45 °C the water is used directly for irrigating about 16,000 ha of oases. Warmer water is first cooled in trickle towers. The thermal springs are also used for heating greenhouses, covering a total area of over 100 ha. According to estimates by the International Geothermal Association (IGA), this involves utilisation of a thermal output of 25.4 MW_t, equivalent to an annual energy input of some 60.9 GWh/a. To date, geothermal energy has played no part in generating electricity because the available water temperatures are too low.[23]

16.6 Rural Electrification

Degree of electrification

According to estimates by the state-owned utility company STEG, the degree of electrification for Tunisia as a whole was 99.1 % in 2005. In rural areas the figure was 98.1 %. Grid coverage is poorest in the southeast of the country, where it reaches around 96.5 %. The high connection rate is the result of constant efforts on the part of the government over the past 30 years. In the 1970s only 6 % of the rural population was connected to the power grid, while around 1990 the figure was still only about half. As a complementary measure along with the expansion of the grid, the installation of more than 11,000 decentralised PV systems has also played a part in the high rate of electrification.

Electrification programmes and projects

A programme promoting decentralised rural electrification that was launched in 1995 on the basis of national and international assistance provides solar home systems (SHSs) rated at 100 W_p to households in rural areas. In order to maintain the functionality of the systems and the supply infrastructure in the long term, training measures were implemented at the same time, covering the fields of service, maintenance and system monitoring.

As a demonstration project, the community of Ksar Ghilène in a desert area in southern Tunisia was electrified with a central photovoltaic system. In this case solar energy is used for water treatment, operating telephones and for lighting.

Exchange rate (Sept. 2006):
1 Tunisian dinar (TD) = 0.59 euro (EUR);
1 US dollar (USD) = TD 1.34

22 See Law No. 2004-72 under Legal Framework.
23 Mouldi Ben Mohamed, The utilization of geothermal energy in agriculture in Kebili region, Southern Tunisia.

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17 Bangladesh

17.1 Electricity Market

Installed capacities

As of June 2005, total electrical power generating capacity in Bangladesh amounted to 4.995 GW. Just under 5 % of this capacity was provided by hydropower projects, while over 95 % was based on conventional thermal energy conversion using, for example, steam turbines, which are installed in 48 % of the country's power plants. As Bangladesh's most important energy source, domestically produced natural gas – which accounts for 85.5 % of fuel fired for power generation purposes – plays a dominant role in shaping the power plant landscape. Mineral oil and diesel, 90 % of which is imported, together constituted not quite 10 % of the energy sources utilised for power generation in 2005. Preliminary figures indicate that installed electricity generating capacity totalled some 5.3 GW by mid-2006.[1]

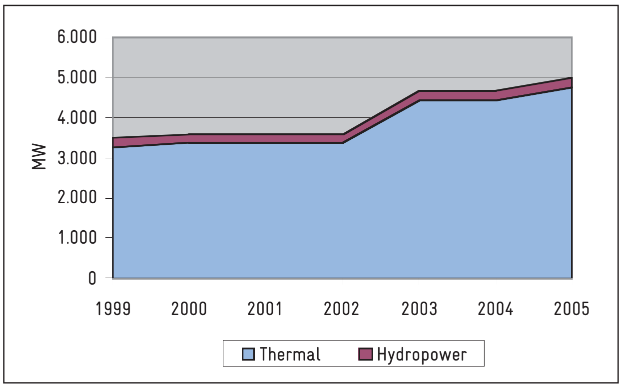

Fig. 1: Electricity generating capacities in MW; Bangladesh; 1999-2005[2]

Electricity generation

The total electrical power generated in Bangladesh in fiscal year 2005-2006 amounted to just under 23 TWh, representing an increase of 7.5 % over the previous year.

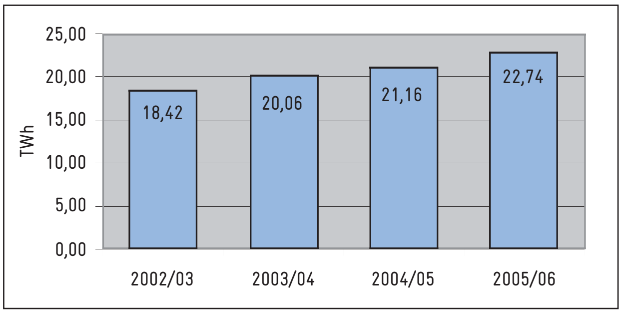

Abb. 2: Total electricity generation in TWh; Bangladesh; 2002/03-2005/06[3]

Most of the electricity in Bangladesh is produced in the eastern part[4] of the country where the domestic natural gas resources are found.[5] The Dhaka region alone is home to 61 % of the nation's power plants. Power generation in the western area of Bangladesh is based on imported mineral oil and diesel.

1 However, experts estimate actual available power plant capacity to be considerably less, at 3.2 GW, one reason for which being the advanced ageing of existing power plants. Currently, 23 of the country's total 102 power plant units are not in operation.
2 Source: Bangladesh Power Development Board (BPDB) 2006. The data collections of state institutions in Bangladesh are based on fiscal years which end on June 30 of each year.
3 Source: Bangladesh Power Development Board (BPDB) 2006.
4 The River Jamuna forms the boundary between the eastern and western parts of the country.
5 All natural gas fields currently under exploitation are located in the eastern part of the country, as well as 21 of the 22 total known storage sites. Power generation costs are also correspondingly lower in the east, in 2001 lying between 0.68 and 1.01 euro cents/kWh. In the western part of the country, costs ranged anywhere from 0.97 to 6.98 euro cents/kWh.

Electricity transmission and distribution

Despite the relatively high population density, establishing and expanding a central electricity supply system in Bangladesh has proven a difficult undertaking. According to information provided by the World Bank, only 32%[6] of the nation's population has access to electrical power, mainly in the eastern part of the country which is considered to be more advanced. The state-run power grid comprises transmission networks (132 and 230 kV) measuring some 6,000 km in total length, with transformer substations providing a transmission capacity of 8,830 MW. The distribution grids (33 kV and less) encompass a total of almost 210,000 km.[7] Low-cost power is transferred from the country's eastern area to the west via a 230 kV line. Grid losses at the transmission level have changed little in recent years, the most recent figures showing losses of 3.5% (2005/06). Technical losses at the distribution level have decreased by almost 15% since 2003, but nevertheless remain considerable, at 19.1% (2005/06).

In recent years, financial losses in power plant operation have significantly hampered possibilities for grid expansion intended to stabilise power supply. Current plans still call for multi-layered expansion of existing transmission networks in broad areas of the country – a major component of which is the erection of a 400-kV line between the Meghnaghat and Aminbazar substations to improve power supply to the Dhaka region.

In areas not served by the central power grid there are also several systems in isolated operation driven by diesel generators or renewable energy sources.

Electricity consumption

Per capita power consumption is among the lowest in the world, at 134 kWh/year. In 2006, total electricity consumption amounted to 20.95 TWh. According to figures from 2001, the main customers are industrial consumers (44%) followed by private households (41%), commerce (8%) and agriculture (5%; others: 2%).

Bangladesh has an extremely high rate of electricity theft. In 2004, a mere 55 to 60% of consumed power was actually paid for.[8]

Electricity prices

Prices for electricity in Bangladesh are mainly determined by the state-owned electrical utility Bangladesh Power Development Board (BPDB), which oversees most of the power plant generating capacities and the entire power transmission grid. To some extent BPDB sells electricity to distribution companies who in turn take care of power supply to end-consumers in broad areas of the country, while in other cases it sells power directly to end-customers. On average, the electricity tariffs for customers in rural regions are higher than in urban areas. This is due to the higher standing charges[9] that electricity customers in rural regions must pay as financial compensation for the structural difficulties of rural electrification.

Electricity tariffs were raised in early 2007.[10] This price rise translated into a 5% increase for small consumers and 10% for major customers. Private households in rural regions were exempted from the tariff hike, as were customers in urban areas who consume less than 100 kWh/year.

6 This figure is a composite of the low degree of electrification in rural regions (19% in 2000) and the relatively high degree of electrification in the cities (2000: 80%).

7 The distribution networks (33 kV and below) are broken down into about 43,000 km of state-operated grid and other networks totalling some 167,000 km in length.

8 Influenced by these high rates of loss, foreign investors shy away from commitment to the energy sector in Bangladesh.

9 All customers of BPDB pay monthly standing charges of between 0.06 euro and 4.50 euro per month in addition to the electricity rates per kWh. Rural customers pay 4.50 euro per month.

10 Among other purposes, this measure could be a reaction to the financially tense situation at BPDB which, in recent years, has accumulated considerable debt, due to various circumstances: electricity sales prices which lie below power generation costs, high grid losses (e.g. due to grid failures, theft of electricity, etc.) and unpaid electricity bills.

Direct consumers/ distribution companies	Range of consumption	Tariff in € cents/kWh since Sept. 2003	Tariff in € cents/kWh starting early 2007
Private households	000-100 kWh 101-400 kWh > 400 kWh	2.79 3.35 5.58	2.79 3.5 5.86
Agricultural irrigation and drainage	Flat rate	2.05	2.15
Small-scale industry	Flat rate Peak load period Outside of peak load period	4.27 5.98 3.4	4.49 6.27 3.57
Trade	Flat rate Peak load period Outside of peak load period	5.85 9.07 4.04	5.92 9.15 4.24
Public and non-profit facilities	Flat rate	3.57	3.74
"Dhaka Electric Supply Authority" (DESA)		2.37	2.6
"Dhaka Electric Supply Company" (DESCO)		2.42	2.66
"Rural Electrification Board" (REB)		2.29-2.7	2.52-2.97

Tab. 1: Electricity prices according to customer groups of the state-owned power provider BPDB in € cents/kWh; Bangladesh; 2003 and 2007[11]

Expansion planning

The existing electricity supply system in Bangladesh is considered unreliable and beset with difficulties. For many customers, 24-hour power availability is not ensured.[12] Expansion of electrical generating capacity and distribution systems is viewed to be absolutely essential in order to meet existing demand for electric power.

There are plans to create an additional 20,496 MW of installed capacity by the year 2025[13] – to be fired almost exclusively by increased use of domestic natural gas resources.[14] In 2003 the government began promoting domestic coal mining to establish a second mainstay alongside the intensive use of natural gas, with the aim of ensuring a nationally independent electricity supply. The first coal-fired power plant (250 MW) went into operation in early 2006. With accessible coal reserves estimated to amount to 2,514,000,000 tonnes, i.e. sufficient to ensure long-term supply for a generating capacity of 4,000 MW, further coal-fired power plants are to follow. As domestic hydropower potential has been largely exhausted, current government plans additionally recommend the construction of large dams in neighbouring Bhutan to feed Bangladesh's domestic power supply system. The government intends to cover costs for expanding generating capacity and transmission systems with funds from state-run power providers, international donors and investment from the private sector.

17.2 Market Actors

Until 1977, the state-owned power provider Bangladesh Power Development Board (BPDP) was the sole institution responsible for power generation, transmission and distribution. Today, although BPDB is still directly or indirectly involved at all levels of the electricity market, changes have come to the state-organised electricity sector. In 2004 the government decided to transform BPDP into a holding company – a step, however, that to date has not yet been implemented.

11 Source: Bangladesh Power Development Board (BPDP) 2003, Daily News Bangladesh 2007.

12 In the capital Dhaka, power failures in 2006 sometimes occurred up to 10 times a day. In order to ensure power supply despite existing deficits, the state power provider BPDB opted to introduce a rotation system in which the individual power distribution units are temporarily taken off line in succession, one after another.

13 These figures come from the Master Plan for 2005-2025, an update of the Master Plan of 1995.

14 12 of 21 confirmed natural gas fields are being exploited to date. Expert estimates projecting how long existing gas reserves will last range between 2020 and 2050.

Power producers

BPDB accounts for over 70% of the electric power generated in Bangladesh. This share also includes the first BPDB-founded subsidiaries such as the Ashuganj Power Company (APS), which originated with the transformation in 2002 of the state-owned Ashuganj Power Station into a joint stock company. In addition, privately owned and operated independent power producers have been allowed since 1996. Between 1998 and 2005, a total of seven power plants belonging to independent power producers were put into operation, all told providing an installed generating capacity of more than 1,290 MW – mainly fired by natural gas.[15] These plants thus represent a 26% share in the country's total electrical generating capacity. Current planning envisages construction of further power plants by non-state-run producers or joint state and private providers for a total output exceeding 1.590 MW.

Self-generators in Bangladesh account for 1.1 GW of installed capacity. Attempts by the government to integrate such autonomous suppliers into the public power supply system have to date remained without success.[16]

Power transmission company PGCB

Since 1996, responsibility for operation and expansion of the entire electricity transmission grid has lain with the Power Grid Company of Bangladesh (PGCB), founded as a subsidiary of BPDP.

Power distribution companies

In 1997 an institution specifically dedicated to rural electrification was founded – the Rural Electrification Board (REB). REB was mandated to assume responsibility for power distribution and supply in rural regions by way of electrification cooperatives, known as Palli Biddut Samities (PBSs). Since then, REB has been working with a total of 70 PBSs, which are organised on a cooperative basis.[17] In addition to power distribution, the PBSs are increasingly supposed to take charge of some areas of power generation.

The state-owned company Dhaka Electric Supply Authority (DESA) was established to regulate power distribution in the capital Dhaka and surrounding vicinity. Since the start of the reform process in 1996, DESA, in turn, has shared electricity distribution operations in the capital with the Dhaka Electric Supply Company (DESCO) which was founded as a state-run joint-stock company. In addition, a further power distribution company – the West Zone Power Distribution Company (WZPDC) – was established in 2003 as a BPDB subsidiary is responsible for the country's southwest.

Other Actors

Energy policy institutions

In Bangladesh the electricity sector lies within the scope of responsibility of the Ministry of Power, Energy and Mineral Resources (MPEMR). The executing arm of the MPEMR comprises on the one hand Power Division, which has overall authority for the electricity sector, and on the other hand Power Cell, which at its founding in 1998 was given the mandate to manage and regulate development of the electricity sector, including implementation of reforms. In conjunction with this, Power Cell's scope of responsibility also encompasses the field of renewable energy. Power Cell thus coordinates and supports, for example, the implementation of renewable energy projects by non-governmental organisations (NGOs) and private actors.

Furthermore, under the auspices of the Energy Regulatory Commission Act of 2003, a regulatory authority was established for the entire energy sector – the Bangladesh Energy Regulatory Commission (BERC). It commenced its activities in 2004. BERC's duties include ensuring transparency in the determination of electricity tariffs. It also introduces uniform standards for operational procedures and ensures the quality of power supply.

15 One example of an independent power producer is the Rural Power Company Ltd. (RPC), equipped with installed capacities totalling 140 MW (4 x 35 kW). RPC generates electricity for rural areas. A 28% share of the company is held by the Rural Electrification Board (REB), while the rural electricity cooperatives Palli Biddut Samities (PBSs) own the remaining 72%.

16 The government hopes in the near future to gain some 500 MW from industrial autonomous suppliers for the public power supply. However, an initial offer directed to self-generators did not yield any positive feedback.

17 PBSs integrate the consumers within their respective areas of responsibility into the cooperatives' activities. This includes, for example, their inclusion in planning and management of distribution grids.

17.3 Legal Framework

The electricity sector of Bangladesh has been undergoing a process of reform since the mid-1990s. The main reform measures include restructuring (i.e. unbundling) of the state-owned energy supplier BPDB into separate companies responsible for power generation, transmission and distribution. Plans furthermore call for transformation of the corporate entities resulting from this process into joint-stock companies. The great need to expand the country's electricity supply system while the possible means for government investment remain deficient has led to the power generation and distribution segments being opened to outside private sector activities as well.

Reforms in the power sector

The National Energy Policy (NEP) of 1996, which has since been updated at regular intervals (most recently in 2002), constitutes the statutory superstructure of the reform process. It spells out the comprehensive guidelines for reforming the power sector and establishing a regulatory authority.

The legal basis for integrating private actors into the power sector is provided by the Private Sector Power Generation Policy of Bangladesh, which was likewise adopted in 1996 and then revised in 2004. The new electricity supply policy aims to introduce competition, attract foreign investment capital and mitigate power supply shortages. Among other things the following tax and financial incentives are designed to encourage private actors to commit to involvement in the power sector:

- Income tax exemption for a period of 15 years
- Exemption from customs duties, value added tax and other charges for importing plant, equipment and components[18]
- Avoidance of double taxation of foreign investors based on bilateral agreements
- Authorisation of foreign investors to enter into joint ventures
- Payment by the state of up to 50 % of the salaries owed to foreign employees delegated to Bangladesh
- Support for local equipment manufacturers.

Projects initiated by independent power producers are to be implemented on a build-own-operate (BOO) basis. Power suppliers themselves must cover the cost of lines connecting their private-sector power plants to the given transmission networks. Local equipment manufacturers are to be strengthened by supporting them in their efforts to supply private-sector power plants with locally fabricated equipment which meets international standards.

In order to satisfy the needs for developing local and mostly small private-sector power generation projects, the government adopted a supplementary Small Power Generation Policy in 1998. This law explicitly supports projects providing electrical generating capacities of up to 10 MW. Such projects are seen as particularly relevant for isolated areas classified as being remote from established grids, or which are hit by an above-average rate of power failures. This legislation is also intended to enable the sale of surplus electricity from self-generators to surrounding regions.

Reform objectives

In 2000 the long-term objectives for the electricity sector, which are also intended to promote and support the economic and social development of the country, were compiled in a governmental statement entitled the Government's Vision and Policy. The three cornerstones of this statement are: 1. To make electricity available for all, 2. To ensure reliability and quality supply of electricity, and 3. To provide electricity at a reasonable price. With the aim of promoting implementation of the introduced reforms, this programme was supplemented to include the following objectives:

- Bringing the entire country under electricity service by the year 2020
- Making the power sector financially viable and able to facilitate economic growth

18 However, this only applies pro rata to 10% of the total value of the plant.

- Increasing the sector's efficiency and making the sector commercial
- Improving the reliability and quality of electricity supply
- Using natural gas as the primary fuel for electricity generation and exploring the possibility for export of power to augment and diversify foreign exchange earnings
- Increasing private sector participation to mobilise finance
- Ensuring a reasonable and affordable price for electricity by pursuing least cost options
- Promoting competition among the various entities in the power sector.

The aim of complete restructuring of the power sector is to provide the prospect of a multi-buyer and multi-seller market model and the establishment of a richly competitive market structure. While PGCB is to remain exclusively responsible for power transmission over the long term as well, it is intended that a large number of companies should become involved in the power generation and distribution segments.

17.4 Policy for Promoting Renewable Energy Sources

The importance of renewable energy sources was first spelled out in the National Energy Policy (NEP) of 1996. The NEP emphasises the need to secure optimum development of domestic resources, including renewable energy sources. In addition, it underlines the significance of renewable energy sources for supplying electricity to rural and at the same time sparsely populated regions – as an alternative to cost-intensive expansion of the central power supply system.

Draft law for a Renewable Energy Policy

Since 1996 the government has been documenting its concepts for national expansion, development and establishment of renewable energy sources[19] in a dedicated draft law, the Renewable Energy Policy. Subsequent to several revisions, the draft of this law was most recently updated in 2004. It includes objectives such as acceleration of the electrification programme through the use of renewable energy sources and raising the proportion of electricity generated from renewables to 10% by 2020. Incentive mechanisms for promoting renewable energy and establishing a dedicated institution for renewable energy sources, the Renewable Energy Development Agency (REDA), likewise form part of this draft legislation.

According to the draft law, in addition to generally disseminating various renewable energy technologies, this institution dedicated to renewable energy sources is to assume a wide range of responsibilities and functions, including the following:

- Establish a Renewable Energy Trust Fund to finance renewable energy projects
- Integrate all political and governmental levels in efforts to promote renewable energy
- Formulate financing to enhance the affordability of renewable energy
- Encourage and support institutions such as non-governmental organisations and rural energy companies in establishing renewable energy use

19 According to the draft law, the category of renewable energy sources includes biomass, solar energy, wind, small-scale hydropower, geothermal energy, wave power and tidal power.

- Establish linkage of renewable energy with provision of all basic services, e.g. installation of drinking water systems.

At the end of 2005, the government decided to set up a Sustainable Energy Development Agency (SEDA) instead of REDA and to implement this decision within the shortest time possible by way of Power Cell.[20] The founding of SEDA was subsequently postponed. As of early 2007, adoption of the draft law for a renewable energy policy has also not yet come to fruition. Power Cell is officially mandated to execute all functions and responsibilities concerning development of renewable energy sources until such time that REDA or SEDA is established.

Instruments of promotion

For the most part, growth in the use of renewable energy in Bangladesh is being promoted indirectly: on the one hand by a number of NGOs as well as state-owned, parastatal and private institutions, and on the other hand by many national and international programmes. The decentralised application of renewable energy systems has emerged as the main area of emphasis of these promotion efforts.

Over 30 national institutions alone are conducting such programmes or projects. These include state-owned and parastatal institutions such as MPEMR (run by Power Cell), the state power supplier BPDB, and REB – the public body responsible for rural electrification – along with the Local Government Engineering Department (LGED). There are also a number of non-governmental organisations, such as the country's largest domestic development organisation, the Bangladesh Rural Advancement Committee (BRAC), and the Bangladesh Centre for Advanced Studies (BCAS). The not-for-profit enterprise Grameen Shakti[21] is likewise a main player. Active research institutes include, among others, the Renewable Energy Research Centre of the University of Dhaka and the Bangladesh Council of Scientific and Industrial Research (BCSIR).

These various institutions are conducting a large number of programmes and projects, mainly in the field of solar power. At least four programmes concerned with wind power are currently underway, three are promoting biogas and one project is presently supporting micro hydropower. The programmes are being financed for the most part by international donors such as the World Bank, the Global Environmental Facility (GEF), the United Nations Development Programme (UNDP), the Asian Development Bank (ADB) and the two German development institutions KfW and GTZ.

Financial incentives

Special promotional incentives providing financial advantages are limited to measures defined in a directive from 1998 by which photovoltaic systems and equipment as well as wind turbines are exempt from value-added tax and customs duties. In addition, the generally applicable promotional incentives for private sector commitment in the energy sector also apply.

Financial incentives applied within the scope of currently ongoing promotion programmes essentially pursue two directions. First, considerable use is made of subsidies – in particular by state institutions such as BPDB and REB – such that renewable energy systems can be obtained at privileged prices. Secondly, financial support is provided to feed loan funds used to cover refinancing of micro-financed systems that are likewise destined for transfer to personal property.[22]

20 See section on "Other Actors".

21 Grameen Shakti is a subsidiary of the well-known microfinance institution Grameen Bank. Translated, "shakti" means "energy". The enterprise is conducting 7 programmes solely dedicated to promoting renewable energy systems, encompassing the fields of photovoltaics, wind, biogas, training, solar-powered computers, research and development, rural information and communication technologies.

22 "Fee-for-service" models are also employed, but to a lesser extent. Instead of private property, such models target payment for use of a system. REB wants to broaden usage of this method in future.

Clean Development Mechanism

Bangladesh ratified the Kyoto Protocol at the end of 2001. The Bangladeshi Department of Environment (DoE) has assumed responsibility as the Designated National Authority (DNA). To date, national activities for utilisation of the Clean Development Mechanism (CDM) have remained very modest in scope. Several projects are in preparation. The DoE has approved two CDM projects and submitted these to the international Executive Board (EB). The first of these projects targets utilisation of landfill gas to generate electricity in Dhaka, yielding potential annual CO_2 savings of 566,000 tonnes. The second project centres on composting of organic residues also in Dhaka and represents an annual CO_2 savings potential of 89,259 tonnes. Both projects were developed in collaboration between two waste management enterprises, one a Bangladeshi company and the other Dutch.[23] Bangladesh's share of the total CO_2 emissions produced worldwide is 0.1 %.

The tentative nature of Bangladesh's efforts to initiate CDM projects is due, among other reasons, to a shortage of personnel capacity as well as to the transaction costs of CDM activities.

Given the flat topography of the country and the fact that it lies just barely above sea level, Bangladesh is considered particularly sensitive to climate change.

17.5 Status of Renewable Energy Sources

Measured against total installed electrical generating capacity, the proportion of power generated from renewable energy is extremely small. Among other things this is because renewable energy sources are barely used at all on a large industrial scale for generating electricity in Bangladesh. Weak infrastructure, high energy costs and the fact that a high proportion of the population lives in isolated areas remote from the established grid have resulted to a situation in which systems employing renewable energy are principally decentralised solutions in isolated, stand-alone operation.

While awareness of the power-generating potential of most renewable energy sources in Bangladesh is still only rudimentary, use of solar power has already developed into the foremost growth industry. One particular aspect in this regard is that the systems used are commercially available on a notably broad scale.

Renewable Energies	End of 2005	Tentative Target 2020
	MW	
Solar power	approx. 6	300
Biomass/small hydropower	< 1	600
Wind power	approx. 1.5	1000

Tab. 2: Installed capacities and targeted objectives of MPEMR to expand use of renewable energy, in MW; Bangladesh[24]

23 World Wide Recycling BV of the Netherlands and Waste Concern of Bangladesh.
24 Source of objectives: Power Cell of MPEMR 2006.

The following aspects are considered obstacles to achieving widespread dissemination of renewable energy systems for generating electric power:

- Inadequate policy framework for developing renewable energy
- Absence of a dedicated governmental institution
- Lack of knowledge among the rural population of available options
- Deficient quality of the systems deployed
- High procurement costs and, at the same time, inadequate financing options
- Lack of transparency in governmental plans for area-specific grid expansion[25]
- Lack of coordinated research and development within the country

Hydropower

The opportunities for harnessing small- or large-scale hydropower in Bangladesh are very limited. This is essentially due to the fact that the country is very flat – with the exception of a few regions in the north and southeast. What is more, the annual dry season in Bangladesh, which lasts several months, entirely rules out year-round use of hydropower in many locations. The sole major hydroelectric power station is located in Kaptai on the Karnafuly River, comprising 230 MW of installed generating capacity. With commissioning of a 100-MW expansion to this plant planned for 2009, the large-scale hydropower potential of Bangladesh is already considered to be largely exhausted.[26]

Total potential for small-scale hydropower is estimated to amount to some 250 MW. To date, studies to identify specific sites have been conducted in only a few areas. These sites are located primarily in the hilly regions of the country considered to have the greatest exploitable potential. At least 24 sites with possible generating capacities of between 3 and 81 kW have been pinpointed.

The use of small hydropower schemes to generate electricity in Bangladesh began merely a few years ago. In order to ensure economical utilisation of hydropower despite wide fluctuations in water levels in many rivers, initial steps have been taken in Bangladesh to link such efforts with irrigation and flood protection measures. This option is currently being investigated within the scope of an irrigation project at Banskhali in the Chittagong district being implemented by the Local Government Engineering Department (LGED), with estimates projecting that the site offers sufficient potential for a 20-MW hydropower plant. One example of a mini hydropower project is located at Monjoypara in the Bandarban district. There, a 10-kW hydroelectric unit installed by the inhabitants of the village of Marma supplies electricity to 40 households.

Expansion plans

A number of existing expansion plans in the field of small and micro hydropower are geared to isolated, stand-alone operations. These include three projects in the Bandarban district (1 x 20 kW, 1 x 25 kW and 1 x 30 kW). All three units are planned to provide 24-hour power generation between June and September and generate power for 2 to 6 hours a day in the period from October to May. The LGED is pursuing, among other goals, a technical expansion of existing concepts for hydropower utilisation by the indigenous population, e.g. at Bamerchara in the Chittagong district.

25 In a pilot project (1993–1998) targeting dissemination of renewable energy technologies, REB supported installation of solar home systems (SHSs) in Karimpur and Nanarpur using funds provided by the French government. DESA connected some of the locations in the areas concerned to the national electricity grid in 2003, with 735 households subsequently returning their SHS.

26 BPDB has identified two further sites for hydropower projects: one on the Sangu River for a 140-MW power plant, and one on the Matamuhuri River for a 75-MW project. Construction, however, is uncertain and does not form part of current planning.

Wind energy

Several systematic series of measurements of wind power potential have been carried out in Bangladesh. These include two studies conducted in parallel in the mid and late 1990s.[27] The findings showed that wind speeds on the coast are higher than in the country's interior, and are higher during the summer months than during the winter owing to the Monsoon. They also showed that on a yearly average the wind power potential in Bangladesh is rather low. This information was first confirmed and broadened within the scope of the Wind Energy Resource Mapping (WERM)[28] study and then following a comprehensive data gathering exercise for the Solar and Wind Energy Resource Assessment (SWERA) programme conducted by the Danish research centre Risø.[29] According to this information, locations with wind speeds of > 5 m/s are limited to a few areas on the coastline, which extends for over 724 km.

Due to the generally rather moderate wind speeds and the fact that the windy coastal regions lie far from the national power grid, conditions in Bangladesh appear to be particularly suited to decentralised use of wind-driven power generation. Options considered to be of particular interest in Bangladesh are wind-driven pumps, power generation in hybrid operation, battery charging stations at remote locations and powering isolated networks. Practical areas of application include shrimp production, fish and poultry farms, salt and ice production, the fishmeal industry, animal breeding centres, irrigation systems and drinking water treatment and supply systems for household use.

A number of small wind generators are operated in the coastal region. These include two units of 300 W and 1 kW, respectively, on the Chakaria Shrimp Farm operated by Grameen Shakti,[30] and eleven small units owned by the Bangladesh Rural Advancement Committee (BRAC). Financed by the state power supplier BPDB, four Vestas 250-kW wind generators fabricated in India were erected at the end of 2005 on an island off the coast northwest of Chittagong.

Biomass

Over 65 % of all energy consumption in Bangladesh is based on the use of biomass.[31] The burning of biomass for cooking and heating purposes accounts for most of this. In addition, exploitation of biomass for energy recovery by means of biogas plants has gained in importance in recent years – in particular in households to provide energy for cooking and lighting as well as for value-adding treatment of fertilisers. According to estimates by the Bangladesh Council of Scientific and Industrial Research (BCSIR), there is a potential for 4 million systems in Bangladesh just for cattle manure biogas plants with a capacity of about 3 m^3. At the commercial level there is growing interest in biogas plants for chicken farms, of which there are 100,000 in Bangladesh according to LGED estimates. The largest of these farms house some 200,000 animals.

27 1. An 18-month wind study at four sites conducted by GTZ in 1996 and 1997 within the framework of the TERNA project, initiated by REB and the Bangladesh Atomic Energy Commission (BAEC). 2. A one-year wind study of seven sites conducted in 1996 and 1997 at an elevation of 25 m on the coast by the Local Government Engineering Department (LGED) in collaboration with the Bangladesh Centre for Advanced Studies (BCAS).

28 Studies were conducted over a time period of more than one year at 20 different measuring stations throughout the country.

29 The data were compiled in a wind atlas and published in 2005. Further information can be found at: swera.unep.net

30 Furthermore, Grameen Shakti has installed four small units (3 x 1.5 kW and 1 X 10 KW) in the Barguna district on the coast. Plans call for these units to be incorporated into a hybrid operation in order to raise the energy output of the facilities.

31 Potential bioenergy sources which come under consideration in Bangladesh include wood, organic residues such as cattle manure, and residues from agricultural production such as straw, rice husks and bagasse.

As of 2004, some 25,000 biogas plants had been installed in Bangladesh. In addition to small units for supplying energy to households, these plants include installations at the municipal level.[32] Although power generation from biogas is still in its infancy in Bangladesh, it is gaining increasingly in significance. At a poultry farm in the Faridpur district, a biogas pilot project is underway trialling the generation of electricity from poultry manure. Currently a 4-kW generator is being used, which in future is to be upgraded to 10 kW. One example of industrial use of biogas is provided by a steelworks in Jessore that fires a blast furnace with such gas.

Promotion and financing of biogas plants

Biogas technology in Bangladesh has been developed to the extent that many banks will grant loans to private consumers to build biogas plants, and applications for such loans are on the increase. Furthermore, use of biogas plants at poultry farms is receiving support from a GTZ project, Promotion of the Use of Renewable Energies (PURE). Within the framework of its ongoing Biogas Plant Pilot Project, the Government of Bangladesh fosters use of biogas units at the household level for cooking and lighting, subsidising each unit to the equivalent of some 84 euro.

Use of landfill gas

Concepts for extracting energy from landfill gas have been under development in Bangladesh since the 1990s. The energy use potential of landfill gas is recognised in the country's major cities, in particular in the capital Dhaka, where it is estimated that deposited waste is sufficient to fire a 30-MW power plant. Implementation of existing plans is moving forward by way of the two CDM projects already registered.

Solar energy

Average daily solar irradiation in Bangladesh ranges between 4 and 6.5 kWh/m^2, reaching its maximum levels during the periods of March-April and December-January. Deploying photovoltaic systems, consumers in rural regions of Bangladesh began utilising available solar energy potential as early as 1980. Installed PV capacity as of August 2004 was calculated to total some 3.1 MW, with over 50,000 PV systems in use.

Although most of the systems are ones installed to serve individual households, larger-scale systems are also employed: in a pilot project funded by the French government, a 62-kW facility was installed on the island of Narsingdi at the end of the 1990s to supply power to 850 island inhabitants. This project demonstrated the technical feasibility and socio-economic acceptance of PV systems in isolated regions remote from established grids, and proved instrumental in helping to further disseminate systems of this type.

Grameen Shakti

Of the total PV generating capacity installed in August 2004, as much as 2.15 MW, in the form of 42,000 solar home systems (SHSs), was attributable entirely to the activities of Grameen Shakti, a non-profit enterprise founded in 1996 that has specialised in the sale of this type of system in rural regions of Bangladesh. In addition to the equipment itself, the product package it offers customers includes installation, free customer training and maintenance services, a 20-year warranty and a financing option based on microcredit. The company markets SHSs throughout the country from a total of 100 local branch offices.[33]

32 Within the scope of an LGED project in Madaripur, 15 systems were installed for a total of 123 families. The project also included training of three villagers in system construction, installation and maintenance.

33 Grameen Shakti ranks among the most successful companies worldwide in the field of rural electric power supply based on renewable energy. For some time now, the product range it offers has been expanding to include small wind generators, micro and mini hydropower systems as well as biogas plants.

Bangladesh's largest solar programme

Since 2003, development of solar energy use by means of SHSs in conjunction with rural electrification in Bangladesh has been supported by a programme carried out by the Infrastructure Development Company Limited (IDCOL).[34] These efforts are based on a fund financed by international donors for providing microloans to SHS customers. In addition, purchase of each small unit is subsidised to the equivalent of about 90 euro. To implement this programme, IDCOL is collaborating with a total of 16 partner organisations including non-governmental organisations, microfinance institutions and private enterprises.[35] These organisations market SHSs with the aid of microloans granted to their customers. Cooperation with local manufacturers of SHS components is viewed to be a contributing factor to the project's success.[36]

Provisioned with funds from the World Bank and GEF totalling € 24 million, the programme initially pursued the goal of financing 50,000 SHSs by the year 2008. This target figure was reached as soon as 2005, with savings of almost € 3 million still on hand. With the approval of additional financial support from the World Bank, KfW and GTZ, the programme target was raised to 200,000 SHSs by 2009.[37] As of November 2006, the number of SHSs sold and installed within the framework of this programme increased by an additional 40,000 to, all told, 90,000 units. Grameen Shakti's share of this total at that time came to 64 % (57,000 SHSs). The capacity of systems sold ranged between 30 and 100 W_p, with more 50-W_p systems than any other, accounting for almost half of the units.

17.6 Rural Electrification

In view of the fact that roughly 80 % of the population of Bangladesh live in rural areas, development of the national power supply system is crucially dependent on rural electrification. Although the PBS cooperatives, active in 85 % of all villages, have with time extended their coverage over almost the entire rural territory of the country, the degree of electrification in relation to the total number of individual households, at 19 %, remains rather low.[38] Slightly less than one quarter of all rural households are connected to the national power grid.

A growing though still small proportion of these consumers now draw their power supply from stand-alone solutions based on renewable energy sources at the village level or, in particular, at the individual household level. In many rural homes in Bangladesh, systems based on renewable energy are replacing existing, traditional energy converters such as kerosene lamps[39] which, while they fulfil the need for lighting, nevertheless often pose a health hazard due to the smoke they generate as well as a fire hazard, and incur recurring monthly costs. Moreover, the cost of kerosene has risen in recent years by around 60 %.

REB foresees that, by 2020, the grid will reach 84 % of the rural population and 100 % of all villages.[40] Adverse aspects hindering achievement of this target include the remote and widely dispersed locations of many households, the financial feasibility of realisation and the very limited financial resources available to erect central infrastructure for power supply. The cost for connecting one rural household to the national grid is estimated to be in the range of US $ 500.[41]

34 The programme is known as IDCOL's Solar Programme or also as the Rural Electrification and Renewable Energy Development Project (REREDP). The programme was approved by the World Bank under the REREDP title.
35 Among others, these include Grameen Shakti, the BRAC foundation, Srizony Bangladesh, COAST Trust and the Centre for Mass Education and Science (CMES).
36 Among others, these include Rahimafrooz Batteries Ltd. In addition to producing rechargeable batteries in its own facilities, the company manufactures part of the SHSs. The solar modules used by Rahimafrooz have an output of 40 to 75 W_p, and are designed to power up to 6 lamps providing four hours of lighting per day.
37 The World Bank is funding an additional 60,000 systems. KfW, in an agreement with IDCOL, has promised to invest € 16.5 million for the installation of approximately 100,000 SHS units. Under contract from the Dutch government, GTZ is providing IDCOL with support beginning in 2007 for the installation of some 40,000 SHSs.
38 Compared with 3.7 % in 1991.
39 A rural household consumes on average about 10 litres of kerosene per month.
40 Those villages that have not yet been reached by REB fall within the scope of responsibility of BPDB or DESA, as well as throughout the entire Chittagong district.
41 At an average customer density of 20 per 1,609 km (one mile). In the country's rural regions, every mile of distribution line costs US$ 10,000.

Bangladesh's rural electrification programme

Since its founding in 1977, REB has been pursuing the Bangladesh Rural Electrification Programme with the goal of resolutely advancing electrification of the country's rural regions. The core of this programme concentrates on building up the rural electricity cooperatives (PBSs). REB is supported in its efforts by a large number of international donors such as the Asian Development Bank and the World Bank. To date, only a certain portion of the cooperatives are entirely financially self-supporting.[42] To ensure that all PBSs become financially stable and self-supporting over the long term, REB makes agreements each year with the PBSs; compliance or non-compliance with these entails financial benefits or penalties.[43] In order to close supply gaps or shortages among existing PBSs, REB is increasingly concentrating on integrating renewable energy systems to create village-based stand-alone solutions alongside the distribution of electric power via the national grid to end-customers, which until now has received the most attention.

Part of the Bangladesh Rural Electrification Programme is based on collaborative efforts between the US organisation National Rural Electric Cooperative Association (NRECA), the Bangladeshi Rural Electrification Board (REB) and the United States Agency for International Development (USAID). NRECA has been providing technical and institutional support for establishing and strengthening PBSs since 1997. One characterising feature of this support, among other aspects, is the in-depth level of customer participation. For example, customers are involved in the development of local master plans for electricity supply, and the advisory board of each PBS is chaired by one female and one male customer.

As a result of the rural electrification programme 70 PBSs have been established to date, reaching more than 6.5 million customers in 85 % of all Bangladeshi villages. In addition, grid losses in these areas, which come to approximately 12 %, are below the national average, and almost 100 % of all electricity bills are being paid. All told, the programme has already attracted more than US$ 1.3 billion from international donor organisations. It is considered to be one of the most successful rural electrification programmes in South Asia, enjoying an annual growth rate of 600,000 new customers and 12,000 km of new power distribution lines. Among improvement measures envisaged for the future is a plan to introduce a noticeable differentiation in end-customer tariffs, in which the differences in service costs between the various PBSs are more strongly reflected in the prices charged to customers.[44]

Programme for sustainable energy supply

Projects are being implemented in Bangladesh under the name Sustainable Rural Energy (SRE) as part of the international Sustainable Energy Management Programme (SEMP), mainly by the Local Government Engineering Department (LGED). The object is to present renewable energy-based power generation concepts that offer broad possibilities for application and use at the municipal level. One example of an ongoing demonstration project is provided by the erection of an isolated grid for 50 shops in a marketplace at Gangutia in Jhenidah district based on a 1.8-kW_p PV system that is operated and maintained by a market committee. Nineteen SRE projects were installed between 1999 and 2002. Another element set up within the framework of this programme is a network for renewable energy in Bangladesh.[45]

42 In order to ensure cheap electricity tariffs at the household level, PBSs make use of cross-subsidisation, i.e. higher rates are charged to commercial and industrial customers to compensate for the cheaper rates charged to private households. This financing concept is often not feasible, among other things because the number of household customers is usually far higher. Widely differing figures are quoted for the percentage of PBSs that are said to be financially self-supporting. For 2003, these range anywhere from 25 to 57 %.

43 The central parameters of this agreement (i.e. the Performance Target Agreement, or PTA) are, for example, system losses, paid bills and the annual growth in number of households reached by the grid. There are 22 central parameters in total.

44 In a purely theoretical sense, the end-prices set by the PBSs today are already determined on the basis of their respective service costs; in reality, however, the difference in end-prices is minimal.

45 For further information, go to www.lged-rein.org.

Microfinance

In the rural areas of Bangladesh microfinance has established itself as a successful method of commercial and sustainable dissemination of renewable energy systems, and in particular of solar home systems (SHSs) by Grameen Shakti. Microcredit is used predominantly to overcome the procurement costs of high-quality renewable energy systems. As many customers of Grameen Shakti were already accustomed to regular incurrence of energy costs due to their former usage of kerosene lamps, etc., microcredit offers them an opportunity to transform their running costs – such as for kerosene – into investment in an SHS. Once they have paid all the instalments owed for a microloan, they are then in possession of a renewable energy system that enables them to save ongoing operating costs. Tailored to the various possible options, Grameen Shakti offers, for example, a number of different SHS financing models that vary according to the amount borrowed and the length of the instalment payment period. A number of institutions involved in the rural electrification of Bangladesh are now making use of microcredit to finance renewable energy systems.

Exchange rates (12 February 2007):
1 Bangladeshi taka (BDT) = 0.01116 euro (EUR)
1 US dollar (USD) = EUR 1.2962

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18 China

18.1 Electricity Market

Installed capacity

In the course of 2006, installed power generating capacity in the People's Republic of China was increased by about 112 GW to reach almost 622 GW by the end of the year. This is equivalent to approximately five times the installed capacity in Germany. Capacity is continuing to be expanded at a fast rate. By 2010, according to the 11th five-year plan, there is set to be a total additional build of another 200 GW. The rate of expansion is fuelling fears, however, that far more than this planned volume will actually be put in place. Government representatives are attempting to prevent this, though, by increasing controls applied in relation to approval procedures for new projects.

Numerous existing small power plants of up to 300 MW are being modernised or shut down in favour of building new medium-sized power stations rated at between 300 and 600 MW and large power stations with a capacity of over 1000 MW.

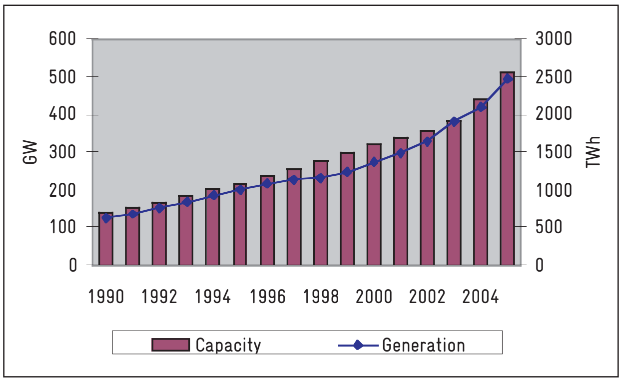

Abb. 1: Electricity generation and capacity; China; 1990–2005; GW, TWh[1]

Power generation

Gross electricity generation has more than quadrupled since 1990, and by 2006 production totalled 2,834 TWh. This makes China the world's second largest electricity producer after the USA.

Most electricity is generated in thermal power stations (80 to 83 %), primarily on the basis of hard coal[2], but increasingly also fuelled by natural gas and supplemented by oil-fired systems Hydropower contributes between 15 and 18 %, depending on hydraulic availability. Nuclear energy accounts for a share of about one per cent, while wind power is still well below 1 %. Not including the large hydroelectric plants, the proportion of renewable forms of energy in China's overall energy mix is significantly less than 2 %.

Even if the average net efficiency of publicly owned coal-fired power stations has been improved to about 34-35 % in recent years, environmental pollution caused by SO_2[3], NO_X and particles remains substantial on account of the fact that the power stations are only partly equipped with air pollution control facilities. Since 2004 however, tighter emission standards have been in force, making desulphurisation a requirement for new plants. In locations close to urban centres the emission standards for existing plants have been tightened, so retrofitting of flue gas cleaning systems has become necessary here too.

China's total CO_2 emissions amounted to about 5.05 billion tonnes in 2005. It is assumed that China will overtake the USA as the world's largest CO_2 emitter as soon as 2008, when the figure is expected to be over 6,000 billion tonnes. The burning of coal in all its uses accounts for roughly 77% of these emissions.

By 2010, natural gas, water and wind, together with nuclear power, are supposed to increase their share to 38 % of total power generation. However, the Chinese Government is keeping to coal as the basis for power generation, its resolve reinforced by the country's huge reserves and the relatively low cost of extracting them.

1 Source: China Electrical Council, 2006.
2 In terms of both the extraction and consumption of coal, China is at the head of any global comparison table.
3 China is the world's largest emitter of SO_2.

That said, thermal electricity generation is being relocated primarily to the mining regions in order to reduce emissions in conurbations and to replace coal transport by electricity transmission ('coal-by-wire' programme). As a new natural gas pipeline has been installed, the aim is also to increase the share of gas used for electricity generation in conurbations. In the meantime there are a relatively large number of gas pipelines that have been recently installed or are under construction. About eight new nuclear reactors were built in 2006, an indication of China's progress towards increasing the share of nuclear power to between 2.5 and 4.5 % by 2020 (from 6,948 MW in 2006 to about 40 GW in 2020). The Chinese Government intends to increase the contribution made by renewables to total energy supply – including large-scale hydropower – from 7.5 % in 2005 to 16 % in 2020, and is earmarking investment totalling US$ 187 billion for that purpose.[4]

Power transmission and distribution

In recent years the existing isolated grids have increasingly been integrated into the 12 regional interconnected grids. These are supposed to be merged initially to form three networks and ultimately by 2020 a single national interconnected grid. In the coming years the government is planning greater efficiency improvements in the transmission and distribution networks. Internal consumption at the production facilities and network losses currently account for about 15 % of gross electricity generated.

Electricity consumption

Net electricity consumption reached a little over 2,800 TWh in 2006. This is equivalent to annual per capita consumption of roughly 1,450 kWh.[5] The growth rate in consumption was over 15 % per year in 2003 and 2004, and in the industrial regions of the Yangtze delta as much as 25 %. Growth in demand slackened off slightly in 2005, reaching a rate of 13.5 %. In the long term it is expected that annual growth rates will average 5 %. The International Energy Agency is forecasting a rise in electricity demand of about 260 % between 2000 and 2030.

By far the most significant consumer group is industry, which accounts for 66 % of electricity consumption. Households are responsible for 15 % of total consumption, while 13 % is attributable to the service sector (including transport) and 6 % to the primary sector (agriculture, forestry and mining). The sustained high rate of economic growth at about 9 % per year results not only in increasing power demand for production but also by private households, as incomes rise. It is expected that private households and the service sector will account for a growing share as time goes on.

For a long time the entire country was affected by electricity shortages and power failures. During periods of peak load in particular it is still the case that the demand for electricity might not be met. In the southern Chinese province of Guangdong – the main centre for light industry and the electronics industry – most companies have now bought their own diesel generators.

The Government of China has linked the endeavour to quadruple GDP by 2020 with the objective of no more than doubling total energy consumption in that time. To this end, the 11th five-year plan for 2006-2010 pursues the aim of reducing energy intensity by 20 %.

Electricity prices

The average national purchase price for electricity across all consumer groups was the equivalent of 5 euro cents/kWh in 2005. The purchase price varies considerably from one province to another: in Shanghai, a load centre, the average price was 5.7 euro cents/kWh, while in the sparsely populated western provinces it was 2.5 euro cents/ kWh. Broken down according to customer groups, commercial customers pay the highest prices, at about 7.7 euro cents/kWh; the prices for interruptible supplies to agricultural customers or for customers in poor regions are the lowest, down as far as 1.8 euro cents/kWh. Domestic electricity prices are somewhere in the middle, as are those for large-scale industry. As the supply costs for these groups differ widely, the pricing is plainly not cost-oriented. Households are favoured by the price policy. Increasingly, a day-night differentiation is being introduced, also for households, for the purposes of load management.

4 These figures were quoted by the Deputy Director General of the Energy Bureau of the NDRC, Wu Guihui, at the end of October 2006 at the Great Renewable Energy Forum in Beijing.

5 By way of comparison: per capita electricity consumption in Germany is approximately 6,400 kWh per year.

As the price of coal has continued to rise, the price-setting authorities have been induced to adjust electricity prices, to the extent that average consumer prices in 2004 had already reached 2.9 euro cents/kWh. The producers were promised automatic adjustments. A new, transparent price system is being trialled in a pilot area, according to which a separate, cost-based tariff is set for each of generation, transmission and distribution.[6]

If this system, which is a prerequisite for further vertical disintegration of the utility companies, is put into practice, the costs of power generation will also become more easily identifiable. Presently the production costs for electricity generated from coal are quoted as 3.5 euro cents/kWh, which implies a narrow margin for transmission and distribution. It is worthy of note that until now by far the largest share of the electricity output has gone to bulk purchasers.

18.2 Market Actors

Up to the time of the electricity sector reform in 2003, the State Power Corporation of China (SPC), created in 1997, was the dominant enterprise with about half the generating capacity, 90 % of the transmission lines above 220 kV, and a majority of the distribution networks. The unbundling of SPC led to the creation of eleven state-owned enterprises, comprising five generating companies, two network operators (interconnected grid operator and holding company for distributors) and four other companies providing supporting services (for example engineering).

Generating companies

The five power generating companies that emerged from SPC each received 30,000-37,000 MW of capacity and hence 45 % of total capacity in 2003. One of these five enterprises, the Guodian Group, was assigned a large proportion of existing wind power capacity, which in turn it concentrated in its subsidiary Long Yuan.

The remaining 55 % is distributed among about 40 other electricity producers, between which a process of concentration is taking place. Industrial self-generators own power station capacity totalling roughly 30 GW. The electricity producers are increasingly supposed to enter into competition with each other. The regulations stipulate that no generating company in any one area (balance group) is permitted to own more than 20 % of the generating capacity.

Grid-operating companies

The two newly created grid-operating companies still currently act as a single buyer. They buy the electricity from the generators, manage transmission and distribution and supply the end customers.

The South China Grid Corporation (SCGC) operates in five southern provinces, centred on Guangzhou. In the other twenty provinces responsibility lies with the State Grid Corporation (SGC) and its subsidiaries. The transmission grids are being integrated to form five regional grids. SGC is also responsible for management of the Lhasa Power Grid in Tibet.

Other Actors

Energy-policy institutions

The responsibilities of government institutions were reorganised in 2003. The State Asset Supervision Administration Commission (SASAC) was a new body set up under a resolution by the National People's Congress. It is responsible for supervision of the assets, performance, finances and management personnel of the state-owned companies and therefore for the most important enterprises in the electricity sector. The amalgamation of three ministries produced the Ministry of Commerce (MOFCOM) and the National Development and Reform Commission (NDRC). The new MOFCOM is responsible for domestic and foreign trade, including issues of equal treatment of foreign and Chinese enterprises.

6 See also the comments in the section headed Legal Framework.

The NDRC is the most powerful decision-making body on economic matters within the Chinese government apparatus, and among other things deals with price control and approval of investments. Within the NDRC the Energy Bureau (EB) was set up for the express purpose of assuming political responsibility for the energy sector – including the field of security of energy supply. Objectives, strategies, policy regulations etc. that specifically relate to developments in the renewable energy sector in China are covered by a separate subsection of the EB. Responsibility for energy efficiency was delegated to the environment department in the NDRC.

Environmental protection and conservation of natural resources

The State Environmental Protection Administration (SEPA) is responsible for defining and monitoring compliance with environmental regulations. This environmental body is represented at all levels (national to local). Alongside this, the Ministry of Land and Resources, the Ministry of Water Resources and the State Forestry Administration (SFA) are responsible for matters relating to natural resources. The Ministry of Agriculture is also a point of contact for rural energy supplies and bioenergy/biofuels. It runs offices down to the district level.

As well as the executive, the environment committee of the National People's Congress, i.e. the legislative, is increasingly concerning itself with energy-related and environmental issues on its own initiative.

New regulatory authority for electricity

A separate regulatory authority, the China State Electric Power Regulatory Commission (SERC), was created to regulate the electricity industry. The primary tasks of the SERC are supervision of the reform process and consistent regulation of enterprises in the power sector. Its functions do still overlap to some extent with those of the price-setting authorities in the NDRC.

Energy research

The Ministry of Science and Technology (MOST) participates actively in formulating and implementing energy policy with research and demonstration projects. Among the institutions allocated to MOST are Tsinghua University, with several energy institutes. The Academies of Science, Engineering and Social Studies also have a series of research institutes investigating energy matters. The Development Research Centre (DRC), which answers to the State Council, also has strategic significance. The Energy Research Institute (ERI) is formally tied to the NDRC, and occupies a position of considerable importance in the debate on energy policy and how it should be implemented.

18.3 Legal Framework

Over the past two decades China's electricity sector has undergone major changes.

Reforms within the power sector

Political responsibility had already been separated from operational responsibility in 1998, but then the reforms of 2003 created an entirely new institutional landscape. The reforms are set out in the policy known as Document No. 5 adopted by the State Council in April 2002, and have been implemented in stages since then (for example the unbundling of generating and grid-operating functions). A further major reform step, the unbundling of transmission and distribution and of other functions, is expected in a few years.

The requirement to set up a national regulatory authority for the power sector (China Electric Power Regulatory Commission) was implemented quickly.[7]

The planned measures to improve the policy framework, in particular relating to environmental protection and the promotion of renewable energy, were implemented in 2004 and 2005. Approval procedures were speeded up. After a certain delay, the price reforms mentioned above have now also begun to be put in place.

7 See also the section on energy-policy institutions under Other Actors.

The NDRC issued provisional arrangements for these in April 2005. As a further reform step it was announced in 2005 that individual regional markets will be able to operate in organised competition and bulk consumers will be able to obtain supplies directly from generating companies. The conditions for self-generation are to be improved over the long term. The various reform steps are ultimately supposed to lead to a comprehensive amendment of the Electric Power Law, currently at the planning stage.

Foreign involvement in the energy sector

A number of measures have been taken in the past to encourage the investment of foreign capital in China's energy sector. Since the mid-1990s the Chinese Government has permitted the direct investment of foreign capital in power generation. In 2004 there was a further opening allowing the commitment of both domestic and foreign private capital for investment in and operation of infrastructure (with the exception of the field of electricity transmission).

The supply of plant and systems to the Chinese market from outside the country is not only subject to the regulations on foreign trade, which have been defined with increasingly greater clarity in the course of China joining the WTO, but also to specific access restrictions. It should be noted, for example, that China pursues a policy of localisation of manufacture for all technologies that attain a certain significance on the Chinese market: as a rule this applies to high-efficiency coal-fired power stations, gas turbines, desulphurisation plants, wind generators and photovoltaic systems. The government uses various steering instruments to achieve localisation. The objective of encouraging local content is to consolidate manufacturing and development capability in the country. Often this is achieved by requiring a partnership (joint venture) to be established with a Chinese company. The purchase of licenses from foreign manufacturers is also very common. When entire plants are bought, this is done with the aim of testing them.

Market access for service providers has generally been improved. On the whole though it is still considered difficult, apart from the fact that it is rarely customary in China to pay for independent consulting services (with the exception of the feasibility studies that are always required). The institutional environment for foreign developers continues to be accompanied by considerable risks.

18.4 Policy Promoting Renewable Energy Sources

The central use of renewable energy for electricity generation is not yet competitive in China without state intervention. The situation is somewhat different with respect to decentralised power generation from small-scale hydropower, wind power or photovoltaic systems in remote areas, and the use of agro-industrial wastes in combined heat and power stations (cogeneration plants). Policy promoting renewable energy was given new impetus with the Beijing Declaration on Renewable Energy for Sustainable Development[8] formulated at the renewable energy conference in Beijing in November 2005. For example, it is now required of all energy supply companies – apart from operators of large-scale hydroelectric schemes – with an installed capacity of over 5 GW that 5 % of their power generation must be based on renewable forms of energy by 2010.

8 This contains a demand to international financial institutions and governments to offer greater assistance for renewable energies as the key to economic development.

Previous promotion of electricity from wind energy

Since the mid-1990s there has been a series of measures and regulations promoting grid-connected wind energy. To support the financing of wind power projects, for example, the government provides low-interest loans provided that the equipment originates from domestic production. Furthermore, in 2002 the rate of value-added tax for wind-generated electricity was halved from 17 % to 8.5 %. The import of wind turbines is presently exempt from customs duties. Most of the existing installations however have very different pricing and infeed arrangements in each individual case, which means that different costs and conditions have to be taken into account. The state's efforts to promote electricity generated from wind power have been given added weight with the national roadmap for wind energy development through to 2020 that has been in place since May 2005.

Large-scale wind-energy projects rated at over 50 MW are within the sphere of responsibility of the central government body, the NDRC. For smaller projects with a capacity of below 50 MW, authority to grant licences, for example, rests at the provincial level. In this range, in particular, private enterprises are also to be found among the investors alongside state-owned utility companies.

Competitive tendering for large projects

For some years now one important means of promoting the use of wind energy has been the government-run invitations to tender for large projects of over 100 MW on a concession basis. Given a minimum term of 25 years, the concessions are meant on the one hand to guarantee investors long-term feed-in tariffs while on the other also keeping electricity generating costs down. The respective feed-in tariff for a wind farm is broken down into two phases: The best price obtained during the tendering process is applicable for the first 30,000 full-load hours. After that, remuneration is aligned with the market price for electricity. The government has promised financial support to investors in large-scale projects in the form of tax relief and favourable borrowing terms – including for grid expansion. As well as that, local grid operators are obliged to purchase the energy generated in the wind farms, while the local governments provide the access roads to the wind farms. For the concessionaires themselves the granting of the concessions is linked with various requirements, such as an obligation to use turbines with a rating of at least 600 kW and to put their wind farms into operation within three years.

Although the invitations to tender are public and geared to the international market, to date the investors have all been national and primarily governmental or part-state-owned enterprises.[9] The first round of bidding was completed in 2003.

Bidding round	Project name	Region	Capacity	Offer price	
			MW	yuan/kWh	€-ct/kWh
1. (2003)	Huilai	Guangdong	100	0.501	4.8
	Rudong I	Jiangsu	100	0.436	4.2
2. (2004)	Huitengxile	Inner-Mongolia	100	0.426	4.1
	Rudong II	Jiangsu	150	0.519	5.0
	Tongyu A+B	Jilin	400	0.509	4.9
3. (2005)	Dongtai	Jiangsu	200	0.487	4.7
	Anxi	Gansu	100	0.462	4.5
	Jimo[10]	Shandong	150	0.726	7.0
	Dafeng	Jiangsu	200	0.462	4.5

Tab. 1: Results of competitive tendering for wind farm concessions in China; 2003–2005[11]

Up to now the state-owned energy suppliers have entered the bidding rounds with offer prices below the average rates of remuneration. In some cases they have even been set below the production costs, and are offset by cross-subsidies.

9 One concession was granted to a private-sector company.
10 This tendering process was called off because the offer prices were too high.
11 Source: Loy 2006.

Renewable Energy Law

The National People's Congress adopted the Renewable Energy Law on 28 February 2005. It came into force on 1 January 2006, and provides a new basis for promoting the development and use of renewable energy. The main provisions of the law encompass the following:

- Definition of renewable energy as non-fossil forms of energy such as wind, solar, hydropower, biomass, geothermal, ocean power etc.
- Scope: in addition to electricity supplies, it also covers other forms of energy such as water heating and renewable fuels.
- Establishment of the areas of responsibility for implementation of the law:
  - for the energy authorities in the various provinces, for example setting targets for renewable energy;
  - preparation of development and supply plans is the responsibility of all levels of government (central, provincial, local); the main areas of responsibility, such as for the approval of such plans, are placed at the central government level;
  - feed-in prices are set via NDRC price authorities in their respective territories.
- Fundamental provisions such as:
  - the requirement to obtain a licence to construct a power-generating facility on the basis of renewable energy;
  - the need to conduct a competitive tendering process if there is more than one applicant for a project licence;
  - permission for grid operators to pass on additional costs arising from the obligation to purchase power – for example as a result of grid connection costs – to the customer in the form of appropriate grid usage charges;
  - the stipulation that fiscal and tax measures such as low-interest loans, tax concessions or a development fund for renewable energy are to be made available in order for example to support projects to supply energy to remote rural regions.
- The obligation on the part of grid operators:
  - to offer a grid connection service;
  - to purchase the power from approved projects in their grid area according to the statutory feed-in tariff or at the accepted offer price in the particular case;
  - to sign a feed-in agreement and, in the event that they are unable to meet their purchase obligation, to pay compensation.

The Chinese Renewable Energy Law is a framework law and merely codifies fundamental provisions. The essential, decisive details are to be specified in a total of twelve implementing regulations without which the law is not able to exhibit its intended effects. Some have already been introduced by the NDRC, such as provisions relating to the feed-in tariffs including the apportionment of costs for grid-linked projects.[12] Although the subsidies[13] for certain biomass projects have already been fixed at 2.4 euro cents/kWh for 15 years from the time the plant starts operation, for the present there is no sign of similar feed-in tariffs for solar or ocean power nor geothermal energy.[14] The implementation provisions for wind energy stipulate competitive tendering instead of fixed remuneration for setting the pricing. The winning bidders in such cases receive long-term power purchase agreements.

No provisions have been put in place yet on the development of a renewable energy fund, on technical standards or on a national compensatory mechanism between the grid operators. It is already certain that the national compensatory mechanism will be designed to take account of the differences both in income levels and in energy consumption. Furthermore, the additional costs arising as a result of the Chinese Renewable Energy Law will be borne by a price premium for all electricity customers – with the exception of customers from the counties and lower administrative districts and those working in agriculture.

12 Further information is available on the website of the Australian Business Council for Sustainable Energy.
13 The basic price for such subsidies is formed from the average electricity generating costs using lignite.
14 This feed-in regulation for biomass can only be used for projects which have not been set up following a public tendering process and which use less than 20% fossil fuels in their operational sequence.

Clean Development Mechanism

China ratified the Kyoto Protocol in 2002 as a non-Annex I Party.[15] As a result it is able to convert direct emission reductions and avoided emissions into financial gain through the Clean Development Mechanism (CDM). In the meantime CDM revenue has become an important factor in the financing of projects – although its significance does vary from one renewable energy technology to another. Whereas the sale of certified emission reductions (CERs)[16] for projects harnessing wind power or hydropower can meet about 10 % of project costs, the sale of CERS to finance projects utilising landfill gas for example can cover the costs in full. All of the wind power projects initiated so far are already using CDM revenue as a central component of their financial planning. For example, the operating company of China's third-largest wind farm, Huitengxile in Inner Mongolia, is covering 8 % of the financing for the current expansion through an emissions fund. Most projects in China are developed on behalf of individual buyers through consultants and/or in a process of cooperation between buyers and individual project owners.[17]

As the world's (at present) second-largest CO_2 emitter, and in view of the rising demand for energy, China presents a broad field for action in terms of CDM measures. A recently published CDM guide for China[18] assumes that the country potentially makes up at least 50 % of the global CDM market. Also, the NDRC identified renewable energy as one of the three main areas for CDM projects. Along with the Ministry of Science and Technology and Tsinghua University, the Climate Change Office (China's Designated National Authority) in the NDRC is the point of contact for such projects. It is responsible for the approval of all CDM projects – irrespective of their size and importance. The number of CDM projects approved (at the national level) in China was 524 in mid-June 2007. Of these, most are to be found in the wind power and small-scale hydropower categories, while landfill gas, for example, is still heavily underrepresented. Of the total of 87 projects registered with the CDM Executive Board of the Framework Convention on Climate Change (UNFCCC), 65 were from the field of renewable energy, comprising 40 wind energy projects, 17 relatively small hydropower projects, five bioenergy projects and three landfill gas plants. CERs (certified emission reductions) have already been issued for 13 projects, including for seven wind power projects with a total of 0.4 million CERs. All in all, projects based on renewable energy would have the potential to generate 7.5 billion CERs in China by 2020. One fundamental prerequisite for CDM projects in the country is however majority Chinese ownership.

18.5 Status of Renewable Energy Sources

The development status of renewable energy sources for electricity generation in China is well advanced in some fields, but distinctly lagging in others.

As far as grid-coupled electricity generation on the basis of renewable energy sources is concerned, small-scale hydropower is by far the most important type. Grid-connected electricity generation on the basis of biomass, geothermal energy, solar energy and tidal power[19] is increasing, but to date has still not reached a level of notable significance. As regards non-grid-coupled applications, there are currently more than half a million installations providing energy to individual households in China, powered one third each by small wind energy units, photovoltaics and micro-hydropower systems. More than one million inhabitants in small settlement centres are supplied with electricity generated from renewable energy (small-scale hydro, PV systems and PV/wind hybrid systems) in isolated schemes.

15 Annex I Parties are subject to requirements to reduce their greenhouse gas emissions. The Annex I countries primarily comprise the members of the OECD.

16 A CER is equivalent to a saving of one tonne of CO_2.

17 The Delegations of German Industry & Commerce in Beijing (AHK) publish a CDM project list that is regularly updated and can be obtained directly from the AHK on request.

18 The CDM Country Guide for China was drawn up by the Institute for Global Environmental Strategies in Japan in cooperation with CERC – downloadable from www.iges.or.jp.

19 Tidal power plants have been in operation along the coast of Zhejiang and Jiangsu for a number of years.

Hydropower

China has the world's largest hydropower potential, concentrated in the west of the country. The large distances between those areas and the industrial conglomerations in which electricity is needed make it more difficult to utilise these resources and raise the requirements to be met for transmitting power towards the east and south coasts.

Installed capacity and expansion plans

At the end of 2006 the total installed capacity of all hydropower plants in China was 128 GW. The technically utilisable hydropower potential is quantified at 676 GW. It is planned to increase the installed hydropower capacity to 190 GW and 290 GW by the years 2010 and 2020 respectively. According to a long-term forecast, hydropower is envisaged as achieving a share of over 20 % of total electricity production by 2020.

The capacity of large hydropower plants is to be expanded in future. In addition to the gigantic Three Gorges power plant on the Yangtze, which will have a capacity of 18.2 GW after it is completed in 2009, it is planned to build a further twelve hydropower plants on the upper reaches of the Yangtze over the next two decades. Just the hydropower projects on the Jinsha River and the tributaries of the Yalong and Dadu alone are supposed to provide additional capacity of 90 GW. These government expansion plans easily hide the fact that criticism of the use of large-scale hydropower is growing in China. Such criticism is triggered among other things by the poor economic performance of existing large hydroelectric schemes, such as China's second-largest power plant at the Ertan dam.

Small and micro hydropower

In China a small hydropower plant is officially defined as being one with a capacity of up to 50 MW.[20] Such plants are mostly operated in isolated networks by the Ministry of Water Resources (MWR). At present there are over 42,000 small, mini and micro hydropower plants in operation with a total capacity of 38.5 GW. The total potential for exploitable capacity across the country is estimated at 125 GW. An area of particular interest is the southwest of the country, where not only 65 % of all administrative districts are to be found but also 50 % of the still unutilised potential for small hydropower. When the isolated networks are connected to the supraregional power grid, many small hydropower plants will be taken out of service. On the other hand, in central and west China there is now once again a strong trend towards building new plants that feed electricity into the grid. Currently about 2 GW of additional capacity is being installed each year.

The technology of small hydropower plants is considered very far advanced in China, and production figures are among the highest in the world. Because of their low price, they are also exported. However, wider distribution on foreign markets is impeded above all by product quality, which is judged to be low. Other aspects considered to be in need of improvement are process measurement and control of small hydropower plants and their operation in practice.

Wind energy

Topping the world league with an estimated onshore wind potential of 250 GW[21], China shows great promise for the exploitation of wind energy. Windy locations are to be found above all in the steppe and desert areas in the west and north of the country, and in coastal regions. The technical potential for offshore locations has been quantified at an additional 750 GW[22] by the Chinese Wind Energy Association.

20 Official classification according to the Promotion Law of Renewable Energy Development and Utilization.

21 According to information supplied by the Chinese Wind Energy Association, the potential of 250 GW refers to wind resources at a height of 10m. According to the Association, the potential doubles at a height of 50 m and more.

22 The wind data obtained from over 900 meteorological stations does not always satisfy international standards, however. This applies in particular to the identification of specific locations for wind power projects.

Wind data

Between 2002 and 2005, wind measurements were taken at ten locations as part of a UNDP/GEF project. These locations are classified as pilot projects within the framework of the national wind energy development roadmap and are to be given priority in receiving state assistance when wind farms are built.

China is also participating in the multinational Solar and Wind Energy Resources Assessment (SWERA) project, supported by UNEP, which is meant to improve the availability of wind data at the regional level. A wind atlas for southeast China has already been drawn up as part of the SWERA programme, and further regions are due to be added.[23] GTZ supported wind measurements in Hubei province under the TERNA wind energy programme between 2000 and 2002.

Wind energy use to date

Additional wind power installations had been built at a low rate in recent years, but now there is a veritable boom in the industry: At the end of 2005, installed capacity exceeded the 1 GW threshold for the first time, at 1.26 GW.[24] In 2006 China was able to more than double its installed capacity in wind energy, which reached over 2.6 GW by the end of 2006.

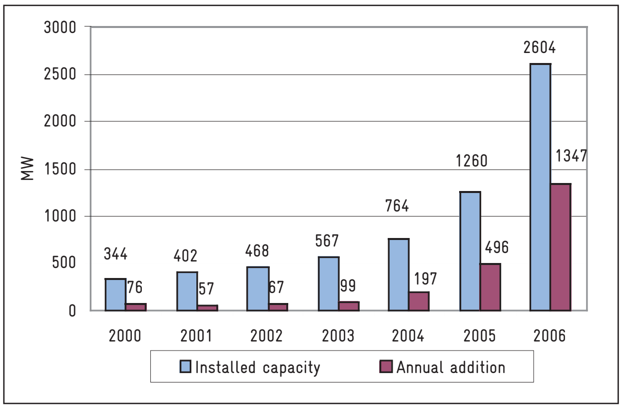

Abb. 2: Installed capacities and annual additional construction of grid-coupled wind power installations; China 2000-2006; MW[25]

Expansion targets

According to targets set in the 11th five-year plan (2006-2010), a total of 5 GW of wind power capacity is to be installed by 2010. The concession projects operated by the NDRC provide for 100 MW to be constructed at each of selected locations. By 2020, wind power capacity is supposed to be raised to a total of 30 GW. Certain functionaries in the energy sector even suggest a wind energy capacity of 40 GW by 2020. On the part of industry there is talk of figures of 170 GW being attainable.[26]

Obstacles to the expansion of wind power

Until the early part of the decade, most of the installed wind power capacity was largely based on bilateral or multinational promotion programmes and funding, and less on the country's own commitment.

Expansion of the wind power sector has been faced with a series of obstacles in the past:

- lack of transparency in permit-issuing procedures
- slow decision-making and approval processes
- sub-optimal legal framework
- high import duties
- the local content requirement stating that wind turbines and their components must largely (70 %) originate from Chinese production[27]
- major frictional problems between institutions
- frequent, usually annual renegotiation of power purchase agreements with remuneration trending downwards
- lack of protection for intellectual property in the case of local production

23 For further information on SWERA see http://swera.unep.net. The Wind Energy Resource Atlas of Southeast China is available at www.rsvp.nrel.gov/wind_resources.html.
24 Up to the end of 2005, 61 wind farms were built in China and 1864 wind turbines were installed.
25 Data source: Chinese Wind Energy Association 2005, Global Wind Energy Council 2007.
26 Source: Hongwen et al. 2006 (CREIA, Greenpeace, GWEC).
27 China intends to build up a competitive wind power industry. In addition it would like to avoid heavy dependence on imports in the provision of energy resources and facilities.

Some of the obstacles have been overcome through the Chinese Renewable Energy Law and its associated implementing regulations. Quite gradually, reliable political framework conditions are being established through which private-sector approaches in the wind power industry are encouraged, as is the commercial development of wind farms. Because of the discrepancy between the objectives for the expansion of renewable energy in China by 2020 and the capacity actually available to achieve those objectives, international cooperation arrangements and business relationships are also gaining central importance. This applies especially to the wind power sector. Until now the development of wind farms, for example, has been hampered by considerable shortages of expertise in a great variety of fields, relating to both human resources and technical issues.

Manufacture of wind turbines in China

Although larger systems rated at 100 kW or over have only been built for about twelve years, either in the context of joint ventures or under licence, China already has the capability of manufacturing all turbines up to a capacity of 750 kW itself. Presently there are more than five national manufacturers of turbines in the 600-660 kW class with a high proportion of indigenous components.[28] In mid-2004 the local content for 600 kW turbines was about 96% and for 750 kW models roughly 64%.

Demand for these types of turbine has been rather low in the past, however, as imported systems are generally cheaper and have a reputation for better quality.[29] At the end of 2002, 11% (54 MW) of total installed capacity originated from domestic production. Through a series of new joint ventures the manufacture of turbines and their components has increased further, reaching a share of about 28% by the end of 2005. Altogether the wind power sector now includes 30 national manufacturers; only few of these produce turbines in the megawatt class. Until now about 90% of such turbines have been imported.

Within the framework of joint ventures, the German manufacturers REpower and Fuhrländer also gained a foothold in China with production in the megawatt range in 2006.

Small off-grid installations

The total capacity of small, off-grid wind power systems (< 3 kW) is about 42 MW. About 250,000 small wind generating systems (0.1-3 kW) were installed in the off-grid sector up to the end of 2002. With 22 producers (end of 2002), China is the world's largest manufacturer of such systems, but these are mainly deployed in the domestic market.

Biomass

The considerable biomass resources available for energy purposes, chiefly in the form of harvest residues, firewood, forest timber residues and organic wastes, were estimated at over 5,500 TWh for the year 2001. Only one third of this potential is used, and this primarily for thermal purposes. China is expecting a further increase in the amount of forest timber residues through the implementation of two ongoing programmes, the Natural Forest Protection Programme and the Sloping Cropland Conversion Programme.

Biomass has been used as an energy source in small stoves and furnaces since time immemorial in all rural areas of Asia, and can be developed to generate electricity in China. There is also thought to be considerable market potential in this segment.[30] By 2006 the installed capacity for power generation from biomass had already reached 2 GW. There are mainly two processes that come into consideration for larger-scale applications: the use of organic materials (mostly bagasse) in combined heat and power stations with steam turbines, and the conversion of biogas into electricity in gas engines.

28 Three manufacturers are engaged in mass production, another three manufacturers have developed prototypes. These also include Nordex, which has a production plant in Xian, and Goldwind, which produces turbines designed by the German manufacturer REpower under licence.
29 At the end of 2002, 11% (54 MW) of the total installed capacity originated from domestic production. In 2002, 28 MW of the total of 67 MW of newly installed plants was purchased from local production.
30 Within the framework of the previous five-year plan (2001-2005) and the 863 Program promoting high-technology R&D, for example, the focus was on developing biomass plants for electricity generation.

Converting bagasse into electricity

For many years now it has been common practice in China's sugar industry to use bagasse to produce its own electricity in its larger factories. Over 800 MW of capacity is installed in the sugar provinces of Guangdong and Guangxi alone. It is not common, however, for this branch of industry to feed surplus power into the grid. According to estimates in a World Bank report, a potential of 700 to 900 MW of electrical energy that could be exploited with clear financial gain is available just in the areas mentioned above and Yunnan. However, a series of impediments hamper expansion of bagasse-generated electricity, including power for feeding into the grid:

- the currently poor economic situation in the Chinese sugar industry, leaving no scope for investment
- a lack of low-interest, long-term loans (low-interest loans with a term of three years were only provided for on-site electricity supply up to 1999)
- the fact that a standardised set of rules on electricity supply and remuneration did not enter into force until 2006
- the seasonal nature of sugar production (and hence of bagasse availability), which only runs for about five months a year

Biogas plants and their promotion

China is the world leader in the use of biogas plants on the basis of anaerobic fermentation. In addition to millions of small and micro plants, which chiefly help to minimise slurry problems on farms, there are some 1500 large-scale plants, including more than 150 in which the organic content of industrial wastewater (from paper, sugar and pharmaceutical industries and from alcohol and food production) is gasified. In 2005 the total number of users of small and micro biogas plants rose from 12 to 17 million – with as many as 12 million of these being used at the household level alone.

A preferential rate of value-added tax applies to biogas, reduced by 4% to 13%. This includes both the cost of biogas production and the cost of equipment. Energy generation from biogas is supported in China's agriculture industry by low-interest loans totalling US$ 33 million, committed by the Asian Development Bank (ADB) at the end of 2002.

Use of landfill gas

With support from the UNDP/GEF project Promoting Methane Recovery and Utilisation from Mixed Municipal Refuse, landfill sites in several municipalities are being examined for their suitability for converting landfill gases into electricity. The relevant studies were completed in mid-2004. There is also great potential for CDM projects in this connection. A first pilot plant in Anshan has already been completed and began operation in mid-2004. At present about 100 million tonnes of residential waste is generated each year, 80% of which is disposed of in landfills.

Enterprises and research institutes

There are now some 200 enterprises manufacturing biomass plants and their components. The Biomass Development Center (Beijing) is very important in the research sector; it brings together a large number of technical institutes as members. There is a network of political and scientific institutions and enterprises for developing, demonstrating and disseminating biomass technologies.

Solar energy

China's potential for solar energy applications is large. The average mean solar irradiation per day is over 4 kWh/m^2. Especially in the west of the country the sun usually shines for over 3,000 hours a year.

Market for photovoltaics

By the end of 2006 the installed capacity of PV systems had reached 65 MW. Approximately half of this was used for supplying electricity to households in remote rural regions of China. By 2010, the installed capacity in these regions alone could reach 300 MW.[31] The PV market for rural households in remote locations is growing at an annual rate of some 20 %. Current forecasts work on the assumption that this market will continue to grow and in the short term (by 2010) will also be the largest PV application market. In the medium to long term it is expected that grid-connected PV systems in the major cities[32] will play an increasingly important role, as will large-scale centralised installations in the deserts of China. Because of the various rural electrification and development projects, this is a continuing upward trend. The target for 2020 is a total of 1.8 GW of installed capacity in the form of photovoltaic systems.

Local production of PV equipment

In 2004, solar cells with a capacity of 65 MW_p were manufactured in China. In 2006 the production capacity had increased to 960 MW_p. Development in China's solar module sector has also accelerated. While the production figures for 2004 were put at around 100 MW_p, as much as 2,500 MW_p was planned for 2007. In order to avoid the global production bottlenecks in cells and modules, it is also planned to expand solar silicon production to 1,500 MW_p. A large proportion of the PV systems produced in the country are exported. The largest companies in the PV sector include the Chinese company Wuxi Shangde Solar Energy Power Co. and the Chinese-Australian joint venture Suntech Power, which has been ranked among the world's ten largest cell manufacturers since 2004. Nanjing CEEG PV Tech. established China's largest PV production facility in 2005. This manufacturing plant is designed to achieve an output capacity of 600 MW. The target for 2007 is an output of 300 MW_p. Together with the two Chinese PV manufacturers – Yingli Solar and Suntech Power – the company intends to increase its production to 1,500 MW by 2008-2010.

Grid-coupled solar systems

Only a few individual larger systems are connected to the electricity grid. In 2004 the country's largest system to date went on line in Shenzhen, with a total capacity of 1 MW. There are currently plans for the first large-scale PV plant, which will serve as a pilot plant in the province of Xinjiang Gansu, with an installed capacity of 8 MW_p. The financing of the project has not yet been clarified, however.

Obstacles to further development

Various obstacles stand in the way of faster growth in the number of installed systems, however:

- only state-supported system suppliers enjoy public-sector promotion; generally loans are rare for system suppliers and installers
- poor maintenance and service provision reduces the service life of the systems
- there is no institutional basis for granting loans or financing solar home systems

There are other obstacles impeding further development in China's PV industry, but overcoming these obstacles can present opportunities to foreign cooperation for technical and financial investment. These relate to:

- a shortage of high-quality inverters, especially in the larger output format
- a shortage of high-quality, long-lasting storage batteries for power supply systems in outlying regions

31 Chinese Renewable Energy Industries Association (CREIA) (2001): New and Renewable Sources of Energy in China – Technologies and Products. About 260 MW is supposed to be installed (off-grid) in the course of the 11th five-year plan.

32 In Shanghai for example there are plans for a 100,000-roof programme. With a view to the Olympic Games in 2008 there are also a large number of options for expanding the PV market in Beijing.

Solar thermal energy

The use of solar thermal energy for heating water is already very widespread in China. At 55 GW_{th}, the country has more than 60 % of the world's installed capacity in this field. New installations in 2006 alone amounted to 10.5 GW_{th} – 80 % of all the solar-thermal capacity added in the world. This comprised a growth in collector area of 15 million m^2 to a total of 90 million m^2 by the end of 2006. In that year, solar heat was being harnessed on almost 50 million Chinese roofs. It is envisaged that the area of collectors used to produce hot water will be expanded to 150 million m^2 by 2010 and 300 million m^2 by 2020.

With around one thousand manufacturers throughout China, the local industry for solar hot-water systems is highly significant. However, only about 10 % of these manufacturers are competitive, a fact which is primarily linked to the brand quality of the systems and the sales and service strategies. The main sales markets for solar water heaters are to be found precisely in the niche between urban and rural areas. This includes, for example, the suburbs of major cities and also districts surrounding small towns.

To date, solar thermal systems have not been used for generating electricity in China. This is supposed to change in future, among other things through a separate research and development programme for this sector as part of the 11th five-year plan. Furthermore, the first solar thermal electricity-generating power plant is being planned in the north of China, through Chinese-German cooperation.[33] After the first construction phase the US$ 2.5 billion project is supposed to have a capacity of 50 MW, and by 2020 it is expected to be expanded to an installed capacity of 1 GW.

Geothermal energy

Despite substantial resources, there has been virtually no development of electricity generation from geothermal sources in China so far. The potential that can be used directly to generate electricity due to high temperatures (> 150 °C) is estimated at 5.8 GW. Potentially utilisable resources are located along the eastern coast facing Taiwan (Taiwan geothermal zone) and in the Yunnan geothermal zone in Tibet. The installed capacity is only 30 MW, shared between a 25 MW geothermal power station in Yangbajing in Tibet and a number of smaller demonstration projects.

255 locations suitable for geothermal electricity production have been identified in China, and by 2010 ten of these are to be developed with a power generation potential of 300 MW.

18.6 Rural Electrification

The bodies that are particularly active in the field of non-grid-coupled rural electricity supply, apart from the large state-owned grid operators, are the National Reform and Development Commission (NDRC) and the Ministry of Water Resources (MWR), with small hydropower plants.

Degree of electrification

Approximately 98 % of the population of China can now be supplied with electricity thanks to grid expansion and rural electrification programmes. Of the remaining 30 million people without a power connection, especially in the provinces in the west and north of the country,[34] about 23 million are to be provided with a basic electricity supply in a capacity range of around 100 W[35] by 2010 within the framework of the highly ambitious Brightness Programme.

33 The technology for the project is being provided by the German company Solar Millennium AG.

34 Tibet is the province in which by far the largest proportion of households (approx. 80%) have no access to electricity.

35 The rating of 100 W should be seen as a guide value. In some areas, for example, solar home systems with an output of 20 W are used for lighting purposes.

In the peripheral territories renewable energies represent an economic alternative to grid supply and a more appropriate and environmentally sound option than conventional diesel-fuelled facilities. The demand for energy in remote areas correlates particularly well with the available potential for solar and wind energy as well as micro hydropower, to the extent that these alternative forms of energy appear predestined to electrify rural areas in China. The high concentration of supply in some regions even makes it possible to harness the potential of renewable energies for grid-linked electricity generation. This applies especially to wind energy.

The provision of electricity supplies to rural regions using renewable energy is receiving new impetus from the government's stated objective of creating modest prosperity for the whole population of China by 2020 ("xiaokang").[36] This is aimed at overcoming the increasing disparity between the newly rich in the cities of China and the great majority of the rural population – among other things by improving the balance in economic and social development.

Township and Village Electrification Programmes

There are currently several national promotion programmes being implemented to improve rural electricity supplies, some with bilateral and multinational support.[37]

One of the most ambitious programmes on any global scale is the Township Electrification Programme (Song Dian Dao Xiang), which the NDRC launched in 2002 as an implementation measure within the National Brightness Programme. It aimed to electrify 1,000 towns in a total of 11 provinces within two years. Based on funding of some US$ 560 million, almost 20 MW of PV systems and hybrid PV/wind systems as well as 274 MW of small hydropower plants were installed and connected to mini electricity grids in about 721 communities up to the end of 2004. Some plants have not yet been completed. In the meantime small hydropower provides an output of 293 MW, distributed among a total of 268 plants.

The local electrification measures were usually each preceded by a tendering process and competition between private companies. Responsibility for power generation and maintenance of the installed systems was then usually passed on to the local or regional authorities. Electricity prices typically vary between 4.9 and 19 euro cents/kWh from one province to another. The fact that at these prices sales revenue is still below operating costs could change in future as a result of the electricity price premiums introduced with the Renewable Energy Law.

Whereas it proved possible to reach nearly all of the towns in China with the Township Electrification Programme, the electrification of many villages has yet to be completed. Under the Village Electrification Programme (Song Dian Dao Cun), some 20,000 villages are to receive PV village systems and solar home systems amounting to a total of 265 MW between 2006 and 2010. Funding of about US$ 2 billion is planned for this. By 2015 the rural regions of China are supposed to be fully electrified.

The Brightness Programme is receiving technical and financial support from GTZ and KfW. In the long term the aim is that sustainable and self-supporting electricity supply systems should develop on a commercial basis. GTZ is also transferring expertise to local teaching staff, who in turn then train local technicians responsible for operating and maintaining the installations.

Because of the extremely tight time-frame within which the demanding target figures had to be achieved when the generating and grid systems were installed, some of the equipment chosen was of poor quality and inadequately dimensioned. In order to identify technical problems as soon as possible, when the first signs appear, and to determine the influence of electrification on the users' living and working conditions, a comprehensive technical and socio-economic monitoring system is being set up, also with GTZ support.

36 This objective was formulated by President Hu Jintao and Premier Wen Jiabao.

37 Including a GTZ project to improve general conditions valued at EUR 7.1 million, a KfW promotion scheme worth EUR 18.2 million financing village electricity systems, and the Silk Road Illumination Project promoted by the Dutch government worth EUR 13.8 million, in which Shell is also participating.

18.7 International Cooperation Programmes and Projects

Capacity Building for the Rapid Commercialisation of Renewable Energy (CCRE)

From 1999 to 2005 the Capacity Building for the Rapid Commercialisation of Renewable Energy (CCRE) project was implemented by the UNDP, assisted by GEF funds. It aimed to establish commercial industrial sectors in the field of renewable energies.[38] With financial support from the Australian and Dutch governments, the project contributed to institution building and the implementation of demonstration projects. The Chinese Renewable Energy Industries Association (CREIA) was established within the scope of the project. This body sees itself as an intermediary between industry and public authorities and in this role aims to bring national and international project developers and investors together. Further measures also included training of technical staff, policy consultancy, demonstration plants and product certification.

China Renewable Energy Scale-up Programme (CRESP)

The China Renewable Energy Scale-up Programme, which the Government of China developed in cooperation with the World Bank and the Global Environment Facility (GEF), was launched in June 2005. Starting out from the basis of the policy objectives of expanding the use of renewable energy, it aims to enhance the cost-effectiveness of renewable energy use and to remove both institutional and economic barriers that have hindered the use of such energy sources in the past. Its central focus is placed on large-scale technologies based on wind and biomass. The first of a total of three project phases will see trialling of the implementation of binding rules and regulations for the energy market in four provinces, supported by the GEF with a budget of US$ 40.22 million.

Renewable Energy Development Project (REDP)

The Renewable Energy Development Project (REDP) has been supported by the World Bank and the GEF since 2001 and is aimed at developing the market for photovoltaic technologies and verifying the potential for commercial development of wind power in coastal regions. In addition to PV and wind, the project includes a third component on technical improvements.

Within the context of the PV component of the REDP, local solar companies are receiving financial and institutional assistance to enable them to procure, install and maintain 300,000 to 400,000 solar home systems with a total capacity of 10 MW_p. These systems are to be sold to households in rural regions of six provinces in the northwest, with a subsidy of US$ 1.50 being granted per W_p sold. Altogether a subsidy of US$ 27 million has been agreed. By the end of 2004 about 175,000 systems had been sold and installed, with a total capacity of 3.5 MW_p. Under the Village Electrification Programme it is planned to provide financial support amounting to up to US$ 20 million for a pilot phase in the provinces of Xinjiang, Inner Mongolia and Tibet.

In order to promote the development of wind power the REDP is supporting the construction of two wind farms totalling 20 MW in the vicinity of Shanghai with a low-interest loan of US$ 13 million. The project is expected to be concluded at the end of June 2008.

Cooperation with Germany

Financial and technical assistance from German institutions for the use of renewable energy is largely provided in China's rural regions. While it is true that the German Federal Ministry for Economic Cooperation and Development (BMZ) has cut its total contributions to technical and financial cooperation in the light of China's growing economic capability, it is now for the most part focussing support on two domains: the conservation and sustainable management of natural resources, and sustainable economic development.

38 It focussed on PV and wind hybrid systems for municipal networks, biogas from industrial and agricultural residues, solar thermal applications, grid-coupled wind power plants, and bagasse-fired CHP schemes.

Since the end of 2001, GTZ together with the NDRC (formerly SDPC) has been implementing a programme to promote the use of renewable energy sources in the provinces of Qinghai, Yunnan and Gansu and the Autonomous Region of Tibet under the title Renewable Energies in Rural Areas. In particular this has provided support to the Township Electrification Programme by training teaching staff to train local operators, and through quality assurance measures and other services. A results monitoring system was set up to verify the socioeconomic impacts of improved rural energy provision. The NDRC will provide advisory services on matters of system design and tariff structuring. The project term is expected to end in September 2007.

KfW is contributing financial cooperation funds towards the installation of approximately 300 hybrid PV/diesel village electricity units for decentralised power supply in the provinces of Xinjiang, Qinghai, Yunnan and Gansu. For these systems, too, local maintenance structures will be set up and technicians trained within the framework of technical and financial cooperation. The expansion of wind energy capacity in China has been promoted by KfW with government bilateral financial cooperation funds and with its own market resources through extensive programmes to build wind farms (in Hainan, Zhejiang, Guangdong, Shandong, Inner Mongolia and Xinjiang).

To support these projects and the national expansion programmes, the China Long Yuan Power Group and the China Electric Power Research Institute (CEPRI) together with GTZ are currently setting up a national Wind Energy Training and Research Project. The centre's priority areas are training, advisory services and applied research, with the objective of improving the technical capacities of private and governmental institutions for a nationwide expansion of grid-connected wind energy.

The Government of China has received support in spelling out the legal framework under the TERNA wind energy programme and within other projects, including in particular the arrangements for feed-in tariffs and the compensatory mechanism specified under the Renewable Energy Law.

Exchange rate (December 2006):
1 Chinese renminbi yuan (CNY) = 0.096 euro (EUR)
1 EUR = 10.39 CNY

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18.10 Annex

Allocation of the target figures of 30 GW of wind energy by 2020 in China (MW)

No.	Province	Installed capacity end 2004 (MW)	New build 2005 (MW)	Total capacity 2005 (MW)	New build 2010 (MW)	Total capacity 2010 (MW)	New build 2015 (MW)	Total capacity 2015 (MW)	New build 2020 (MW)	Total capacity 2020 (MW)
1	Hebei (incl. Beijing)	35.1	84.5	119.6	1,000	1,120	600	1,720	780	2,500
2	Jiangsu				450	450	700	1,150	850	2,000
3	Inner Mongolia	135.1	30	165.1	230	400	1,000	1,400	600	2,000
4	Fujian	12.8	9.4	22.2	150	170	500	670	830	1,500
5	Guangdong	86.4	21.5	107.9	150	260	500	760	740	1,500
6	Liaoning	126.5		126.5	100	230	320	550	650	1,200
7	Gansu	52.2	11.9	64.1	100	160	200	360	640	1,000
8	Xinjiang	113.1	8.5	121.6	100	220	200	420	580	1,000
9	Jilin	30.1		30.1	300	330	300	630	370	1,000
10	Zhejiang	34.5		34.5	50	80	100	180	620	800
11	Shandong	33.6	2.3	35.8	170	210	200	410	390	800
12	Shanghai	4.9	19.5	24.4	100	120	200	320	280	600
13	Heilongjiang	36.3		36.3	50	90	100	190	410	600
14	Jiangxi						100	100	400	500
15	Ningxia	55.3	35.2	90.5	50	140	100	240	160	400
16	Hainan	8.8		8.8		10	130	140	260	400
17	Guangxi						50	50	150	200
18	Shanxi						50			
19	Guizhou									
20	Shaanxi									
21	Henan									
22	Tianjin									
23	Hubei		13.6	13.6		13.6	100	110	40	150
24	Yunnan						50	50	100	150
25	Hunan						50	50	100	150
26	Chongqing						50	50	50	100
27	Sichuan						50	50	50	100
28	Tibet						50	50	50	100
29	Anhui						50	50	50	100
	Total	**764.4**	**236.3**	**1,000**	**3,000**	**4,000**	**6,000**	**10,000**	**10,000**	**20,000**

19 India

19.1 Electricity Market

Installed capacity

By mid-February 2007, India's installed power generating capacity reached about 128 GW.[1] Of this, 54 % is accounted for by coal-fired power plants, 27 % by large hydropower plants, 11% by gas, 3 % by nuclear power plants, and 5 % by renewable energy sources (non-conventional energy sources).

Year	2002	2003	2004	2005
Thermal [MW]	74,427	76,606	77,968	80,902
Hydropower [MW]	26,261	26,910	29,500	30,935
Nuclear [MW]	2,720	2,720	2,720	2,720
Wind energy [MW]	1,507	1,735	1,869	2,979

Tab 1: Power generating capacity in India, 2002-2005; MW[2]

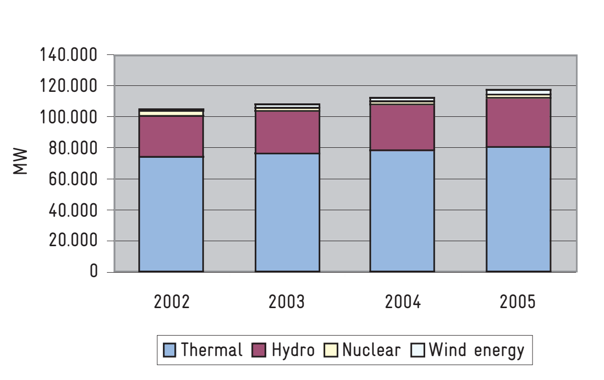

Fig. 1: Power generating capacity in India, 2002-2005; MW

Expansion plans

Since the beginning of the 21st century, power generation capacity has been registering annual growth of about 3 % with a slightly upward trend; reaching a figure of 5.1 % in the year 2004-05. For the period 2002-2012, covered by the 10th (2002-07) and 11th five-year plans (2007-2012), the Ministry of Power had planned new plants with a generating capacity of 100 GW. However, according to the Ministry of Power, less than the 41 GW expansion target formulated in the 10th five-year plan was achieved by end of March 2007.[3] The difficulties for expanding capacity are linked in part to the fact that neither the central government nor the individual states have sufficient funds for new investments.

The central government reacted to these difficulties and the uninterrupted demand for new generating capacity with several steps: it is pushing the construction of large power plants, as well as promoting private-sector participation. For the last few years for instance, private power suppliers have had access to the market.[4] Up to now however, long approval processes and insufficient financial means have proved serious obstacles to realising numerous private projects. The assumption nevertheless is that the share of private sector participation will reach about 13 % of the total production by 2012 as per the estimates made by the Central Electricity Authority (CEA). At present, it represents only 11 %. The Ministry of Power, CEA and the Power Finance Corporation have already developed plans for five large-scale coal-fired plants with a capacity of 4,000 MW each, and some sites have been selected for their construction. It is planned that public calls for tenders will be issued and the projects will be awarded to private investors and operators.

1 Source Ministry of Power, (the installed electrical capacity amounted to 127.4 GW at the end of September 2006.)

2 Sources: Ministry of Power, Annual Reports 2002/2003 until 2005/2006. Most balance sheets and statistical years in India span the period from 1 April until 31 March of the following year.

3 75% of the 5,245 MW target for the year 04/05 was achieved, and only 45% of the 6,934 MW target for the year 05/06 had been achieved two months before the end of the phase.

4 Independent power producers have to take part in invitations to tender, as prescribed by the Indian Government, except for projects on the basis of non-conventional energy sources.

During the 11th five-year plan period (1 April 2007-31 March 2012), the tentative capacity addition as estimated by the Ministry of Power in its 'Report of Working Group on Power for 11th Plan (2007-12) Ministry of Power', January 2007, is 68,869 MW, as shown in the following table.

Sector	Hydro	Thermal	Nuclear	Total	
	MW	MW	MW	MW	%
Central sector	9,685	23,810	3,160	36,655	53.2
State sector	2,637	20,352	-	22,989	33.4
Private sector	3,263	5,962	-	9,225	13.4
Total all India	15,585	50,124	3,160	68,869	100.0

Tab 2: Targeted power generation capacity addition during 11th five-year plan (1 April 2007-31 March 2012)

As regards the energy sources used, attention continues to be paid to the use of India's vast coal reserves, which are considered the cheapest primary energy source, thanks to efficient and "clean" technologies. Proven national coal reserves are considered to amount to about 96 billion tonnes. In the medium term the use of gas resources is also regarded as having a significant role to play. As for the six nuclear power plants existing at present, their number is expected to triple by 2020. Renewable (non-conventional) energy sources are also planned to play a growing role for power generation.

Power generation

As per the data compiled by CEA, gross electricity generation in India during the year 2004/05 was 666 TWh. Of this, public sector utilities (central sector, state electricity boards and electric departments/government undertakings/corporations, etc.) accounted for 80%, private sector utilities accounted for 9%, while the non-utilities (captive power plants in the industries) generated the balance of 11%. In terms of prime mover utilised for gross electricity generation, the percentage breakdown of contribution in the year 2004-05 was as follows:

Prime mover	% of gross generation
Steam	70.32
Hydro	12.72
Gas	11.50
Diesel	2.20
Nuclear	2.56
Wind	0.67
Biomass	0.03
Total	**100.0**

Tab 3: Electricity generation by prime mover; India; 2004-05

According to the 'Report of Working Group on Power for 11th Plan (2007-12) – Ministry of Power', January 2007, the actual year-by-year power supply situation for the 10th plan period 2002-07 was as shown in the table below:

Year	Peak			Energy		
	Requirement MW	Availability MW	Shortage %	Requirement mill. KWh	Availability mill. KWh	Shortage %
2002-03	81,492	71,547	12.2	545,983	497,690	8.8
2003-04	84,574	75,066	11.2	559,264	519,398	7.1
2004-05	87,906	77,652	11.7	591,373	548,115	7.3
2005-06	93,255	81,792	12.3	631,757	578,819	8.4
2006-07 (up to Dec. 2006)	100,466	86,415	14.0	510,223	465,149	8.8

Tab. 4: Actual power supply situation on an all-India basis in the 10th five-year plan (2002-07)

Power transmission and distribution

An extensive network of transmission and distribution lines has been developed over the years for evacuating power produced by electricity generating stations and distributing the power to consumers. Depending upon the quantum of power and the distance involved, lines of appropriate voltages are laid. The nominal extra high voltages used are 500 kV HVDC and 765 kV, 400 kV, 23/220 kV, 110 kV and 66 kV AC lines. These have been installed by the state electricity boards and by generation, transmission and distribution utilities in the central sector.

The standard voltages of operations on the distribution side are 33 kV, 22 kV, 11 kV, 400/230 volts along with 6.6 kV, 3.3 kV and 2.2 kV. By the end of March 2005, the length of transmission and distribution lines operating at various voltages was 6,570,823 ckt. km.

India originally had five separate regional grids. The Power Grid Corporation of India Ltd. was established in 1989 and led to the connection of the individual grids and thus to the creation of a national electricity grid.[5] 45 % of the electricity generated nationally is already transmitted on the interstate grid to the consumption regions. The total transmission capacity already amounts to 11,500 MW, and by 2012 the national transmission grid is planned to be expanded to reach a transmission capacity of 37,150 MW.

How efficient and powerful the network eventually is depends in part on the ability to resolve problems such as insufficient stability. Indeed, the Indian Government estimates the yearly damage caused by power blackouts at more than US$ 35 billion.

Power consumption

Total electricity consumption in the 2005/2006 fiscal year amounted to nearly 567 TWh. In the 2004-05 fiscal year, household consumption made up a share of 21 %, agriculture 20 %, industry 44 % and other sectors 15 % (including trade and public services). For the same year, the per capita electricity consumption was about 613 KWh per year.

The Indian electricity market remains characterised by significant shortcomings as regards meeting peak demand (2006: 14 %) and satisfying electricity demand (2006: 8.8 %). With the implementation of measures for energy efficiency and energy saving at all production and consumption levels, the Indian Government is hoping to provide a cheap alternative to the cost-intensive strategy of capacity expansion and grid development. The Ministry of Power for instance awards distinctions and prizes such as the "Productivity Award" to ensure that thermal power plants are operated as efficiently as possible.

Electricity prices

The lack of efficiency and profitability of national and state electricity suppliers are in part the result of a distorted price structure that does not offer cost recovery and favours the agricultural sector and private households. The commercial sectors and industry, on the other hand, are penalised by higher prices.

5 Information on installed capacity, expansion plans and inter-regional connection of the national transmission grid can be found at www.cercind.org/powergrid.htm.

The Expert Committee on Integrated Energy Policy (Planning Commission, August 2006) has estimated that Indian consumers, particularly in industry and commerce, pay among the highest tariffs in the world. On the basis of country reports it calculated that in 2002 the average purchasing power parity price in US cents per kWh was 30.8 in India, 7.7 in US, 9.5 in Germany, 15.3 in Japan, 20.6 in China and 27.6 in Brazil.

At the same time, the unreliability of the electricity grid has pushed a number of industrial users to generate their electricity in their own captive power plants. In spite of the fact that public utilities thus lose their most profitable customers, this price policy remains common. Most of the state electricity regulatory commissions have now published new tariffs, and these partly contain approaches aimed at correcting the aforementioned imbalances as well as at designing electricity tariffs at more cost-recovering levels. Reaching the aim of a balanced price policy remains hampered by insufficient electricity consumption measurement and illegal tapping of electricity. It is estimated that a mere 55 % of the generated electricity is billed, and only 40 % correctly accounted for.

19.2 Market players

The most important players in the Indian electricity sector are the states. There, electricity supply is operated to a large extent by 13 State Electricity Boards (SEBs) and 13 Electricity Departments (EDs) in the states and the union territories. The SEBs and EDs control 90 % of regional power distribution in 25 of the 28 states; they are also partially in charge of electricity transmission. The states' public suppliers own 57 % of the total electricity generation capacity (as of March 2006).

Besides these regional players, central sector utilities (CSUs) play a predominant role in the Indian electricity sector. With a 32 % share of the national electricity generation capacity, the National Thermal Power Corporation (NTPC)[6], the National Hydroelectric Power Corporation (NHPC)[7] and the Nuclear Power Corporation (NPC), which sell electricity to the SEBs, all belong to the CSU. The Power Grid Corporation is responsible for power transmission between states. The Power Trading Corporation was established in 2001 and is responsible for power trading between large independent electricity generators and different states.

The private sector is gradually taking on a more significant role among market players, especially as regards remote areas where more and more private companies and municipalities are intended to provide electricity generation and distribution services. The share of private sector participation in power distribution now amounts to about 10 %. In two states – Orissa and Dehli – power distribution was completely privatised as part of a reform of the electricity sector. Splitting up and privatising the SEB in Orissa alone resulted in the creation of two generating, one transmission and four distribution companies.

6 The NTPC operates coal- and gas-fired plants. It alone has a 20 % share of the national electricity generation capacity.
7 The NHDC is the largest organisation for the development of hydropower in India. Its goal is also to ensure that the use of hydropower, wind, tidal and geothermal energy develops in accordance with the national economy policy.

19.3 Legal Framework

The Ministry of Power (MoP) has primary responsibility for power sector development in the country, and is assisted in technical and economic matters by the Central Electricity Authority (CEA). The Ministry of New and Renewable Energy (MNRE)[8] is responsible for the development and promotion of renewable energies, and nine regional MNRE offices ensure that all MNRE programmes are effectively implemented in the individual states. These regional MNRE offices work directly with the state governments. The five-year national plans for the various economic sectors including the power sector are formulated by the Planning Commission, an institution specially established for this purpose. This institution is also in charge of co-ordinating the planning activities of the various energy ministries, as well as tuning these with the economic goals of the central government.

Reforms in the power sector

Over the years, India's electricity sector has proved resistant to reforms. The Electricity Laws (Amendment) Act of 1991 as well as a reform of the electricity acts of 1910 and 1948 to open the market for private and foreign investors initially proved unsuccessful. Hardly any use was made of measures resulting from these amendments, such as the reduction of import tariffs and taxes or guaranteed returns for independent electricity producers. At the same time, it became obvious that the deteriorating financial situation of the SEBs made it impossible for investments in the electricity sector to keep up with the rapidly growing electricity demands resulting from economic growth.

A key strategy paper for the reform of the states' electricity sector, the Minimum National Action Plan for Power, was adopted at the end of 1996 with the aim of ensuring the profitability of SEBs and their independence from political institutions.[9] The idea was to ultimately create a regulatory and operational environment that enabled far-reaching private investments.

Against the background of India's federal structures and, linked to this, state autonomy, the reforms were at first implemented only in a few states. Now, though, they are acquiring broader acceptance:[10] in 12 states SEBs have been unbundled and corporatised by their respective state governments. In another 10 states, similar steps towards unbundling the electricity sector are in preparation. Nevertheless, independent electricity producers continue to play a secondary role, in spite of the fact that they are considered to have an essential role to play to ensure security of supply. As regards the area of power transmission, private sector participation has up to now remained basically insignificant.

Power trading was instituted with incorporation of the Power Trading Corporation of India in 1999. Enactment of the Electricity Act 2003 paved the way for developing the market for optimal utilisation of energy, promoting the exchange of power with neighbouring countries and easy access for exchange of power within the country from surplus to deficit systems. By the end of March 2005, 13 power trading companies had been issued power trading licenses. However, during the year 2004-05 only 4 companies were engaged in power trading. The total volume of electrical energy traded by these companies was about 11,846 GWh, which constitutes about 2% of the total electricity generated by the utilities.

8 The "Ministry of Non-Conventional Energy Sources" was renamed "Ministry of New and Renewable Energy" on 14 October 2006.
9 The SEB in the state of Orissa was privatised that year.
10 For current information on the state of the reforms in individual states, please refer to the website of the Ministry of Power at: http://powermin.nic.in.

Regulatory commissions

An Electricity Regulatory Commission Act was passed in April 1998 for the establishment of regulatory commissions at central and state level in order to introduce an urgently needed tariff reform and create more transparency around financial subventions.[11] The Central Electricity Regulatory Commission (CERC) sets the tariffs of state power producers, regulates national electricity transmission and distribution, and advises the central government on matters of tariff or competition policy. The role of the State Electricity Regulatory Commissions (SERCs) is to regulate the regional generation and distribution market. So far, 24 of the 28 states have either constituted or notified the constitution of SERCs.

Central Electricity Authority

The Central Electricity Authority (CEA) was established in 1948. It assists the MoP on technical and economic matters, and also advises the central government on issues related to national electricity policy. Further, CEA co-ordinates the activities of the national planning agencies with the aim of meeting national economic interests while ensuring reliable and affordable electricity supplies for all electricity consumers.

Electricity Act 2003

The Electricity Act became effective in June 2003 and replaces all previous electricity acts. The Act seeks to eliminate the near-monopoly of the SEBs and aims for a multi-buyer, multi-seller market model. With the removal of a series of administrative obstacles to the development of the electricity sector, it also eases potential investors' initiatives. It is especially self-generators and players in rural areas who will benefit from this act. Indeed, those companies generating their own supplies are no longer required to seek approval from the relevant energy commission in order to generate and transmit electricity to the grid. Besides industry, commercial users such as hotels and hospitals as well as co-operatives and associations are now also allowed to produce electricity to cover their own needs.

Electricity producers and traders now can access, for a fee, the transmission and distribution grids.[12] Power generation no longer requires licensing, with the exception of hydropower. However, licenses are issued for power trading, transmission and distribution.

For locally operating organisations in rural areas (municipalities, co-operatives, concessionaires, non-governmental organisations, etc.) not only power generation, but also transmission, distribution and trade are not subject to licensing requirements.

The Act puts the SEBs under considerable pressure to adapt, as it can lead them to losing an important part of their customers. In addition to the growing opportunities for self-generation, this loss can be connected with the fact that electricity producers no longer have to sell their electricity to the financially crumbling SEB. Instead, they now may conclude agreements with private buyers.

11 "Electricity Regulatory Commission Act" from 25. April 1998.

12 Transmission companies operating at regional or supra-regional level may demand a surcharge on transport fees for power transmission. Power transmission to other sites for own use is exempted from such fees.

19.4 Policy for the Promotion of Electricity Generation from Renewable Energy Sources

A department of "non-conventional energy sources" was set up as early as 1982 in the Ministry of Power. In 1992, this department became an independent Ministry of Non-conventional Energy Sources (MNES). In October 2006, MNES was renamed the Ministry of New and Renewable Energy (MNRE).

The mandate of MNRE covers the entire renewable energy sector, namely solar, wind, hydro, biomass, geothermal and tidal energy sources.

MNRE has set up the following institutions under its auspices:

Indian Renewable Energy Development Agency (IREDA), a financial institution to provide concessional financial support to the renewable energy sector.

Solar Energy Centre, National Institute of Renewable Energy and Centre for Wind Energy Technology (C-WET) for research & development, technology development, testing and certification, etc. in the respective fields.

Various renewable energy projects and programmes are implemented through a country-wide implementation network, consisting of state nodal departments, state nodal agencies, autonomous organisations, NGOs, R&D institutions, financial institutions and private entrepreneurs.

Nine regional offices of MNRE have been set up in various state capitals for monitoring, supervision, awareness creation and liaison with state agencies, NGOs and project promoters, and providing feedback from the field.

According to the Electricity Act of 2003, states have to set up rules to determine electricity remuneration from renewable energies. In 2005, the states of Karnataka, Uttaranchal and Uttar Pradesh introduced special feed-in tariffs for electricity from renewable energy, bringing the number of states with similar feed-in policies from three to six. The state of Maharashtra extended its wind-power feed-in tariffs to biomass, bagasse and small hydropower plants. In early 2006, the Indian Government announced the introduction of a new tariff policy seeking to further promote electricity generation from renewable sources with the help of quota regulation, preferential tariffs and guidelines for the regulation of prices in case of unsecured service.

Renewable Energy Plan 2012

According to a draft by the government, the aims of the Renewable Energy Plan 2012, which is geared towards providing basic energy supplies to rural areas, include the following:

- Achieving a 10 % share (about 12 GW of installed capacity) of national power supply from renewable energy sources[13]
- Providing electricity to at least 4,500 rural settlements (25 % of the 18,000 villages without electricity) on the basis of renewable energies
- Installing 5 million solar-powered lanterns and 2 million solar home systems

13 Share of each sector: wind power 6,000 MW, biomass 3,500 MW, small hydro 2,000 MW, energy from wastes 400 MW, solar thermal 250 MW and solar photovoltaic 30 MW.

Financial and fiscal incentives for renewable energies

As part of various programmes, the MNRE supports development projects in the electricity sector for wind power, small hydropower, biomass, biogas and solar photovoltaic, taking advantage of several central and state government measures. Subsidies, credits and fiscal incentives enable research and development, the realisation of demonstration projects and participation in commercial investment projects. Financial and fiscal incentives at central level include:

- VAT exemption for most renewable energy products
- Reduced import duties for specific components
- Temporary exemption from income taxes for electricity generation projects
- Accelerated depreciation for tax purposes in the first year after the installation of systems
- Capital and interest subsidies, financial assistance with a reduced rate of interest for manufacturers and users of commercial and semi-commercial technologies
- Facilities for wheeling and third-party sale

And at the state level:

- Possibility of selling electricity to public electricity providers
- Preferential electricity transmission over the grid ("wheeling")[14]
- Preferential transmission over the grid
- Privileges in cases of power shortages (no cut-off)
- Banking opportunities[15]
- Preferential sales tax (e.g. deferment)
- Exemption from the electricity tax for self-generators
- Capital subsidies

The table below provides an overview of the various state assistance provisions for wind power.

		Andra Pradesh	Karnataka	West Bengal	Madhya Pradesh	Maharashtra	Rajasthan	Tamil Nadu	Gujarat	Kerala
Wheeling[16]	%	2	20	2	2	2	2	5	4	5
Banking	Months	12	2% p. million. for 12 months	6	–	12	12	5% (12 months)	6	9 (June–Feb.)
Tariff	Rs/kWh	2.25	2.25	Case by case	2.25	2.25	2.89	2.70	2.60	2.80
Annual tariff adjustment	%	5	5.2	Case by case	–	(0.15 RS/kWh for 13 years)	5	–	0.05 Rs/ kWh	5 and for 5 years from 2000-01
Third-party sale		not allowed	allowed	not allowed	allowed	allowed	allowed	not allowed	not allowed	not allowed
Capital subsidies		max. 20% (2.5 million Rs)	(max. 2.5 million Rs)	–	As for other industries	max. 30% (max. 2 million Rs)	–	–	–	–
Other systems of incentives		Industry status[17]	5-year exemption from electricity tax	–	–	–	5-year exemption from electricity tax	–	Exemption from electricity tax for 30% of the installed capacity	–

Tab. 5: State assistance provisions for electricity generated from wind power, India[18]

14 "Wheeling" means that a specific percentage of the electricity is billed as transmission surcharge. For instance, if the wheeling charge is 5%, 100% of the contractual quantity must be fed in, but the grid operator passes only 95% to the recipient.

15 "Banking" means that electricity (surplus) is supplied to the local electricity supplier for resale. If he needs it, the supplier is allowed to draw the exact same quantity of electricity from the grid within a given period of time.

16 Percentage of electricity quantity fed in.

17 The industry status confers entitlement to certain other incentives.

18 Sources: MNES, Annual Report 2002/2003, Wind Power Monthly, 11/2003.

Indian Renewable Energy Development Agency

The Indian Renewable Energy Development Agency (IREDA) was established in 1987 as a public limited government company to ensure financial assistance for research and implementation programmes related to renewable energies.[19] As a public financial institution, it also grants credits on a not-for-profit basis for projects. As counterparts at state level, state nodal agencies concentrate their work on the selection, promotion and dissemination of information on renewable energy projects.

As of 31 March 2006, the IREDA had granted € 1.3 billion (74.5 billion Rs) in credits at a reduced rate of interest. Of this sum, € 650 million (40.18 billion Rs) had at this point been disbursed for investment projects – € 240 million (13.9 billion Rs) of this into the wind power sector. The funds came from both national and international financing sources, among which was a US $ 78 million World Bank loan for wind power projects. The German KfW (Bank for Reconstruction) also supports the IREDA with a € 61 million line of credit.[20]

Clean Development Mechanism

India officially adopted the Kyoto Protocol in August 2002. The National CDM Authority (NCA) was set up in 2003 as part of the Ministry of Environment and Forests (MoEF) to be the designated national authority (DNA) for the Clean Development Mechanism (CDM). By the end of February 2006, the NCA had already approved 227 projects, 118 of these on the basis of renewable energies. By the end of December 2006, the CDM Executive Board (EB) had registered 141 projects located in India, which corresponds to 30 % of all projects presently registered by the EB, putting India in first place. As for the emissions certificates issued with these projects, India ranks fourth worldwide with 12 %. Among the most recent CDM projects registered by the EB are two biomass-based power generation units: an 8 MW grid-bound plant with a yearly CO_2 saving potential of around 21,000 tonnes and a self-supplying plant for a textile company with a yearly CO_2 saving potential of around 19,400 tonnes.

The memorandum of understanding signed at the end of 2006 by the Industrial Development Bank of India (IDBI) and the International Finance Corporation (IFC) guarantees support to Indian companies for the realisation of CDM projects, including assistance with the sale of national certificates on the global market in order to give them quick and easy access to the revenues generated by CDM projects.

The Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation – GTZ) together with the Bureau of Energy Efficiency (Statutory Body under Ministry of Power) started the bilateral project CDM – IGEN under the Indo-German Energy Programme (IGEN). Among other things it fosters the implementation of specific emissions reduction projects with partners in India. GTZ presently supports ten projects with capacity building, among them a 300 MW wind farm in Tamil Nadu and two small hydropower plants of 6 and 9 MW.[21]

19 The IREDA is now also in charge of financing energy efficiency and energy saving projects.
20 German governmental funds for financial co-operation combined with KfW's own funds.
21 For more information on the co-operation between Germany and India on CDM, please consult www.cdmindia.com.

19.5 Status of Renewable Energy Sources

In September 2006, the installed power generating capacity of renewable energy based plants amounted to close to 9,100 MW (excluding large hydropower). Over the past years, wind power has become the most important technology after hydropower and will probably strengthen its position in the coming years. India is however making use of only a fraction of the available potential for the use of renewable energies. An overview of available potential and cumulative achievements, as given by the MNRE, is shown in the following table:

Sources/ systems	Estimated potential	Cumulative achievements (as at 30.09.2006)
Power from renewables		
Grid-interactive renewable power		
Bio power (agro residues & plantations)	61,000[1] MW	466 MW
Wind power	45,000[2] MW	6,070 MW
Small hydro power (up to 25 MW)	15,000 MW	1,850 MW
Cogeneration-bagasse	5,000 MW	572 MW
Waste to energy	7,000 MW	35 MW
Solar power	50,000[3] MW	2.7 MW
Sub total	**183,000 MW**	**8,996 MW**
Distributed renewable power		
Biomass/cogen. (non-bagasse)	-	11.5 MW
Biomass gasifier	-	76 MW
Energy recovery from waste	-	11 MW
Sub total	-	**98.5 MW**
Total (A + B)	-	**9,094.5**
Remote village electrification	-	2,237/594 (villages/hamlets)
Decentralised energy systems		
Family type biogas plants	12 million	3.9 million
Community/institutional/ night-soil-based biogas plants	-	3,902 nos.
Improved chulha (cooking stove)	120 million	35.2 million
Solar photovoltaic programme	20 MW/km^2	
I. Solar street lighting system	-	54,659 units
II. Home lighting system	-	301,603 units
III. Solar lantern	-	463,058 units
IV. Solar power plants	-	1,860 kW_p
Solar water heating systems	140 million km^2 collector area	1.5 million km^2 collector area
Aero-generator/ hybrid systems	-	520 kW
Solar photovoltaic pumps	-	7,068 units

Tab. 6: Estimated medium-term (2032) potential and cumulative achievements as at 30 September 2006

Source:
- Ministry of New and Renewable Energy

1: 16,000 MW from agro-residues and 45,000 MW from around 20 m ha of wastelands yielding 10 MT/ha/annum of woody biomass giving 4000 k cal/kg with system efficiency of 30 % and 75 % PLF. Bringing wastelands under biomass cultivation would require a major inter-Ministerial effort with, among others, Ministry of Agriculture; Rural Development; Panchayati Raj; Environment and Forests; and Bio-Technology as major partners.

2: Depending upon future developments making solar technology cost-competitive for grid power applications.
3: Figures are being firmed up.

Hydropower

In the fiscal year 2005-06 hydropower contributed about 16% of total power generation in India. Although installed hydropower capacity has been continually increasing, reaching 33 GW in 2006, i.e. 22% of the total potential, its share of the total installed capacity declined (in the last 40 years) from over 50% in 1962-63 to 26% by the closing of the year 2005-06 (to just under 26%). In order to reverse this trend, competence for small hydro projects (3-25 MW) was transferred at the end of 1999 from the Ministry of Power to the MNRE, which had already been responsible since 1989 for mini hydro power plants (< 3 MW). The Ministry of Power is now only involved in large hydro projects (> 25 MW). In the fiscal year 2004-05, 1.435 GW by large hydro power plants were added.

Hydropower potential

India's total hydropower potential is evaluated at 84 GW at 60% load factor. By the end of March 2006, 19.1% of the potential (about 16 GW at 60% load factor) had already been developed and about 5.6% was under development. This means that 75.3% of the hydroelectric potential is yet to be harnessed. Studies have already been conducted for 162 hydropower projects in 16 states with a total capacity of nearly 48 GW. According to MNRE and CEA studies the potential of small hydropower plants (< 25 MW) alone is estimated to reach more than 15 GW, and that of mini (< 3 MW) and micro-hydro (< 100 kW) together to total 10 GW. An MNRE database lists around 4,400 potential sites with a capacity of nearly 10.5 GW. Projects with a total capacity of about 1,750 MW were carried out up to the end of 2005.

Mini hydropower expansion and systems of incentives

Micro and mini hydropower generally represent an economically advantageous option for electricity generation in remote and mountainous regions with no access to regional supply grids. Thanks to good promotion by the state governments, mini hydropower plants with an installed capacity of about 1250 MW (by end of September 2006 according to the MNRE) have been implemented in India, which meant that electricity generation by such plants had quadrupled in the last ten years. It was predominantly the government that constructed small hydropower in the past, but measures offering incentives to private investors resulted in the latter now being the source of most of the added capacity. In addition to several incentive systems at state level,[22] the following promotional elements are managed at national level by the MNRE and IREDA:

- Financial assistance for studies and expertise;
- Financial support for detailed project evaluation and reports;
- Investment assistance;
- Reduced rate of interest for commercial projects;
- Subsidies for plant revision and modernisation, as well as rehabilitation and expansion.

Manufacturers and traders

India has a well developed network of producers and traders which can provide the market with complete systems as well as construction components and spare parts. There are eight producers for small hydro turbines alone.

22 16 states have adopted policies for the promotion of small hydro projects, sometimes including considerable concessions, or have announced such policies and sparked off important demands from private investors. In those states, more than 760 sites with about 2,500 MW of potential capacity are already on offer and have partly already been allocated.

Wind power

The Indian wind industry has been experiencing rapid growth for the past several years. With an added 1,430 MW in 2005, the installed wind power capacity totalled 4,435 MW at the end of 2005, putting India in fourth place worldwide. This includes of 4,336 MW of private projects. In the first nine months of 2006, India's installed wind capacity grew to reach 6,070 MW. The availability of certain plants is however likely to be restricted due to technical damage.[23] Under the Small Wind Energy and Hybrid Systems programme implemented by the MNRE, 1,141 farms combined with water pump systems had been installed by the end of September 2006 (with an additional 464 kW of installed electric wind farm capacity) with a maximum 5 kW rating as well as hybrid systems with a 10 kW maximum rating. The installed wind capacity is presently expected to increase and reach 12 GW by 2010.

State	Total potential	Technical potential	Installed capacity as of 2003	Installed capacity at the end of 2005
	MW			
Andhra Pradesh	8,275	1,750	93	126
Gujarat	9,675	1,780	173	288
Karnataka	6,620	1,120	141	487
Kerala	875	605	2	2
Madhya Pradesh	5,500	825	23	35
Maharashtra	3,650	3,020	401	655
Rajasthan	5,400	895	73	313
Tamil Nadu	3,050	1,750	1,004	2,527
West Bengal	450	450	1	1
Other	2,990	–	2	2
Total	**45,195**	**12,875**	**1,912**	**4,435**

Tab. 7: Wind power potential and installed capacity in the Indian states; 2003 and 2005; MW[24]

Wind Resource Assessment Programme

The total potential of Indian wind resources is evaluated at about 45 GW. A comprehensive assessment was made possible by the Wind Resource Assessment Programme (WRAP), managed by the MNRE and supported by the Centre for Wind Energy Technology (C-WET), which is also the central institute for research and development for the Indian wind industry. An evaluation of the data collected at about 1000 monitoring stations resulted by 2004 in the identification of 208 potential sites on land.[25] The chosen locations will be identified by SEBs and usually sold or leased to private investors. 22 further monitoring stations were set up in 2005 and 2006, and 47 are being planned. No data are available for the utilisation of offshore wind power on the coasts of India. A wind atlas for the whole country is presently being developed to provide a detailed and complete overview of India's wind resources.

Promotion of wind power

A wind power programme co-ordinated among others by MNRE has been set up to promote and further develop the utilisation of wind power in India. This programme covers for instance studies on wind potential, research and development projects and demonstration wind farms. The latter receive subventions of up to 60 % for a maximum of 6 MW per state. The government agency IREDA also grants loans for private projects. In addition to excise duty reductions and low custom duties for single wind energy components, a tax regulation specifying that wind farms can benefit from a depreciation of 80 % of the project costs in the first year sets an incentive for investing in wind power.

23 This is a downside of the present system of incentives: as time passes, plants often suffer technical damage, as their operation, unlike their construction, only brings in insignificant profits for their investors.

24 Sources: Indian Wind Energy Association, 2003; Ministry of New and Renewable Energy – Annual Report 2005/2006

25 The selection criterion for appropriate sites is a wind power density of 200 W/m^2 at a 50 m height. A map of wind potentials is available at www.inwea.org/map.html.

Many State Electricity Regulatory Commissions (SERCs) in their respective states have introduced preferential tariffs for wind power. The wind energy remuneration price presently varies from state to state, reaching between 3.9 and 6 euro cents/kWh (2.25 and 3.5 Rs/kWh). Some states offer an additional yearly premium, whose main purpose is to adapt tariffs to inflation, although its role in some states goes further. With a feed-in tariff of 6 euro cents and a 0.26 euro cent yearly premium over a period of 13 years, Maharashtra presently offers the best conditions for feeding in wind energy. The attractiveness of remuneration rates, and thus their use by private investors, varies considerably from state to state. Indeed, nearly 90% of the wind farms installed up to 2003 were set up in only 4 states.

The context particularly benefits companies producing for their own needs: For one, they can by-pass electricity charges for commercial users, which at 6.3 euro cents/kWh are fairly high compared to that of other countries. But companies that can also feed their electricity into the national grid[26] further enjoy the privilege to be the last taken off the grid in case of power shortages. Some 80% of India's wind-based energy is produced for captive use, primarily by companies that want to avoid the high prices of state power suppliers.

Technical barriers to the development of wind energy

Although the theoretical potential of wind energy resources amounts to 45 GW, the technical wind potential is about 13 GW. This gap can be explained by, among other things, the insufficiently developed grid, which renders feeding-in impossible in many locations. Grid overloading and repairs lead even connected wind farms to stop at times of good wind power. The condition of roads presents a further barrier to the development of wind power in many places. Against this background, several sites with a potential for wind power exploitation, especially for wind farms of the megawatt class, become difficult to exploit from the outset.

Domestic wind turbine production

In the past few years India has established itself as an important wind turbine manufacturer. Around 15 manufacturers partially co-operate with international companies in joint-ventures or as part of licence agreements, increasingly for export. Only eight of these companies however actually offer wind generators for more than 250 kW, so the import share for large plants remains high.

The Indian manufacturer Suzlon ranks as the fifth largest wind turbine manufacturer worldwide, with a 6% share of the global market. In 2005, Suzlon Energy alone produced and sold wind power plants with a total capacity of 758 MW for the Indian market. The company produces wind turbines with a capacity of between 350 and 2100 kW. The German-Indian joint-venture Enercon India ranks second, and since its inception in 1994 has already installed around 750 MW, with 225 MW coming in 2005 alone. The national manufacturer NEPC India, which specialises in small turbines, ranks fourth, right behind Vestas RRB.

India has hardly any independent planning offices or servicing companies, so wind turbine manufacturers are generally also responsible for the upkeep and operation of their turbines.

26 Those who generate electricity for their own use on a site that is not the usual industrial site, and thus transmit their electricity via the public grid, must sell between 4% and 18% of the transmitted electricity, depending on the state.

Biomass

The biomass from agricultural and forest residues available for energy generation is estimated at 120-150 million tonnes, which represents a power generation potential of 16 GW. According to the MNRE, some 5 GW could be generated by sugar cane bagasse-based co-generation plants alone in sugar mills. The total capacity of biomass-based generation plants using bagasse and agricultural residues reached about 970 MW in 2005. Further, the cultivation of unused surfaces offers a considerable potential for the production of biomass, with an estimated 62 GW that could be made available for grid-bound solutions and another 15 GW for decentralised use. A detailed study was launched in almost all states under the ninth five-year plan (1998-2002) in order to estimate more precisely and localise the available resources. The data collected are meant to be incorporated into a comprehensive resource atlas.

Plants connected to the grid and the plants of industrial self-generators with a minimum capacity of 1 MW are supported under the MNRE Biomass Power/Co-Generation Programme, as is research and development for state-of-the-art gasification plants and engines, for example. Assistance is provided in the form of reduced rates of interest, subsidies, fiscal incentives, feasibility studies and training measures. A number of states offer further incentive mechanisms such as wheeling, banking, higher feed-in tariffs and the option to sell electricity to a third party.

With these initiatives, by the end of the year 2005 capacity addition of 118 MW by biomass power/cogeneration projects in five states was achieved against a target of 160 MW. During the year 2004, in the private sector sugar mills the steam parameters were upgraded from 67 ata steam pressure to 87 ata and 515 °C which give almost 5 % to 6 % higher output in gross power generation. As of now there are 12 plants already in operation in four states and about 15 projects are under implementation.

Biomass gasification plants

Large biomass gasification plants with a capacity of 3 to 500 kW are built in India. Over 1,800 gasification systems with a capacity of 70 MW are presently in use for decentralised electricity supply. Biomass gasification plants are being increasingly used thanks to various Village Energy Security test projects conducted under the MNRE rural electrification programme. These projects develop supply structures in a participatory process, with a particular focus on the participation of women, to cover the various energy needs within a village on the basis of the available energy resources. These systems are also being used for operating water pumps, and meeting unmet demand for electricity in the villages. Most of these systems are being implemented in association with district rural development agencies and village panchayats, which operate and maintain these systems.

The MNRE provides a subsidy for the installation of biomass gasifier systems. Rs 1.5 million per 100 kW_e on a pro rata basis is provided for 100 % producer gas engines with biomass gasifier systems for meeting electricity needs in electrified villages as well as for grid connected power. The balance cost is to be met by the user agency/entrepreneur.

Biogas plants

Family-type biogas plants[27] are widespread in rural areas, with 3.89 million such plants in operation at present, fired for the most part with organic animal and household residues. The MNRE estimates the total potential of biogas at 12 million plants. The MNRE launched a National Biogas and Manure Management Programme for the 2005/2006 period with the objective of installing 66,000 new small biogas plants. The programme is supported by the Reserve Bank of India (RBI) and the National Bank for Agriculture and Rural Development. An intermediate target of 33,700 installed plants was achieved by the end of 2005.

Solar energy

The potential for the use of solar energy in India is great, with a daily insolation averaging between 4.4 and 6.6 kWh/m^2 and a yearly insolation length of between 2,300 and 3,200 hours. Solar photovoltaic technologies offer a unique decentralised option for providing electricity locally at the point of use. There are now 1.3 million photovoltaic (PV) systems with a total capacity of about 85 MW in operation in India, including first and foremost 342,000 solar home lighting systems, 560 thousand solar lanterns[28] and 7,000 PV water pumping systems for irrigation purposes, in addition to PV telecommunication facilities. Most systems are installed in rural regions remote from grids, but solar electric systems are also used in urban centres. Indeed, all street lights in Indian cities are planned to be operating with PV modules by 2012. Over 20 PV plants connected to the grid and with a total capacity of approximately 2.74 MW are in operation in the country.

Solar lanterns are particularly popular because of their low cost and flexibility of usage. Multi-purpose products such as lighting and television are also in demand. Financial access to these products is made possible by micro- credits and loans. They are granted by national banks among others, but also by self-help groups at village level. Further assistance measures comprise various financial and fiscal incentives. Manufacturers for instance benefit from credits with a reduced interest rate and tax exemption.

Solar thermal

Solar hot water systems

By the end of September 2006, the installed surface area of collectors amounted to approximately 1.5 million m^2. In recent years market activities evolved on a scale of 100,000 m^2 yearly, with the largest share to be found in the household use of solar thermal systems with a collector area of between 2 and 10 m^2. The commercial sector, where collector areas of 10 to 100 m^2 are used, and the industrial sector also gained in significance. More than 70 manufacturers of solar thermal systems have already been certified by the Bureau of Indian Standards (BIS).

In 2005, the MNRE launched a programme on solar water heating that aims at increasing collector surface by one million m^2 by March 2007. The programme provides soft loans with reduced interest rates repayable over a period of 5 years to domestic, institutional and commercial users of solar thermal systems. 19 banks and micro-financing institutions are taking part in the programme.

27 The size of the plants most used in India lies between 1 m^3 (for cooking and lighting purposes for a 3-4 people household) and 6 m^3 (for cooking and lighting purposes for a 18-24 people household).

28 SHSs are particularly in demand due to the numerous ways in which they can be used. The low costs and flexible use of solar lanterns are criteria that led to their increasing popularity.

Geothermal energy

Geothermal energy in India has up to now been used for heating purposes but not for commercial power generation, the potential of which is estimated at 10,000 MW.

The Geological Survey of India[29] identified more than 300 possible sites for geothermal power plants and published its study in a resource atlas. Since then, a network of research institutes has been looking into the ways of exploiting this potential and set up small demonstration electricity generating plants. The geographical focus of the studies lies on geothermal fields in Chhattisgarh, Jammu and Kashmir, but high temperatures suited for electricity generation have also been recorded in geological layers in the states of Himachal Pradesh, Uttaranchal and Jharkhand.

19.6 Rural Electrification

The central transmission and distribution grids reach by no means all Indian villages and households. About 79% of Indian villages have access to electricity,[30] but this rate varies considerably among individual states: between 100% in the states of Andhra Pradesh, Goa, Haryana, Kerala, Maharashtra, Nagaland, Punjab and Tamil Nadu and below 60% in the states of Bihar (47%), Jharkand (22%), Meghalaya (50%) and Uttar Pradesh (58%). In terms of households, the electrification rate reaches about 44%, i.e. approximately 78 million households of the more than 138 million households as per 2001 census still have no access to electricity supplies.

In the Electricity Act of 2003, the Indian Government pledges to electrify all rural settlements. Corresponding guidelines are to be drawn up in co-operation with the states.[31] Decentralised energy systems fed from renewable energy are particularly adapted to those villages that are located on hardly accessible sites and thus cannot hope to be connected to the grid. Separate municipal grids will be set up in addition to small individual systems such as solar home systems.

National activities

The MNRE contributes to rural electrification with several sectoral programmes. The Remote Village Energy Programme focuses on villages with no prospect of being connected to the national grid in the near future. The Village Electrification Programme of MNRE was initiated in 2001 for the provision of basic lighting facilities in unelectrified census villages for lighting 5,000 unelectrified census villages without reference to the fact whether these villages were likely to receive grid connectivity or not. The scheme was subsequently modified to cover only those unelectrified census villages that were not likely to receive grid connectivity. By the end of September 2006 2,237 census villages and 594 hamlets had been provided with lighting. The MNRE provides a subsidy for up to 90% of the benchmark installation costs of various non-conventional energy systems/devices. Initially, the programme provided SPV home lighting systems with 1-4 light connections, but from 2004-05 the subsidy has been restricted to models with only two light connections. These lighting systems provide around 0.1 kWh of energy per household per day. A few villages have also been electrified with distributed SPV power plants, biomass gasification systems and small hydro systems.

29 See also www.gsi.gov.in
30 Since February 2004 'A village would be declared as electrified if electricity is provided to public places like schools, panchayat office, health centres, dispensaries, community centres etc. and the number of households electrified should be at least 10% of the total number of households in the village.'
31 The Ministry of Power's November 2003 "Discussion Paper on Rural Electrification Policies" describes the pending reform tasks, gives a short overview of rural electrification in India and presents alternative supply schemes at municipal level.

The Integrated Rural Energy Programme (IREP) focuses both on villages that are already electrified and on villages whose electrification is still pending. It aims to provide renewable energy based on non-electrical energy systems, such as solar thermal systems for cooking and drying, and also offers subsidies for pilot projects and technical assistance. The IREP further aims to strengthen personnel and organisational capacities in order to involve local actors in the energy supply planning process.

As part of this strategy, in April 2005 the Ministry of Power introduced the Electricity Infrastructure and Household Electrification programme. Under this programme, the Rural Electrification Corporation (REC) is responsible for ensuring that all villages that are not covered by the MNRE programme either get connected to the national grid or receive a separate conventional-fuel-based grid within four years.[32] Thus, another 10,000 villages were planned to be supplied with electricity by the end of 2006.

The (REC) is answerable to the Ministry of Power. It provides financial assistance for all measures for the improvement of rural electrification, including renewable energy. Under the national strategy "Mission 2012 – Power for all", all villages are planned to have basic electricity supplies by the end of 2007 and all households are to be electrified by 2012.[33]

Rate of exchange (28.12.06):
1 Indian rupee (INR) = € 0.01717

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20 Indonesia

20.1 Electricity market

Installed capacity

At the end of 2005, the public power grid in Indonesia was being fed by an approximate total of 28 GW of installed generating capacity. The power plants operated by the state electricity company Perusahaan Listrik Negara (PLN) accounted for 87 % of power generating capacity. A large proportion of those plants (42 %) are oil-fired, although other types of plant also make important contributions to power generation, namely coal-fired (PLN: 20 %), gas-fired (PLN: 22 %) and hydropower (PLN: 14%).

Energy source	GW
Oil	10.04
Coal	4.78
Gas	5.26
Hydropower	3.35
Geothermal	0.48
Total	23.9

Tab. 1: Power plant capacities of the state electricity company PLN according to energy source; Indonesia; 2005[1]

Indonesia has numerous energy resources. Consequently, the national energy supply has enjoyed extensive independence based on indigenous deposits of petroleum, natural gas and coal[2] in such abundance that energy resources can even be exported.[3] At present, Indonesia is able to cover all demand for electricity within the country, though no electricity is being exported.

Power generation

Power generation has been expanding continuously in recent years. In 2005, power output reached 123 TWh, a 4 % increase over the previous year.

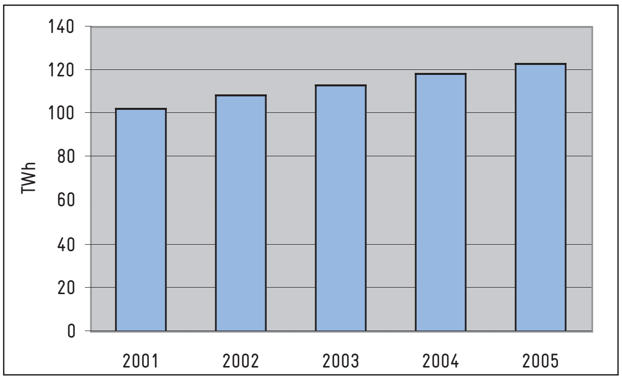

Fig. 1: Power generation [TWh]; Indonesia; 2001-2005[4]

Power transmission and distribution

In view of the highly subdivided national territory of Indonesia, consisting of some 6,000 inhabited islands, diverse approaches are taken to the supply of electricity. While the densely populated main islands of Java and Bali are almost fully electrified, the more remote islands have to contend with major supply gaps. Indonesia has two principal, mutually independent power grids: a high voltage grid on Java and Bali, and a "peripheral" medium voltage power grid for the other islands. Low technical standards cause periodical breakdowns on the one hand and, on the other, inefficiency and power losses of up to 12 % of all generated power, with attendant pecuniary losses totalling US$ 600 to 800 million annually.

1 Source: Association of the Electricity Supply Industry of East Asia and the Western Pacific; 2007.
2 A member of OPEC, Indonesia has more than 4.5 billion barrels of petroleum reserves (the largest of which are located on Sumatra), proven natural gas reserves totalling approximately 32 trillion m^2 (mainly in Aceh, East Kalimantan and off the coast of Java), in addition to 38 billion tons of coal resources.
3 Indonesia is the world's largest exporter of liquefied natural gas.
4 Source: BP Statistical Review of World Energy Full Report 2006.

The Indonesian power grids served more than 30 million households in 2004. That corresponds to a 53 % electrification level[5]. Two-thirds of all households without access to electricity are located in rural areas[6]. Indonesia has one of the lowest electrification levels of any country in Southeast Asia.

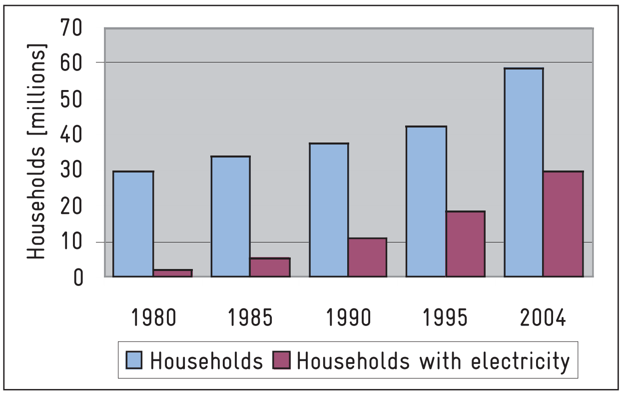

Fig. 2: Increasing access to electricity in Indonesia; millions of households; 1980-2004[7]

Despite the inefficiencies and the gaps in the grid, the electrification of Indonesia is a success story, considering that only 7 % of all households had electricity in 1980.

Power consumption

Nearly 80 % of all generated power is consumed on the main islands of Java and Bali. In 2004, energy demand totalled some 90 TWh there, in contrast with 24 TWh on all the remaining islands together. By 2006, overall power consumption had increased to 122 TWh. During periods of peak consumption, Indonesia's existing generating capacities no longer suffice. The Indonesian Ministry of Energy is anticipating an increase in demand for power to 122 TWh for Java and Bali alone by 2010, plus 36 TWh for the remaining islands. Average annual growth in demand for electricity through to 2012 is forecast to be about 9 %.

In 2006, per capita power consumption in Indonesia came to approximately 500 KWh. Despite significant increases in recent years, this is still one of the lowest rates of power consumption in the region. According to 2004 figures, the industrial sector accounted for 42 % of all electricity consumed, while private households used around 40 %, the services sector 13 % and the public sector 5 %.

Electricity prices

The state electricity company PLN enjoys an extensive monopoly in the sector and can therefore dictate the country's electricity prices. Following a sharp drop in electricity prices caused by devaluation of the Indonesian currency in connection with the Asia crisis, when the rupiah dropped from about 7 US ct/kWh to 2.5 US ct/kWh in the late 1990s, step-by-step increases since then have returned it to the equivalent of 6.2 US ct/kWh. With the aid of governmental subsidies, the PLN price structure is designed to provide the very numerous low-income households with electricity at reduced prices.

Despite ample domestic energy resources and governmental subsidisation of the electricity sector, Indonesia's electricity prices are higher than those of such countries as Thailand and Vietnam. The business practices of the state electricity company PLN are regarded as the primary factor in that connection. This is manifested by its production and provision costs among other things, which, at about 6.5 US ct/kWh, exceed the prices paid by ultimate consumers and which therefore have to be covered in part by state subsidies.[8] PLN presently has debts totalling some US$ 5 billion, which are hardly likely to be repaid at current electricity prices.[9] At the same time there is minimal room for raising prices – in a country in which nearly half the population, i.e. more than 110 million people, has to live on less than US$ 2 per day.

5 Source: National Committee on Infrastructure Policy and Investment, 2004.
6 The densely populated islands of Java and Bali, where 96 % of all villages have electricity, constitute an exception.
7 Source: Center of Energy Resources Development Technology; 2006.
8 Due to reduced fuel subsidies, this leeway is also shrinking.
9 The financial situation at PLN also leaves little room for new investments, and that, in turn, is making it difficult for PLN to find new customers.

Since 2006, to counter the existing power supply bottlenecks, bulk consumers in industry are having to pay higher prices for electricity during the peak hours of 6 to 10 p.m. Nevertheless, overloaded grids still regularly cause regional and broad-scale blackouts, particularly in remote rural regions, but also in metropolitan areas.

Expansion planning

Expansion plans in the electricity sector are largely determined at present by a noticeable dwindling of the country's once rich oil reserves.[10] Considering the combined effects of the increasing demand for energy, the dependence on oil of the country's power generating sector, the high world market prices for crude oil, and the substantially subsidised fuel prices on the domestic market, the avoidance of a repeatedly impending national energy crisis[11] takes absolute priority.

The Indonesian energy strategy, as described in the National Energy Management Blueprint, envisages a cutback in the use of oil for generating electricity from 55 % at present to between 15 and 20 % in 2025. Most of the resultant gap is to be filled by domestic coal and natural gas resources.[12] The intensified use of renewable energy resources is also envisaged within the scope of the upcoming transformation of the electricity sector.[13]

In response to countrywide increases in demand for electricity and the attendant worsening supply shortages, the Indonesian Government is planning to expand electricity generating capacity by 14 GW between now and 2012. The cost of investment for the provision of this new capacity is estimated at US$ 12 billion, most of which is supposed to be raised by the private sector.

20.2 Market Actors

The state electricity company PLN

Indonesia's electricity market is dominated by the state-owned[14] electricity supply company Perusahaan Listrik Negara (PLN). Nearly 87 % of all power plants feeding into the public power grid are run by PLN. As a fraction of the country's overall generating capacity, i.e. including autonomous suppliers, PLN's share is still above 50 %. As the sole certified operator of transmission and distribution networks, PLN enjoys a monopoly through its subsidiaries to the extent that the independent power producers licensed following partial privatisation of the electricity market are wholly dependent on the infrastructure of the state-operated company.

The publicly owned enterprise is undergoing a process of transformation in which subsidiaries engaged in power generation, transmission and distribution are being spun off. At present, the company as a whole comprises a holding company named PLN Pusat and two 100 % subsidiaries, namely the power producers Indonesia Power (IP) and Pembangkit Jawa Bali (PJB)[15], plus a total of six entities known as strategic business units (SBUs). One of the SBUs (P3B) is responsible for the transmission network, while the five others are concerned with the distribution of electricity to ultimate users.

The holding company, PLN, also includes a trading company which has the task of managing the power purchase agreements between private suppliers and the subsidiaries or SBUs. A third subsidiary – a joint venture between PLN and private investors – is in the process of being set up and will be responsible for the construction of new power plants in the future.

10 For several years now, Indonesia (a member of OPEC) has had to import crude oil due to insufficient domestic yields. Indonesia became a net importer for the first time in 2004, and this situation has since regularly jeopardised its membership of OPEC.

11 Around one-third of all government expenditures serve to support the domestic supply of power. Reductions in fuel subsidies in October 2005 caused an overnight jump in fuel prices of 120 % on average, and that, in turn, led to countrywide protests. The reductions largely brought the subsidisation of oil-fuelled power generation to an end.

12 The Government of Indonesia is presently endeavouring to convert national power production to a natural-gas basis, but is encountering difficulties, particularly in connection with the requisite infrastructure. While more brown coal (lignite) could be mined, a large proportion (40 %) of the existing deposits would necessitate above-average expenditures.

13 See section entitled Policy Promoting Renewable Energy Sources.

14 As a state-owned enterprise, PLN answers to three different ministries: the Ministry of Public Works in its capacity as the owner of PLN's corporate enterprises; the Ministry of Mines and Energy, which regulates the energy sector and defines energy policy; and the Ministry of Finance as the financial owner of PLN.

15 PJB generates electricity for the high voltage grid on Java and Bali. IP produces power for the "peripheral" medium-voltage grid.

Private actors

When the electricity sector was opened up for private activities in the late 1980s – due in part to the unreliability of the centralised supply of power – there was a substantial initial thrust in the development of autonomous power production. In the meantime, more than 10,000 companies in numerous sectors of the economy have gained the means to produce their own power. However, the autonomous commercial and industrial power producers have not yet begun to contribute anything toward the national power supply. Their opportunities in this regard are very much limited, above all else by infrastructural deficiencies in the power grid outside Java and Bali – problems that would be very expensive to rectify. Autonomous power generation by non-governmental actors (such as rural cooperatives) also plays a role in off-grid areas.

A number of contracts concluded in the mid-1990s between PLN and international power utilities were intended to provide an opening for independent power producers to feed into the national grid. Due in part to the Asia crisis, however, this IPP integration process is taking substantially longer than expected. PLN has been unable to meet its contractual obligations regarding the purchase of electricity.[16] Due to the fact that Indonesia is bound to a structural adjustment loan it was granted by the World Bank in 1998, PLN is obligated to fulfil the contracts as quickly as possible. Overall, international private-sector actors have shown little interest in investing in Indonesia. Independent power producers presently account for some 13% of the national power supply. As yet, no private actors have become active in the fields of power transmission or distribution.

Other Actors

Energy policy actors

The Ministry of Energy and Mineral Resources (MEMR) bears primary responsibility for the legislative structuring of the Indonesian energy sector and for decisions on energy policy. The Directorate General of Electricity and Energy Utilization (DGEEU) has specific competence regarding the systematic and ongoing development of the energy sector. The role of the DGEEU is therefore to:

- regulate and license independent (non-governmental) power producers;
- draw up the annual National Electricity General Plan (NEGP);
- publish yearly statistics on the national electricity and energy sector.

MEMR has bestowed upon PLN the responsibility for involving independent power producers in the national power supply systems.

16 Due to the Asia Crisis, PLN incurred a substantial debt burden. At the same time, electricity prices slipped well below the break-even point.

20.3 Legal Framework

Reform of the electricity sector

The Indonesian energy sector is in the early stages of transformation. The reform process was initiated by Electricity Law 20/2002 from the year 2002, which specified that:

- competition mechanisms are to be introduced into the electricity sector step by step and region by region;
- a regulatory authority, the Electricity Market Supervisory Authority (EMSA), is to be established for supervising independent power producers in the newly legally established "competition regions";
- electricity tariffs in the competition regions must be adequate to cover all costs and remain subject to regulation and supervision by EMSA;
- levies must be imposed on transmission and distribution in competition regions as a source of funding for the expansion of power grids in less developed regions;
- authority for the issuance of business and operating licenses must be decentralised, i.e. transferred to the regional and local authorities;
- power transmission and distribution must be recognised as natural monopolies that are to be made accessible to private enterprises in a non-discriminatory manner;
- private-sector activities in the energy industry[17] must be permitted in at least the following areas: power generation, transmission, distribution and sale;
- an annual National General Electricity Plan must be drawn up, in which the regional and national objectives stated in the National Energy Management Blueprint are concretised.

In December 2004, however, this first reform law was annulled by the constitutional court.[18] Hence, pending the enactment of a new electricity law[19], the electricity law of 1985 has regained validity. A number of regulations adopted since the end of 2004 also apply – one example being Government Regulation 3/2005 from 2005, which incorporates various provisions of Electricity Law 20/2002. All the same, the legal amendments have had a substantial influence on the reform process. Private enterprises, for example, are presently limited to the generation of electricity, and the political steps taken in 2002 regarding the introduction of competition regions, the unbundling of the state electricity company PLN and the establishment of an independent regulatory authority have all been shelved.

National Energy Management Blueprint

The National Energy Management Blueprint identifies ambitious short- and long-term developmental objectives for the electricity sector. The current version 2005-2025 lists the following objectives:

- satisfaction of electricity demand: increase the electrification level to 90 % of all households by 2020 and to 100 % of all villages by 2010;
- reduction of subsidies: increase electricity tariffs to a level that covers the prime costs and enables a reasonable profit;
- raising the efficiency of electricity supply: implement a limited scope of competition in the power generating sector in Batam (from 2004), Java-Madura-Bali (JAMALI; from 2007) and on the remaining islands beginning in 2008, including strong participation by the private sector (non-governmental, independent power producers and semi-private enterprises) in Indonesia's power supply sector;
- expansion of the electricity infrastructure: the central and regional governments are to provide more funding for expanding the transmission and distribution networks;
- renewable energy: Indonesia's renewable energy resources are to be better utilised.

Foreign involvement in the electricity sector

With the support of the World Bank, MEMR has begun to convert the electricity sector from oil to natural gas on Java and Bali, the main point being to integrate the state gas supplier Perusahaan Gas Negara (PGN) into the power generating sector. In October 2003, Indonesia was granted a World Bank loan of US$ 141 million to help implement the pertinent measures.

17 Private-sector activities in the field of public power supply were first permitted in 1989 on the basis of an amendment to the 1985 electricity law.

18 Provisions on the introduction of competition on the electricity market and on the unbundling of the power provider were judged unconstitutional.

19 Planned for the second quarter of 2007.

In 1999, within the scope of the Energy Partnership Program (EPP) sponsored by the United States Energy Association (USEA) and the United States Agency for International Development (USAID), PLN entered into a partnership contract with the US electric utility company Portland General Operations Co. Inc. (PGO) for the purpose of modernising and/or rehabilitating the PLN-operated hydroelectric plants. The Asian Development Bank (ADB) has been promoting the energy sector since 1971 with loans totalling US$ 3.4 billion.

20.4 Policy promoting renewable energy sources

In connection with the political objective of reducing Indonesia's dependence on oil for generating electricity while simultaneously raising the household electrification level, the further development of renewable energy resources is becoming increasingly important. Within that context, the use of geothermal energy for generating electricity is receiving special attention.[20] According to Presidential Decree No. 5/2006, renewable energy resources – not including large-scale hydropower and geothermal energy – are supposed to be accounting for 5% of the public electricity supply by the year 2020.

Central actors

The promotion of renewable energy sources via the legal framework as a contribution to the national power supply sector falls primarily within the sphere of responsibility of Indonesia's Ministry of Energy and Mineral Resources (MEMR).

Within MEMR, DGEEU's responsibilities include the specific design of official promotion programmes in the renewable energies sector, improving energy efficiency, cutting CO_2 emissions, and the advancement of rural electrification.

The Directorate General of Mineral, Coal and Geothermal (DGMCG; department within MEMR) is responsible for expanding the basis of power generation by way of geothermal resources. To analyse and overcome political constraints in the development of geothermal power within Indonesia, the DGMCG has drafted a Geothermal Barrier Removal Programme.

The non-governmental organisation Indonesian Renewable Energy Society (METI) is particularly committed to training human resources for Indonesia's future renewable energy industry.

Promotion mechanisms

A number of specific regulations within the national energy legislation support the promotion of renewable energy resources. Examples include the Geothermal Law[21] and the Ministerial Decree on Renewable Energy Resources and Conservation.[22]

Concrete incentive mechanisms covering all renewable energy resources include:

- compulsory power purchasing by the grid operator PLN;
- promotion of on-grid plants and systems based on renewable energy sources: operators of small (< 1 MW) and medium-sized (between 1 and 20 MW) power plants receive 60 % or 80 % of their power generating costs for a period of at least 10 years;[23]
- tax breaks for semi-private enterprises;
- financing options for renewable energy projects by way of the Clean Development Mechanism (CDM);
- establishment of an institution for the financial promotion and development of renewable energy resources.

20 The Government of Indonesia is also investing much hope in the development of biofuels as a long-term substitute for dwindling mineral oil resources.

21 Geothermal Law No. 27/2003 seeks to expand the use of geothermal energy sources in the interest of promoting sustainable development, increasing government revenues and promoting the country's economic development.

22 Ministerial Decree No. 002/2004 pursues such objectives as optimising and improving the efficiency of renewable energy resources, securing sustainable, environmentally compatible forms of power generation, increasing public awareness and improving consumer behaviour with regard to energy conservation.

23 60% for injection into low voltage networks, and 80 % for injection into medium voltage networks.

Clean Development Mechanism

Indonesia signed the Kyoto Protocol in 1997 and ratified it on 28 July 2004, by adopting Law No. 17/2004. As a developing country, Indonesia can take part in emissions trading with industrialised countries on the basis of the Clean Development Mechanism (CDM). According to the National Strategy Study on CDM in Energy Sector in Indonesia, as conducted by the Ministry of the Environment (Kementerian Lingkungan Hidup – KLH), the country has potential for a 2 % share of the global emissions trading volume. Theoretically, this could yield revenues ranging from US$ 81.5 million to US$ 1,260 million.[24]

Indonesia's Designated National Authority (DNA) was established in 2005 under the name National Commission on CDM, or Komisi Nasional Mekanisme Pembangunan Bersih (KN-MPB). ASEAN began promoting CDM project activities in Indonesia in 2001. Then, in 2005, Indonesia signed bilateral emissions trading agreements with the Netherlands, Denmark, Austria and Canada.

In 2006, the CDM Executive Board (EB) registered eight CDM projects in Indonesia with a total annual CO_2-reducing effect of 1.1 million tonnes. The project activities involve geothermal, biomass and solar thermal energy, and are being conducted in cooperation with companies based in the United Kingdom, Finland, the Netherlands, Japan and Germany.[25]

20.5 Status of Renewable Energy Sources

At the end of 2005, renewable energy sources were contributing just under 5 % (or 1,345 MW) to Indonesia's total installed power generating capacity of 28 GW. This does not include the power produced by large-scale hydroelectric plants, which themselves account for roughly 15 % (approx. 4,100 MW).

Type of renewable energy	Potential	2005	"Blueprint 2025"
Geothermal	27,000 MW	807 MW	9,500 MW
Small-scale hydropower	75,000* MW	84 MW	500 MW (on Grid) 330 MW (off Grid)
Solar energy	4.8 kWh/m^2	8 MW	80 MW
Biomass (power generation)	50,000 MW	445 MW	810 MW
Wind energy	9,290 MW	0.6 MW	250 MW (on Grid) 5 MW (off Grid)

Tab. 2: Potentials (* referred to the overall hydropower potential), installed capacities and the development-planning blueprint for renewable energy resources; MW; Indonesia[26]

24 Assuming 125 – 300 million tonnes of CO_2 for a CER yield of US$ 1.5 – 5/tCO_2, less project expenditures.

25 Further information on CDM activities in Indonesia can be found in the CDM country guide for Indonesia at www.iges.or.jp/en/cdm/pdf/countryguide/indonesia.pdf.

26 Source: bfai 2006, MEMR 2006, Center for Energy Resources Development 2006.

The development plans for the individual renewable energy sources are specified in the MEMR's 2005 National Energy Management Blueprint.

The following renewable energy system components are produced or assembled in Indonesia (= local content):
- small hydropower plants: turbines, speed governors, electric components (high local content), e.g. by CV Sampurna Energy;
- photovoltaics: local assembly of modules, e.g. by Microtech Indonesia;
- solar thermal: complete solar water heaters and solar dryers are manufactured locally;
- biomass: biomass gasifiers are made in Indonesia; they are, however, less reliable and efficient than those built in other countries;
- small wind energy conversion systems: except for the generators, all components are locally manufactured, e.g. by the Contained Energy company.

Hydropower

Indonesia has a theoretical hydropower potential of 75,000 MW. Small-scale hydropower plants, which as a rule can be accommodated to natural river landscapes more readily than can plants on a larger scale, presently account for 84 MW of installed, utilised capacity. In Indonesia a basic distinction is drawn between micro-hydropower plants with outputs up to 25 kW and mini-hydropower plants with outputs of up to 500 kW.

PLN is presently executing twelve micro-hydropower projects in Papua, Nusa Tenggara, Sulawesi and Kalimantan, all of which are being financed by the Asian Development Bank and scheduled for completion by 2006/07. Between 2008 and 2010 PLN plans to launch a further eight projects in these regions.

More than 200 mini-hydropower plants have been installed to date, most of them in rural areas with no grid access. Since both micro- and mini-hydropower plants are relatively inexpensive and easy to operate, they often make attractive opportunities for individual investors and local cooperatives. Their installation is facilitated by easy access to loans from the government and/or by development cooperation projects.

In the future, hydropower in the form of tidal and wave energy is also to be exploited. The theoretical potential in these fields is estimated at around 240,000 MW. The technologies required for tapping this potential, however, are still at the experimental stage: one pilot project with a capacity of 1.1 MW is ongoing at Baron Beach, Yogyakarta (Java).

Wind energy

Due to the minor influence of trade winds in Indonesia, the country has relatively little potential wind energy – amounting to 9,290 MW. The average wind speed is 3-5 m/s. In the eastern regions, however, it exceeds 5 m/s. Hence, the Indonesian wind regime is mainly suitable for small and medium-size wind power plants requiring wind speeds of 2.5-4 m/s and 4-5 m/s, respectively, for corresponding outputs of < 10 kW and 10-100 kW. At only a few locations is wind potential sufficient to power large wind energy conversion systems (> 100 kW) that require wind speeds in excess of 5 m/s.

DGEEU has identified three regions with 10 sites that are suitable for exploiting wind energy potential:
- Nusa Tenggara Barat (NTB) region: with wind speeds of 3.4-5.3 m/s;
- Nusa Tenggara Timur (NTT) region: with wind speeds of 3.2-6.5 m/s;
- Sulawesi: with wind speeds of 2.6-4.9 m/s.

Given the total installed generating capacity of 5 MW, only a small fraction of Indonesia's overall wind power potential is being utilised. Small aerogenerators are used in Indonesia for rural and/or decentralised electrification, for driving water pumps, for charging batteries, and for such mechanical purposes as aerating fish-farm ponds. The state electricity company PLN is presently constructing large-scale wind power installations on Bali (3 x 250 kW), Nusa Tenggara Barat (3 x 250 kW) and Nusa Tenggara Timur (6 x 250 kW), all of which are scheduled to go on line in 2007.

Biomass

Indonesia has major theoretical potential for generating energy from biomass, totalling some 50,000 MW. This is based on the energy content of more than 200 million tonnes of agricultural biomass, forestry and plantation residue and urban waste produced every year.

According to official estimates, 35% of all energy consumed in Indonesia, particularly in rural areas, stems from biomass – mainly unsustainably managed firewood. At the end of 2005, total installed capacity for power generation based on biomass had reached 445 MW. The construction of additional biomass-fuelled power generating installations is planned.

Energy source	Capacity (MW)	Location
Palm oil residue	12.5	North Sumatra
Palm oil residue	10.5	North Sumatra
Palm oil residue	10.5	Riau
Palm oil residue	15	Riau
Rice husks	10	Lampung
Rice husks	20	Bali
Bagasse	7	Lampung
Urban waste	60	Jakarta

Tab. 3: Biomass power plants in Indonesia, planned by private enterprises; MW; 2006 [27]

In addition to its use for generating power and heat, biomass is also and primarily of interest for producing biofuels such as vegetable oil and biodiesel in Indonesia. The requisite technologies are already available and disseminated. Pertinent development plans extend all the way to the establishment of a "Biofuel OPEC" in cooperation with Thailand, and have even given rise to a number of concrete promotion incentives. The Government of Indonesia regards biofuels as a potential substitute for petroleum-based fuels.

Use of landfill gas

According to expert opinion, twelve major Indonesian cities have a combined potential of 566 MW for generating electricity from communal waste.

Solar energy

As a tropical country with an average daily insolation rate of 4.8 kWh/m^2 and 300 days of sunshine in a typical year, Indonesia has major potential for solar energy.

Photovoltaics

Photovoltaic systems, especially solar home systems (SHSs), are used in rural areas in particular, generating power for such applications as lighting, water pumps, telecommunication equipment and medicine cooling systems at health centres. Since the early 1980s some 50,000 SHSs have been installed, and relatively large hybrid plants, for example in combination with diesel generators, are also in widespread use. In late 2005 the installed capacity totalled about 8 MW, over 1 MW of which was feeding into the central power grid.

27 Source: MEMR – Country Plans and Policies for Developing and Implementing Renewable Energies in Indonesia 2006.

Expansion plans

In the 1990s the Indonesian Government began to systematically promote the use of isolated photovoltaic systems for providing rural, off-grid regions with electricity, and since 2004 private banks have been offering loans for the purchase of PV systems. National plans envisage the transfer of additional links of the solar-system production chain to Indonesia in order to reduce the country's dependence on imports. The use of photovoltaics is to be promoted not only for rural, decentralised applications, but also for urban areas in which grid-infeed mechanisms can be utilised. The Solar Power Entrepreneur Association (APSURYA) is a national institution providing particular encouragement to the countrywide development of photovoltaics.

With a view to further developing photovoltaics in the country, the government in Jakarta is planning to install 15,000 photovoltaic systems (SHSs) in eastern Indonesia, each with a generating capacity of 100 W. Each unit will cost between US$ 500 and US$ 600 and is to be paid for with funding from the government and PLN.

Geothermal energy

The volcanic belt extending along the islands of Sumatra, Java, Nusa Tenggara, Sulawesi and Malaku has blessed Indonesia with abundant geothermal potential, roughly 40 % of the world's total geothermal resources. According to MEMR estimates, the country has 217 geothermally useful sites – mostly on Sumatra, Java und Sulawesi. Indonesia's theoretical geothermal potential is calculated at around 27,000 MW. As of late 2004, a mere 807 MW, or 3 %, of that potential had been harnessed.

Location	Operator	Installed capacity in MW (2006)
Sibayak	Pertamina	2
Salak	Unocal	330
Kamojang Darajat	Pertamina	140
Kawah Cibuni	Yala Teknosa	110
Dieng	Geodipa	60

Tab. 4: A selection of Indonesia's operational geothermal power plants; MW; 2006[28]

National expansion plans and incentive systems

The existing geothermal power plants are presently being operated by the state electricity company PLN and its contractual partners. In the future, however, independent power producers are supposed to play a larger role in the development and exploitation of new thermal sources. With a view to promoting that aim, the Indonesian Government is offering potential investors a number of tax abatements, such as the remission of property taxes on power plant premises and the exemption of principal plant components from value-added tax. In addition, foreign investment is also being disburdened.

In 2005 the government designated 28 new sites with a combined potential capacity of 13,500 MW and attracted the interest of several private-sector actors. In 2006 Medco Holding announced the construction of a new power plant with a generating capacity of 10 to 20 MW in Tangkuban Perahu, West Java. A joint venture embarked on by the Japanese company Sumitomo and the Indonesian firm PT Rekayasa won a contract to build a 20 MW geothermal power plant in Lahendongon, North Sulawesi.

Nonetheless, many of the designated sites are still reserved for government projects. PLN alone is planning to put up 16 geothermal power plants with a total capacity of 1,150 MW. The state-owned oil and gas provider PT Pertamina is also involved in the construction of several new plants.

28 Source: Center of Energy Resources Development Technology, 2006.

Additional large-scale geothermal power plants are planned for the following sites:

- Sarulla, North Sumatra: the biggest geothermal project in the world, with an output of 340 MW[29]
- Patuha, West Java (3 x 60 MW)
- Dieng, Central Java (2 x 60 MW)

20.6 Rural Electrification

Approximately 45 % of Indonesia's population of over 245 million live in rural areas. There are around 29 million rural households, of which 41.5 % (some 12 million) have no access to electricity, although the electrification rate varies widely from region to region.[30] The development-policy objective of raising the national electrification level includes substantial expansion of Indonesia's rural power supply infrastructure.

In the past, the foremost objective of rural electrification was to connect into PLN's central grids: some 96 % of all electrified households in rural Indonesia were successively tied into the gradually expanded power supply networks. Privately operated isolated grids and systems account for a mere 4 % of all rural electricity provision.

Rural electrification actors include MEMR and PLN, both of which work to expand the country's power generating, transmitting and distributing capacities by way of public-private partnerships in cooperation with private investors. Other actors include non-governmental organisations, community level groups, private actors and international donors.[31]

National activities

The strategy pursued by PLN for the future electrification of rural areas is based on the following principles:

- empowerment of the rural population to secure electricity according to their own conceptions
- utilisation of local energy resources, in particular renewables
- increasing the involvement of the private sector and of rural cooperatives

Part of that strategy is the "community-based rural energy development" concept, according to which cooperatives, municipal institutions, non-governmental organisations and/or private actors, with the technical assistance of PLN, serve as power providers or producers in rural areas. PLN provides assistance at two different levels: either for establishing a stand-alone (isolated) grid including power generation, or for establishing a village network for connection to the PLN-operated central power grid.

As a source of financial assistance for rural electrification, MEMR (acting through DGEEU) has devised a programme entitled Trust Fund Facility for Rural Energy Services. Its purpose is to involve local financial institutions in rural electrification, with the government providing appropriate credit-redemption guarantees.

The Community Empowerment through Micro Hydro Power Plant (MHPP) - Development in Rural Villages programme aims to promote agricultural production processes and micro-enterprises. Over the past few years, 20 micro hydropower projects have been implemented under the auspices of the Ministry of Cooperative and Small and Medium Enterprises. Four of the projects were financed by the Indonesian Government and the remaining 16 by international donors. All 20 projects are now being operated by rural cooperatives.

29 The total project investment is put at approximately EUR 470 million. The project will be implemented in 3 phases of 110–120 MW each. The first unit is scheduled to go online within 30 months and the last within 48. The power output is to be injected into the North Sumatra and Aceh grids. Once all units are in operation, the operators anticipate annual electricity revenues of the order of EUR 86 million.

30 According to PLN data, Yogyakarta and Bali have reached 94 % and 81 %, respectively. By contrast, the rural parts of Lampung have an electrification rate of only 22 % – and Nusa Tenggara a mere 13 %. Beyond the grasp of statistics – naturally – the high level of power theft in rural areas goes undocumented

31 One of most important external actors is the Asian Development Bank (ADB), which grants loans for the expansion of electricity supply infrastructure.

International cooperation: actors and programmes

One major actor is the ASEAN[32] Centre for Energy (ACE), which in particular works to promote projects devoted to the utilisation of small-scale energy systems based on renewable energy sources for rural electrification and productive activities.

The Deutsche Gesellschaft für technische Zusammenarbeit (GTZ), in cooperation with MEMR and the Netherlands development cooperation organisation Directoraat-Generaal Internationale Samenwerking (DGIS), has initiated a project entitled Mini-Hydropower Schemes for Sustainable Economic Development, the goals of which are rural electrification and the establishment and development of rural micro-enterprises.[33] To that end, the project cooperates with Indonesian universities and non-governmental organisations to communicate technical expertise in the planning, construction, maintenance and operation of micro hydropower plants. Since 1999, more than 100 power generating systems with capacities ranging from 7 kW to 250 kW have been installed and are now providing electricity for approximately 20,000 rural households, micro-enterprises and public facilities. More than 85 % of the system components are of local origin.

The German Federal Ministry of Education and Research began promoting the multisectoral project Water Resources Management of an Underground River in a Karst Area in 2002. The project focuses on supplying drinking water to the population during dry seasons through the use of renewable energy sources. The relevant technology consists of partially damming an underground stream to enable the generation of electricity in an underground hydropower plant, with the generated electricity being used for pumping water.

The World Bank and the Global Environment Facility (GEF) are helping to disseminate photovoltaics for decentralised power supply in rural, off-grid areas of Indonesia by way of the Solar Home Systems Project. The project is promoting the installation of 200,000 SHSs in four regions. In addition, the Indonesian Agency for the Assessment and Application of Technology (BPPT) is to be assisted in its measures for establishing photovoltaics in the energy sector.

Exchange rate (7 February 2007):
1000 Indonesian rupiah (IDR) = 0.08548 euro (EUR)
1 IDR = 0.0001106 US dollar (USD)

32 Association of Southeast Asian Nations.
33 The main point of interest is to generate additional income through hydropower while establishing a market for rural energy services.

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21 Pakistan

21.1 Electricity Market

Generating capacity

In mid-2006, Pakistan's total installed power generating capacity amounted to 19,450 MW, and had therefore more than doubled since 1990/91 (8,776 MW). Thermal power plants contributed 64 % of that total, while hydropower accounted for 34 %, and Pakistan's two nuclear power plants 2 %.[1]

	Hydropower		Thermal		Nuclear		Total
	MW	%	MW	%	MW	%	MW
2001/02	5,051	28.4	12,286	69.0	462	2.6	17,799
2002/03	5,051	28.4	12,285	69.0	462	2.6	17,798
2003/04	6,496	33.7	12,299	65.4	462	2.4	19,257
2004/05	6,499	33.5	12,423	64.1	462	2.4	19,384
2005/06	6,499	33.4	12,489	64.2	462	2.3	19,450

Tab. 1: Power generating capacities by energy source; Pakistan; 2001/02-2005/06, MW, %[2]

Power generation

The electricity market in Pakistan has been characterised in recent years by marked changes in the primary energy sources used for producing electricity. In the 1990/91 accounting year, hydropower still accounted for nearly 45 % of all electricity generated in the country, but by 2005/2006 that share had dropped to only 33 %, after falling as low as 26 % in 2001/2002. In the same period, the share of thermally generated electricity increased from 54 % to 64 %. Most of that increase is the result of capacity expansion since the early 1990s in response to power shortages and the resultant frequent power outages.

Pakistan has little commercially exploitable oil of its own. Consequently, as much as 75 % of the country's oil needs were met by imports in the fiscal year 2005/06. The imports were used for such purposes as firing thermal power plants. Plants fuelled with natural gas, however, operate almost exclusively on domestic resources. This also applies to Pakistan's few coal-fired power plants.[3]

In 2005/06 the partly state-owned enterprises WAPDA and KESC produced 57 % and 10 % of the country's electricity respectively. The two state-owned nuclear power plants contributed 3 %, while independent producers accounted for a share of 30.5 %. In the 2005/2006 accounting period the amount of electricity generated increased by 9.3 % compared with the previous year, to approximately 94 TWh.

	Hydropower		Thermal		Nuclear		Total
	GWh	%	GWh	%	GWh	%	GWh
2001/02	18,941	26.1	51,174	70.7	2,291	3.2	72,406
2002/03	22,351	29.6	51,591	68.2	1,740	2.3	75,682
2003/04	26,944	32.1	52,122	64.5	1,760	2.1	80,827
2004/05	25,671	30.0	57,162	66.8	2,795	3.3	85,629
2005/06	30,862	33.0	60,283	64.4	2,484	2.7	93,629

Tab. 2: Power generation by energy source; Pakistan; 2001/02–2005/06, GWh, %[4]

Transmission network and power losses

The transmission network in Pakistan consists of 500-kV and 220-kV lines.[5] According to a report from the Pakistani grid operator published in January 2007, the transmission system is not capable of meeting the load. In 2006, 77 % of the 500-kV power transformers and 69 % of those rated at 220 kV were overloaded. In January 2007 the Asian Development Bank (ADB) put up a loan amounting to US$ 226 million for expansion of the network.

1 The nuclear power plant in Karachi has been in service since 1971 and a second in Chashma was commissioned in 2001.
2 Source: HDIP (Pakistan Energy Yearbook). The fiscal year in Pakistan ends on 30 June.
3 Pakistan's commercially exploitable gas reserves were estimated at approximately 32.6 billion cubic feet in 2006. Since some substantial new deposits of brown coal (lignite) have been located in the Thar Desert in the province of Sindh, Pakistan is planning to increase the share of coal used for generating electricity.
4 Source: HDIP.
5 A map showing the existing transmission lines can be found on the homepage of the distribution network operator, NTDC. See: www.ntdc.com.pk/TransmissionLines.asp

The existing national power transmission- and power distribution systems reach so far 55 % of the Pakistani population. The safe and reliable transmission and distribution of electricity remains a major problem in Pakistan. Due to weak grid infrastructure and substantial theft of electricity, losses from the transmission and distribution network totalled 26,5 % in 2005. The government has set the aim of reducing losses to 21.5 % by 2010.

Demand for electricity rose by 6.6 % in the fiscal year 2004/05 compared with the previous period. In 2005/06 the rate of growth was even higher, at over 10 %. Further rises in electricity demand are expected to continue in the years to come. As the growth in demand will exceed the new capacity that is planned to be added in the short term – an increase of more than 4 % per annum is expected for the period 2006 to 2009 – it is possible that there will be shortfalls in electricity supply in the coming years. These deficits are meant to be countered by private investment.

	Households		Industry		Agriculture		Public institutions		Trade/commerce		Street lighting		Total
	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%	TWh
2001/02	23.2	46.0	15.1	29.8	5.6	11.0	3.4	6.7	3.0	5.9	0.2	0.6	50.6
2002/03	23.6	44.8	16.2	30.7	6.0	11.3	3.3	6.3	3.2	6.0	0.2	0.4	52.7
2003/04	25.8	44.9	17.4	30.2	6.7	11.7	3.6	6.3	3.7	6.4	0.3	0.5	57.5
2004/05	27.6	45.0	18.6	30.3	7.0	11.4	3.7	6.0	4.1	6.7	0.3	0.5	61.3
2005/06	30.7	45.4	19.8	29.3	7.9	11.7	4.0	5.9	4.7	7.0	0.4	0.6	67.6

Tab. 3: Power consumption by ultimate user; Pakistan; 2001/02-2005/06; TWh, %[6]

Power consumption

With the sole exception of fiscal year 1998/99, power consumption in Pakistan has grown steadily in recent years. Between 2001/02 and 2005/06, total consumption increased by more than 33 %, from 50.6 TWh to 67.6 TWh. Again with a single exception – fiscal year 1990/91 – the domestic sector was the consumer group with the largest proportion of consumption, followed by industry and agriculture.

Electricity tariffs

Electricity tariffs are set individually for each of the eight distribution companies by the regulatory authority NEPRA. The tariffs are differentiated in various ways, for example between households, commerce, agriculture, industry and public lighting. Apart from a fixed monthly standing charge that has to be paid regardless of electricity consumption, the tariff system is progressive. In addition, the electricity tariffs vary according to peak-load and low-load periods.[7] In January 2007 it was announced that the electricity tariffs were to be raised by an average of 20 %.

6 Source: HDIP.
7 Detailed tables can be found on the homepage of the regulatory authority: www.nepra.org.pk

Expansion of generating capacities

In light of the projected increase in the demand for electricity by some 10,000 MW by the year 2010, the Government of Pakistan launched a large-scale expansion programme for the long term. To minimise future supply deficits, Pakistan has adopted a development plan called 'Vision 2025' that targets a long-term capacity increase of around 35,000 MW by the year 2025. The plans for expanding generating capacity were updated for the period 2005 to 2010 in the government's medium-term development plan. In this plan, the Government Planning Commission sets the objectives for 2030 of continuing to increase the proportion of domestic hydropower (almost 33,000 MW), making more use of domestic coal resources for electricity generation (20,000 MW), expanding the installed capacity of nuclear energy from today's figure of 400 MW to 8,800 MW, and making greater use of renewable energy (9,700 MW, i.e. a share of at least 5 %, not including hydropower). This is intended to increase the security of supply for the country and reduce dependence on imports, in particular crude oil.

21.2 Market Actors

Utility companies WAPDA and KESC

Two utility companies, both still partly in state ownership, currently dominate the electricity market in Pakistan: WAPDA (Water and Power Development Authority) and KESC (Karachi Electric Supply Corporation). The Pakistan Water and Power Development Authority was founded in 1958 to help coordinate work in these two sectors. In addition to the generation, transmission and distribution of electricity, its tasks also included water supply, flood management and inland waterway transport. WAPDA is by far the largest power producer in Pakistan: in June 2006 it owned 58 % of all generating capacity, while KESC held 9 % of the total . WAPDA's transmission and distribution network extends across large parts of the country, whereas KESC is responsible for supplying the trading area of Karachi, capital of the province of Sindh.

In addition to the state operators of the two nuclear power plants, Karachi Nuclear Power Plant (KANUPP) and Chashma Nuclear Power Plant (CHANUPP), since 1994 a series of private operators have set themselves up as independent electricity generating companies.

Vertical unbundling and privatisation of WAPDA and KESC

The vertical disintegration of WAPDA was begun in the year 2000 as part of the country's new electricity market restructuring and liberalisation programme. WAPDA was broken down into thirteen separate units: four generating companies, eight distribution companies, and the National Transmission and Dispatch Company (NTDC). The Pakistan Electric Power Company (PEPCO) was founded in 1998 to handle the unbundling and privatisation process.

By the end of 2006 only the generating company KAPCO had been privatised. This company, which was listed on the stock exchange in April 2005, is now the country's largest privately owned producer, with an installed capacity of 1,600 MW. The distribution companies FESCO and GESCO and the generating companies Jamshoro Power Co. and National Power Construction Corporation Pvt. Ltd. are the next ones scheduled for privatisation.[8] In December 2005, 73 % of the shares in the regional state-owned utility company KESC were sold to a Pakistani-Saudi Arabian consortium.[9]

8 The companies being readied for privatisation are presented on the homepage of the national Privatisation Commission (www.privatisation.gov.pk).

9 The consortium is made up of Hasan Associates, Al-Jomeih Holding Co. and Premier Mercantile Services.

However, the envisaged privatisation of these independent generating and distributing companies is proving difficult, because they often operate at a loss due to unpaid bills and submarginal electricity tariffs. Despite the repayment of debts, WAPDA and KESC have continued to make losses in recent years. Moreover, the national trade unions are opposed to the privatisation of the electricity companies. For the time being, hydropower will continue to be excluded from the privatisation process as it is a separate field within WAPDA; it will therefore remain in WAPDA's possession.

Independent power producers

All in all, 19 independent power producers of notable size had been granted licences by the regulatory authority by the end of 2006.[10] The two largest privately owned electricity generating companies are the HUB Power Company (HUBCO) and the Kot Addu Power Company (KAPCO). HUBCO belongs to a consortium formed by National Power (United Kingdom), Xenal (Saudi Arabia) and Mitsui Corporation (Japan), and possesses just under 1,300 MW of generating capacity.

In addition to engaging in competitive bidding, privately owned producers can apply to NEPRA for permission to implement a project without being requested to do so. Instead of negotiating the power purchasing contracts bilaterally with each power purchaser, NEPRA sets the tariffs following consultation with the independent power producer and the power purchaser.

At the end of 2006 the Private Power and Infrastructure Board PPIB, the state-owned consulting institution for private investors which is responsible among other things for conducting negotiations on the implementation of projects, dealt with 50 projects with a total capacity of over 13,000 MW. These are supposed to enter service over time through to January 2016. The additional capacity is shared relatively evenly between hydroelectric and thermal power plants. In 2005 the Ministry of Water and Power decreed that the regulatory authority NEPRA should draw up tariff tables for independent power producers according to technology type, with the aim of achieving greater transparency and simplifying the award of licences. These tables were not yet available by January 2007.

Other Actors

Private Power and Infrastructure Board (PPIB)

With a view to improving investment incentives in the Pakistani power sector, a new state-owned consulting institution was established in 1994: the Private Power and Infrastructure Board (PPIB). This institution is intended to serve as a central contact point primarily for private investors in Pakistan's power sector, providing advice and guidance for the implementation of power plant projects. PPIB's main task is to negotiate the implementation agreement and provide support in negotiating fuel supply contracts and power purchase agreements. PPIB also provides guarantees to private investors that government entities will meet their obligations in the power market, monitors litigation and international arbitration for and on behalf of the Government of Pakistan, and assists the regulatory authority in determining and approving tariffs for new private power plant projects. PPIB is staffed by representatives of the four provinces and the semi-autonomous territory of Azad Kashmir.

10 The license for another power producer, New Park Energy Ltd., is currently in the pipeline.

Regulatory authority NEPRA

The sectoral regulatory authority, the National Electric Power Regulatory Authority (NEPRA), was created by statute in December 1997. In particular NEPRA is intended to ensure fair competition and the protection of consumers. NEPRA's most important powers include the issue of licences for power production, transmission and distribution (including the setting of licensing fees) and the specification of electricity tariffs. As consumers have so far not had the option of purchasing electricity from producers of their choice through bilateral agreements, NEPRA is also responsible for specifying the sale of electricity by the producers to NTDC. In addition, NEPRA is able to impose fines for non-compliance with the relevant regulations.

Alternative Energy Development Board (AEDB)

The Alternative Energy Development Board (AEDB) was established in May 2003; it answers directly to the Prime Minister. The purpose of the Board is to promote and exploit the country's renewable resources and achieve the objective set by the government of expansion to 10 % by 2015 (not including hydropower). The AEDB is also responsible for developing the national policy for promoting renewable energy sources in the medium and long term, which has been set out in a set of measures known as the Policy for Development of Renewable Energy for Power Generation. In addition, its functions include the coordination of joint ventures with the aim of having foreign technologies in the field of alternative energies fabricated in Pakistan. The AEDB is also responsible for handling projects in the renewable energy sector.

21.3 Legal Framework

The ministry responsible for formulating Pakistan's energy policy is the Ministry of Water and Power (MoW&P). Due mainly to the shortage of electricity in the 1980s and early 1990s, a strategy plan geared to restructuring the Pakistani electricity sector was adopted in 1992.

Private sector power law of 1994

An energy law was adopted in 1994 (Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan). It was meant to encourage private investment in Pakistan's electricity sector and standardise the investment conditions for independent power producers. It covers the following measures in particular:

- Up-front setting of a uniform rate of remuneration amounting to 5.7 US cents/kWh, coupled to the exchange rate between the Pakistan rupee and the US dollar, including allowance for the U.S. inflation rate and potential fluctuations in raw-material prices[11]
- Surrender of decision-making powers to the project's implementing institution with regard to the size, technology, energy source and siting of the power plant
- Guarantee of power-grid connection and purchase of power within the framework of standard contracts
- Guarantee of supply of the required primary energy sources, for as long as a supply contract with a government institution is in place
- Exemption of independent power producers from numerous forms of taxation (corporation tax, income tax and turnover tax) and duty

11 In addition, a bonus of 0.25 US cents/kWh was offered for power plant projects commissioned by the end of 1997.

Power law of 2002

A new power law was enacted in 2002. Basically, it closely resembles its predecessor dating from 1994, but it has a broader range of application. Entitled 'Policy for Power Generation Projects – Year 2002', the new power law promotes both private investment projects and public-private partnerships (PPP). It also makes it possible for private investors not only to participate in public tendering for projects but also to propose power plant projects on their own.

The respective provincial governments are now responsible for approving plants with ratings below 50 MW. A two-component system of remuneration has been defined for power providers: part of the remuneration depends on the output of the respective plant (capacity purchase price, CPP), and the rest is a function of the sources of energy employed for producing the electricity (energy purchase price, EPP). According to the law of 2004, the latter is supposed to account for at least 34 to 40 % of the total remuneration.

The new provisions from 2002 give preference to projects involving the use of domestic energy resources, i.e. mainly water, coal or natural gas and renewable energy. This manifests itself primarily in the exemption of all such power plant projects from income taxes, turnover taxes and capital gains taxes on imports (with oil-fired power plants constituting an exception). Moreover, import duties on plant components have been reduced to a mere 5 % of the standard rate.

Wholesale market

Regarding the creation of a wholesale market, as a first step a so-called 'single buyer plus' model was established in July 2002. In that model, the NTDC functions as the sole purchaser of all electricity generated by all producers. Beginning in mid-2009, major consumers are to be allowed to purchase electricity from producers of their own choice by way of bilateral supply agreements. The introduction of a wholesale market is envisaged for mid-2012.

21.4 Promotion of Renewable Energy Sources

Pakistan's first promotion measures for renewable energy sources were implemented in the early 1980s. For example, the sixth Pakistani energy plan (1983-1988) devoted approximately EUR 14 million to work on regrowable energy crops and biogas and to a feasibility study into the commercial exploitation of solar energy.

Pakistan Council for Renewable Energy Technology (PCRET)

In the 1970s and 1980s, initial measures aimed at the promotion of renewable energy were advanced by the Pakistan Council of Appropriate Technology (PCAT, founded in 1975) and the National Institute of Silicon Technology (NIST). In May 2001 these two separate research establishments merged to become the Pakistan Council for Renewable Energy Technology (PCRET). The main purpose of this move was to better coordinate research activities and avoid overlaps.

Policy for Development of Renewable Energy for Power Generation

In December 2006 the Government of Pakistan published the first national package of measures aimed at promoting renewable sources of energy. The provisions apply to hydropower plants with a capacity of up to 50 MW, solar thermal, photovoltaics and wind energy. Over the short term, i.e. to mid-2008, technologies that are already in commercial use internationally are to be trialled through the mechanism of attractive power purchase contracts and partial risk coverage. In the medium term, i.e. to 2030, it is hoped to have installed at least 9,700 MW of capacity for renewable electricity in this way.

Under these provisions, the grid operator is obliged to purchase the electricity and has to erect connecting lines up to a certain length.[12] In contrast with conventional power producers, generators of renewable electricity have the possibility of selling either some or all of the electricity they produce to end customers within the framework of bilateral contracts. Special incentives are granted for those producers of renewable energy who feed all their generated power into the national grid. These include the risk of varying wind speeds being borne by the power purchaser. If the producer does not attain the previously calculated benchmark level at the project location due to factors beyond his control (for example an unforeseeable lack of wind), remuneration is payable on the basis of the benchmark as originally set. However, remuneration drops if the reduced rate of infeed is attributable to the producer (such as because of a failure to perform maintenance). The benchmark used for this purpose is the average of mean monthly wind velocities at the project location. The average figure is calculated on the basis of data from at least three years. 10 % of the tariff is paid for power produced over and above the benchmark figure. In this way the additional income is shared between the producer and the consumer. The same applies to electricity generated from hydropower.[13]

It is generally a matter for the grid operators to extend and expand the transmission line network. The level of remuneration is set either through public competitive bidding procedures, bilateral negotiations between the independent power producers and NEPRA, or up-front tariff setting (power input remuneration model). NEPRA is currently drawing up precise tariff tables so as to shorten the time needed to set tariffs. The assumptions and methods it uses to do this are to be published.

Operators of renewable energy power plants for self use have the possibility of selling surplus power to the grid operator[14] and of purchasing additionally required electricity at the respective standard tariff. Renewable energy-based power producers are granted further fiscal and financial incentives as part of the package of measures. These include not having to pay customs duty on imported plant components and exemption from income tax.

The conditions for installing off-grid generating plants, especially small hydropower projects, are to be considerably simplified. Relevant arrangements are to be developed by the AEDB and the responsible provincial governments. Small hydropower projects connected to isolated grids of up to 11 kV may then be put into operation by anyone, following consultation with the local authority, without having to obtain approval from the AEDB, the provincial authorities or the Environmental Protection Agency. The tariffs will be negotiated at a bilateral level between the power producers and the consumers. The Government of Pakistan grants a one-time subsidy for the implementation of small hydropower projects of up to 5 MW, based on the plant's installed capacity. Similar arrangements are to be put in place for off-grid wind and solar plants.

For renewable energy-based power generation plants approved after July 2008, competition within the technology categories is to be increased, subsidies reduced and risk cover minimised. In the long term,[15] renewable energy is supposed to become an integrated part of national energy planning and to compete with conventional sources of energy. Further arrangements relating to the use of biomass and other forms of renewable energy are being drawn up by the AEDB and the government.

12 The guarantee applies on condition that the plant is located no further than 70 km from the nearest 220-kV transmission line. At lower voltage levels the maximum distance is reduced (50 km for 132 kV, 5 km for 11 kV and 1 km for 400 V). The producer also has the possibility of installing new power lines to connect to the national electricity grid at its own cost. The electricity purchase tariff is adjusted in accordance with these determinants.

13 A water use charge of 0.15 rupees per kWh is payable in the context of hydropower projects. The charge is adjusted annually according to the rate of inflation.

14 The basis for payment in the case of plants with a capacity greater than 1 MW is the tariffs determined by NEPRA for oil-fired power plants over the applicable quarter of the year, less 10 %. This arrangement applies to all renewable technologies.

15 Long-term projects are classified as those that will be completed from mid-2012 and then begin supplying electricity.

Clean Development Mechanism

Pakistan signed the Kyoto Protocol in January 2005. The Designated National Authority (DNA) for Pakistan answers to the Ministry of Environment. It is made up of the national CDM Steering Committee, the Technical Committee and the CDM Secretariat, and is advised by the Committee on Climate Change. The latter is composed of several ministers and is chaired by the Prime Minister. The Steering Committee, under the chairmanship of the Ministry of Environment, is responsible for political advice, inter-ministerial coordination and supervision of the implementation of CDM projects. The Technical Committee is divided into three entities: renewable energy/energy efficiency, waste management, and agriculture, forestry and livestock. The CDM Secretariat is the main point of contact for CDM affairs and issues licences for CDM projects on behalf of the government.

The first CDM project was registered with the UNFCCC in November 2006. According to the package of measures for renewable energy of December 2006, all qualified renewable energy projects (in the initial phase these are projects in the fields of windpower and mini-hydropower) are to be encouraged to register as CDM projects to enable them to trade in emission reduction certificates. The receipts from the trade in emissions certificates are supposed to be taken into account when setting tariffs, and must be openly declared to the regulatory authority. The Government of Pakistan aims to promote the implementation of CDM projects in cooperation with international development organisations, and allocated about EUR 500,000 (39 million rupees) for this purpose in 2006.

21.5 Status of Renewable Energy Sources

In addition to growing levels of research and other work to determine the actual potential for utilisable renewable energy sources in Pakistan, plans to develop these sources are also multiplying, as indeed are development operations themselves. In particular the expansion of hydropower and wind power is currently being stepped up, for both large- and small-scale plants.

Hydropower

The total theoretical hydroelectric potential in Pakistan has not yet been fully evaluated. Conservative estimates assume a capacity of roughly 45,000 MW. In view of the expected growth in demand and the fact that not even 20 % of the potential for hydropower is being exploited, the government is planning to expand hydropower in several stages. By the end of 2006 the total installed hydropower capacity was 6,608 MW, mostly in the northern parts of the country. This was made up of 5,928 MW in large hydropower plants (> 250 MW), 437 MW in medium-sized plants (from 50 MW to 250 MW) and 253 MW in small to micro plants (< 50 MW).

One important major project that commenced operation in 2003 is the Ghazi-Barotha run-of-river plant on the upper reaches of the Indus, built for a total output of 1,450 MW. The additional plant has enabled the share of hydropower in total installed capacity to be considerably increased again. The project was financed by the World Bank, the ADB, the Japan Bank for International Cooperation (JBIC), the European Investment Bank, the Islamic Development Bank, and resources from German Financial Cooperation (KfW). WAPDA covered 47 % of the total costs, contributing about US$ one billion.

In addition to this major project, further medium-size hydroelectric plants were installed by GTZ between 2002 and 2005 as part of the national programme to promote hydropower. In 2006 the Government of Pakistan applied for a loan from the ADB for projects in the field of renewable energy. The first tranche of the loan, amounting to US$ 510 million, was pledged by the ADB in December, and among other things is supposed to be used to implement medium-sized and small hydropower projects in the north-west of the country. The projects include eight grid-coupled hydropower plants ranging in capacity between 2.6 MW and 36 MW. In recent years, 570 locations with a total capacity of 2166 MW have been identified in the category of hydropower projects with ratings between 1 MW and 50 MW.

Micro hydropower

In northern Pakistan alone there is an estimated potential of 300 MW for micro-hydropower plants with installed capacities below 100 kW each. The potential in the canal system of the Punjab amounts to a further 350 MW. Up until 2006, PCRET had installed 300 micro-hydropower systems in the mountainous North-West Frontier Province, with a total capacity of 3 MW. The systems have a rated output of between 5 kW and 50 kW. All of the components come from domestic production.

Wind energy

There are many regions in Pakistan suited to the commercial exploitation of wind energy, including in particular the south of the province of Sindh and the coastal region of Balochistan. At the beginning of the 1990s initial wind measurements were conducted at locations throughout the country but especially in the province of Balochistan, which were used to produce the first wind maps.[16] In recent years wind measurements were taken in the region around Gharo-Keti Bandar for the specific purpose of planning wind farms.

UNDP/GEF project 'Commercialisation of Wind Power Potential in Pakistan'

The first official initiative to stimulate the use of wind power in Pakistan was launched in November 2000. With financial support from UNDP and GEF, Pakistan's Ministry of Environment initiated a project entitled 'Commercialisation of Wind Power Potential in Pakistan'. This included a study that identified the existing obstacles to the use of renewable energy in Pakistan and put forward suggestions on how to overcome them. The suggestions were largely taken up within the framework of the package of measures for renewable energy from December 2006.

Under the aegis of the follow-up programme, Sustainable Development of Utility-Scale Wind Power Production: Phase 1, which was launched in January 2004 for a period of five years, wind power is supposed to gain a foothold in Pakistan through the elimination of political, institutional, legal, fiscal and technical barriers. Wind power is also supposed to be integrated into Pakistan's power grid, especially in remote regions.

Wind energy projects

Planning for commercial wind farms in Pakistan is concentrated on the area around Gharo-Keti Bandar in the province of Sindh in the south-east of the country. The AEDB has identified a wind corridor in this region that because of excellent local conditions promises a potential wind energy capacity of 50,000 MW. Average wind speeds at a height of 65 meters are around 7 to 8 m/s. The AEDB will facilitate use of the land on favourable rental terms at approximately EUR 15 per hectare and year. The NTDC will construct new transmission lines from Mirpur Sakro to Thatta to cater for the additional capacity in the region.

16 See Nasir/Raza/Raja, 1992 and Nasir/Raza/Abidi, 1991.

In 2004 the AEDB authorised the private company New Park Energy to build the first 45 MW of a wind farm in Koti-Kun near Gharo that is ultimately planned to have a capacity of 400 MW. The project is to be implemented in further phases of 45 MW each. General Electric will supply 30 turbines for the first phase, each rated at 1.5 MW. The power generated from wind energy is to be fed into the KESC grid. Before the commencement of physical implementation, in the spring of 2007 the investor had not yet submitted a Performance Guarantee, which the AEDB requires before it issues a final Letter of Support (LOS).

The pre-feasibility study in the region was carried out by the AEDB. By December 2006 the AEDB had entered into 59 agreements on cooperation with national and international enterprises through Letters of Intent (LoI). By this route it is intended that 700 MW of wind power is to be installed by 2010, and by 2030 as much as 9,700 MW in total. At the end of 2006 six companies filed applications with the regulatory authority NEPRA to generate electricity from wind energy; three applications were approved, with 50 MW each. The AEDB has leased land to twelve investors. By the end of 2006, thirteen private investors had given the AEDB firm undertakings to install 50 MW each over the next two years.

The producers are able to choose between accepting a standard tariff set in advance by NEPRA or applying for remuneration from NEPRA. The up-front tariff averages 7.2 euro cents/kWh for a period of 20 years. For the first 10 years the rate is 8.7 euro cents/kWh, while over the subsequent 10 years it drops to only approximately 3.8 euro cents/kWh. So far New Energy Park is the only company to have applied for the tariff to be fixed for its project and to have had this approved.

An international consortium was set up for the local production of individual plant parts in Pakistan. However, it is not expected that the production of individual components for wind turbines will begin until there are clear signs of an appropriate market volume.

Micro installations

By the end of 2006 there were 140 micro wind turbines (300-500 W) installed in Pakistan for generating electricity and others for pumping water (about 30 systems). As a result, 356 households have been provided with electricity in the province of Sindh and 111 in Balochistan.

Biomass

According to the last census from 1998, approximately two thirds of the population of Pakistan live in rural areas, and these people in particular rely almost exclusively on biomass in the form of fuelwood or charcoal for cooking and heating. 30 % of the country's energy needs are therefore met by biomass, and its use is continuing to rise, by an average of 5 % per year.

The Government of Pakistan launched a programme promoting the use of biogas in 1974. By 1987 more than 4,100 biogas plants had been installed, in a number of phases. However, as the last phase no longer offered any official financial assistance, no more such systems were installed. Since May 2003 a further 1,200 plants have been installed as part of a new biomass/biogas programme operated by PCRET, with each plant being state-funded to the tune of 50 %.

The potential for generating electricity from bagasse is estimated at 400 MW. Operators of sugar mills have the possibility of feeding any excess electricity they produce into the power grid. This option is available for combined heat and power plants with a capacity of up to 700 MW. The as-yet unutilised potential for electricity generation from waste is estimated at 500 MW per major city.

Solar energy

Pakistan's potential for the use of solar energy is very good. The average daily insolation rate is approximately 5.3 kWh/m^2. Almost half of the area of the country shows potential for the economically viable exploitation of solar energy. The south-western province of Balochistan in particular offers excellent conditions. There, the sun shines approximately 3,000 hours per annum. The potential for the country as a whole is estimated at about 70,000 MW.

Despite these favourable prerequisites, the use of solar energy for generating electricity or for heating is still only in its infancy. At the beginning of 2006 output from photovoltaics amounted to about 0.8 MW, used for rural electrification, garden lighting and telecommunications. As far back as the early 1980s, the Government of Pakistan had 18 PV systems with a composite output of 440 kW installed in various parts of the country. Due to a lack of technical expertise in operation and maintenance, though, no further systems were installed. For the same reason, seven other PV systems with a total output of 234 kW, which were installed in the Pakistani part of the Hindu Kush in the late 1980s, are now no longer in operation.

Within the context of public-sector development programmes, several '100 Solar Homes' programmes were conducted by the AEDB in 2005 and 2006. These enabled a total of 991 households to be supplied with electricity from off-grid solar home systems with modules rated at 88 W each.

The utilisation of solar thermal energy is currently being trialled by the AEDB in the course of pilot projects in the provinces of Sindh and Balochistan. The potential is estimated at 10,000 MW_{th}. In future, solar energy is also to be used for drinking-water treatment and desalination. To this end, the AEDB has initiated a project in which PV systems are to be installed for treating drinking water in five villages in the remote district of Tharparkar in the province of Sindh, along with solar thermal systems for desalination. Two solar-powered desalination facilities which can provide a daily supply of 22,710 l of fresh water are in use in the province of Balochistan.

Geothermal energy

There are numerous hot springs in various parts of Pakistan, for example in the vicinity of Karachi and the Pakistani part of the Himalayas, with temperatures ranging from 30 to 170 °C. Potential areas of use for geothermal plants were identified as long ago as the 1980s.[17] To date, though, no use has been made of geothermal energy in Pakistan for generating power.

17 See Tauquir, 1986.

21.6 Rural Electrification

An estimated 40,000 villages still had no access to electricity in 2006. In the province of Balochistan the population density is very low, averaging only 22 inhabitants per km^2; 90 % of the villages in this province continue to have no access to grid power. The government has initiated a multiplicity of projects on rural electrification in cooperation with international institutions. Microcredits are made available by the Kushali Bank. The ambitious target set by the government's Kushal Pakistan programme, which envisaged every inhabitant of the country being supplied with water and electricity by the end of 2007, will definitely not be achieved. The rural electrification programme was called into being by the government in 2001, initially for a period of two years, and was then extended for a further five years.

Roshan Pakistan programme

The Roshan Pakistan programme is a key part of the Government of Pakistan's overall strategy for rural electrification. All in all, 7,874 remote villages that are more than 20 km from the national electricity grid and for which there are no grid expansion plans in the coming 20 years will be provided with an electricity supply. 906 villages are in the province of Sindh and 6,968 in Balochistan. The AEDB is heading the project in cooperation with the provincial governments of Sindh and Balochistan, and is planning for the electrification of 400 villages in the provinces of Sindh (100) and Balochistan (300) in the first phase. This is meant to be completed by 2009. GTZ provided support to the AEDB in planning its electrification strategy.

Five PV systems of various sizes will be made available in order to implement this programme. The Government of Pakistan is subsidising the cost of purchasing the systems, depending on the number of occupants and number of rooms in each house. The users of the systems are supposed to pay only for operating and maintenance costs. German and other European companies took part in the tendering process for the project at the end of 2006. A total of 18,000 solar home systems are supposed to be installed.

Exchange rate (19 February 2007):
100 Pakistan rupees (PKR) = EUR 1.25

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22 Philippines

22.1 Electricity Market

Installed capacity

The installed power generating capacity in the Philippines totalled 15,619 MW at the end of 2005. Due to the overcapacities that prevailed over many years, this level is only slightly higher than that of the year before. Expansions in capacity required to cope with the increasing demand for electricity in the country are estimated to be 9 GW by 2016. There are no grid-connected imports of electricity from abroad.

Total capacity [MW]	2003		2004		2005	
	15,124		15,548		15,619	
	MW	%	MW	%	MW	%
Oil	3,604	24	3,669	24	3,663	23
Coal	3,958	26	3,967	25	3,967	25
Hydropower	2,876	19	3,217	21	3,222	21
Geothermal	1,931	13	1,931	12	1,978	13
Natural gas	2,764	18	2,763	18	2,763	18
Solar/wind					26	0.002

Tab. 1: Power station capacities according to energy source in MW and %; Philippines; 2003-2005[1]

Power generation

Power generation in 2005 amounted to roughly 57,000 GWh. The most important domestic primary energy sources used for this were natural gas (30 %), geothermal energy (18 %) and hydropower (15 %), and among the imported energy sources coal (27 %) and oil (11 %). This means the share accounted for by the various domestic energy sources has grown considerably over the past years and the country has come closer to its goal of achieving greater independence in the energy supply market.

A crucial factor in this shift has above all been the development and expansion of domestic gas reserves[2], through which the country's level of independence in energy supply increased by 5.4 % to 50.9 % from 2001 to 2002 alone. [3]

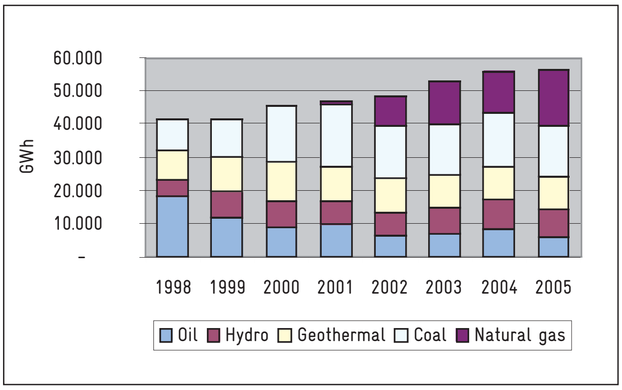

Fig. 1: Power generation in GWh; Philippines; 1998-2005[4]

According to the Philippine Energy Plan 2005-2014, national independence in the field of energy supply is to reach 60 % by 2010.

Power transmission and distribution

The geography of the Philippines, which comprises some 7,000 islands, has a decisive influence on the nature of the country's mains-borne power supplies. As well as three large, separate national electricity transmission grids (Luzon[5], Visayas and Mindanao), there are regional supply systems on smaller islands. Under the Transmission Development Plan (TDP) the power grids are to be considerably expanded in the coming years.[6] Two-thirds of the Philippine villages still without power[7] are to be connected to the grid in this way.

1 Source: Department of Energy, 2006.
2 The signal to begin exploitation of domestic gas reserves was given by the discovery and development of the Malampaya offshore gas field in the northwest of Palawan in 2001/2002, which on its own supplies three gas-fired power stations with a total capacity of 2.76 GW.
3 While in 1973 as much as 92 % of primary energy consumption was still met by imported oil, this figure has now dropped below 50 %. In relation to the share of oil used for power generation purposes, this consumption figure has fallen by 5 % to just under 11 % within the space of just 12 months (2004 to 2005).
4 Source: Department of Energy, 2006
5 The Luzon power grid – the largest of the three cited – alone carries 72 % of the domestically generated electricity.
6 The TDP is part of the Power Development Plan 2004–2013. DOE – Department of Energy: Highlights on the Implementation of Republic Act No. 9136, Electric Power Industry Reform Act of 2001 for the Period May 2003 – October 2003.
7 Almost 6% of Philippines villages are not as yet connected up to the existing supply systems.

The poor reliability of the transmission grids that make up the national power supply system is reflected by regular power failures, which in 2003 accounted for a total of 52 hours downtime without power. The greatest power losses occur at the distribution level, adding up to a total of 6,817 GWh in 2005.

Electricity consumption

Electricity consumption in 2005 amounted to roughly 45,000 GWh. Of this, 35.5 % was attributable to households, 34.8 % to industry and 27.1 % to trades and crafts ("other": 2.6 %). This ratio has barely changed in the past years.

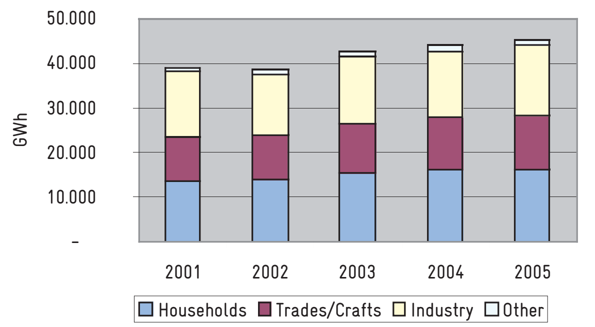

Fig. 2: Electricity consumption according to sector in GWh; Philippines; 2001-2005[8]

Electricity prices

In comparison with certain neighbouring countries, such as Malaysia, Thailand and Indonesia, the Philippines has high electricity tariffs. The reasons for this include the high costs of loan capital for the state-owned power utility National Power Corporation (NPC or NAPOCOR), considerable network losses at the distribution level, and the dispersed location of the many islands – making power supply difficult. A renewed rise in tariffs[9] across all customer groups in 2005 can be put down to the abolition of long-standing cross-subsidies in many supply areas. The highest tariffs are still paid by electricity customers on the main island of Luzon. In terms of customer groups, the highest tariffs are paid by industrial consumers and trade/craft enterprises.

	Households	Trades and crafts	Industry
	€-ct/kWh		
Electricity tariffs	2.54–8.66	2.97–7.97	2.71–8.76

Tab. 2: Average electricity tariffs; Philippines; in euro cents/kWh; 2005[10]

8 Source: Department of Energy, 2006.
9 From an average of 8.9 euro cents/kWh in 2004 to 10.8 euro cents/kWh in 2005.
10 Source: ASEAN Centre for Energy, 2006.

22.2 Market Actors

Since centralised reforms in the electricity sector began in 2001, the structure of the market has been undergoing a process of change in which the importance of private-sector actors is growing compared with public-sector actors.

Power generation and transmission companies

The main actor in the field of power generation is the state-owned National Power Corporation (NPC).[11] This corporation's power plants, the majority of which are operated by private, independent power producers, currently supply 75 % of the electricity generated nationally. In addition to power stations owned by NPC, the private power producers also operate a large number of their own power generating facilities.[12] Power generation in regions not connected to the grid is primarily under the control of the Small Power Utilities Group (SPUG) that belongs to NPC. Since January 2004, the Philippines' Department of Energy (DOE) has been engaged in opening the way for private initiatives to access these off-grid areas, too.[13]

Following the reforms introduced in 2001, ownership and management of the nationwide transmission grids was handed over to the National Transmission Corporation (TRANSCO). So far, TRANSCO has been acting as a wholly owned subsidiary of the Power Sector Assets and Liabilities Management Corporation (PSALM). The long-standing plans to sell the transmission grid to private concessionaires and power distribution companies are now being implemented.[14]

Power distribution companies

By far the largest company in the power distribution segment is the partly state-owned (26 % share) Manila Electric Company (MERALCO), in whose service area a quarter of the population of the Philippines lives. Its share of the total amount of power distributed throughout the nation is actually as much as 70 %, due among other things to the high proportion of urban customers in its service area. Apart from MERALCO, 141 distribution companies control the rest of the power delivery market to the end customers. This group is made up of 18 private providers, 4 municipal utilities and 119 rural cooperatives. The latter have relatively small numbers of customers individually,[15] but together actually serve a total of around 55 % of all customers in the country. Not only MERALCO but the other distribution companies, too, purchase the electricity they distribute either from NPC or the independent power producers.

Privatisation of power stations

Privatisation of NPC's power stations is one of the functions of the state-owned Power Sector Assets and Liabilities Management Corporation (PSALM). Since late 2005, 31 power stations with a total generating capacity of 4,337 MW have been offered for sale. Five small power stations with a total capacity of 8.5 MW have already been sold.[16] By the end of the first quarter of 2007, 70 % of the NPC power plants connected to the Luzon and Visayas transmission grids will be in private hands – and by 2008 a total of 25 state-owned power stations. Besides the privatisation of existing power stations, the construction of additional power stations and expansion of the grids are in future also supposed to be carried out primarily by private actors.

11 NPC was founded back in 1936 and for decades was responsible for all power generation and transmission activities in the country.
12 The large number of independent power producers can be traced back to a period when many new companies were set up at the end of the 1980s after the Philippines had suffered a power supply crisis lasting several years and the government had responded with a vigorous political campaign promoting private-sector involvement in the power generation sector.
13 Seven of a total of 14 regions NPC has identified as "first wave" regions had been opened up for private-sector involvement by the end of 2005.
14 One of the reasons for the long delay (of several years) in the privatisation of TRANSCO is the lack of qualified prospective purchasers. Further information on this topic can be found in the 8th EPIRA (Electric Power Industry Reform Act) Status Report (www.doe.gov.ph).
15 89% of the rural cooperatives have fewer than 100,000 customers.
16 The sale of one of the largest power stations in the Philippines – the 600-MW Masinloc power plant – in 2004 to an Australian consortium had in the end to be cancelled due to the consortium's inability to pay. This was a serious setback for the current privatisation process.

Other Actors in the Electricity Sector

The most important institution determining energy policy is the Department of Energy (DOE), as it is responsible for drawing up plans, laws and programmes. It underwent a reorganisation in August 2002 as part of the power sector reform. Since then, the newly created Electric Power Industry Management Bureau (EPIMB) has been part of the DOE; among other things it has the task of monitoring the reform process, ensuring a reliable and efficient power supply and elaborating strategies and plans for rural electrification.

Regulatory functions are performed by the independent Energy Regulatory Commission (ERC)[17], which was set up under the Electric Power Industry Reform Act (EPIRA) in 2001. The commission is also responsible for drawing up and enforcing implementation guidelines and specifications in line with this Reform Act. Its scope of responsibility also covers:

- Regulation of the 141 power distribution companies
- Maintenance of competition, including controlling and monitoring measures against anti-competitive behaviour
- Supervision of tariffs, including setting up and enforcing methods for wheeling tariffs
- Enforcement of regulations in the distribution and transmission sector and in the wholesale market, as well as monitoring compliance with these regulations.

22.3 Legal Framework

Electric Power Industry Reform Act 2001

The Electric Power Industry Reform Act (EPIRA), which entered into force in June 2001, was a milestone in the restructuring of the electricity sector.[18] The Reform Act creates a new legal and regulatory framework for the electricity sector and has already paved the way for the unbundling of power generation, transmission and distribution. The most important objectives are to reduce the high costs in the electricity sector, to privatise state-owned enterprises, to attract foreign capital and to expand domestic resources. The coming launch of a wholesale market is supposed to guarantee free access to distribution networks and free choice of power supplier by end customers with a monthly average peak demand of 1 MW.[19]

New tariff system

The Reform Act EPIRA also aims to increase the level of transparency in the tariff system: a separate price has to be specified for each service in the electricity supply chain (generation, transmission, distribution, sale). The planned examination and approval of the disaggregated tariff structures by the regulatory body, the ERC, has been widely implemented.[20] The policy of abolishing cross-subsidies is now also well advanced after initial delays.[21]

17 Support for the establishment of the regulatory authority is guaranteed within the framework of technical cooperation, in particular by the Asian Development Bank (ADB). With an overall budget of US$ 1.2 million, it also supports the privatisation of NPC.

18 Republic Act No. 9136. The DOE is obliged to report on the status of the reforms twice yearly. The last report published was entitled "8th Status Report on EPIRA Implementation: 11/2005-4/2006", available on the DOE website: www. doe.gov.ph.

19 This 1-MW threshold is to be reduced after the wholesale market has been up and running for a certain length of time. In the long term, the regulatory authority has the task of opening up the market completely, to the extent that households will also be able to choose their electricity supplier freely.

20 In February 2006, of the 141 applications for disaggregation of tariffs submitted to the regulatory authority a total of 138 had been approved, among them those from NPC and NPC-SPUG.

21 In February 2006, 119 of the 120 electrical cooperatives and 14 of the 18 private utilities had already begun abolishing cross-subsidies. Originally, the total abolition of cross-subsidies was to have been completed within three years of the Electricity Power Industry Reform Act being enacted.

Another element of tariff reform is what is referred to as the “universal charge”, a fixed charge to be paid by the final electricity customer that serves the purpose among other things of financing the debts of the former electricity supply company, NPC, and electrification measures. Socially balanced tariffs are to be granted to financially weak sections of the population.

Wholesale market

In order to strengthen competition at the generator level, it was decided as part of the reforms to set up a Wholesale Electricity Spot Market (WESM) whose structure is based on the principles of the electricity markets in Australia and New Zealand. The main emphasis is to trade all electricity flows through a power exchange that is binding for all participants. The computer-based system required is currently being put in place with assistance from the Asian Development Bank. The first major test run of the system, which also served to prepare the 53 participating companies for the WESM, was conducted in Luzon between April and December 2005. The test run in Visayas was begun in March 2006.[22]

As soon as the ERC has approved the pricing and the structure and levels of the market dues for the WESM, its commercial operation is to begin. The Philippine Electricity Market Corporation (PEMC), which was set up by the DOE at the end of 2003 as the agency responsible for the WESM and for developing an efficient, highly competitive, transparent and reliable electricity market, is now ready to begin work, according to the DOE.

One of the critical factors that has contributed to launching of the programme being delayed up to now relates to the high demands efficient running of the WESM makes on all the market actors as regards their financial resources and possibilities. The extent to which the model is actually able to integrate all market actors when it is implemented is still uncertain in this connection.

22.4 Policy Promoting Renewable Energy Sources

The key political motives of the Philippines for supporting renewable forms of energy are the reduction of energy imports and the supply of energy to the rural population.

Executive Order 462

The New & Renewable Energy Programme was initiated by the Department of Energy (DOE) when it adopted Executive Order EO 462 in 1997. The programme is aimed at strengthening the commitment of private actors in the field of renewable energy and in the process also particularises Executive Order 215[23], which already cleared the path for the commercialisation of renewable energy projects. It includes the promotion of large-scale application systems.

According to Executive Order EO 462, private actors are granted the right to launch alternative energy projects.[24] Along the same lines as when exploration rights for fossil energy sources are awarded, in the case of renewable energies, too, a contract must be concluded with the state according to which a share of the net profits is paid to the state (“production sharing contract”). The level of this levy is determined by tender or by direct negotiation. Criticism of the executive order led to a modification in 2000 according to which projects with a capacity of below 1 MW are now exempt from the levy, and the levy is limited to a maximum of 15 %. Furthermore, support was promised from the DOE with project development and financing, for example with the development of locations and drawing up feasibility studies.

22 The launch of the WESM is considerably behind schedule. According to the original legal situation, the electricity trading market ought to have begun operation in June 2002.

23 Executive Order 215, which was passed in 1987, formed the initial basis for participation by the private sector in the electricity market by regulating the integration of independent power producers in law, for instance.

24 Executive Order No. 462, "Enabling Private Sector Participation in the Exploration, Development, Utilization and Commercialization of Ocean, Solar and Wind Energy Resources for Power Generation and Other Energy Uses". Important additions were made in Executive Order No. 232, which came into force in 2000.

Regional programmes

In order to support the use and development of technically and economically mature renewable energy systems in the provinces, Area-Based Energy Programmes (ABEPs) are being advanced as part of the New & Renewable Energy Programme. Local energy supply concepts are also being drawn up within the scope of these regional programmes. The ABEPs are implemented by partner institutions (Affiliated Non-Conventional Energy Centers – ANECs) such as universities.

Planned renewable energy law

The central legal code for the electricity sector, EPIRA, adopted in 2001 emphasises expansion of the use of renewable energy sources. The liberalisation of the market associated with this legislation, along with free access to the power grids, opens up opportunities in particular for large application systems such as wind farms, which can produce electricity cost-effectively and sell it to major customers.

To enable smaller systems that use alternative energy technologies to also make inroads into the liberalised market and to strengthen the establishment of renewable energies overall, it is intended to enact a separate law targeted specifically at renewable energy sources.[25] The current bill contains among other things provisions for financial and non-financial incentives, a quota system for renewable energy sources that every power producer must comply with as well as the basis for the establishment of a trust fund. It is also envisaged that electricity generated from renewables should be identified as such ("green pricing") and that existing and possibly also new investment incentives should be locked in.

Investment incentives

Renewable energy was included in the government's Investment Priorities Plan. As a result, investors can apply for certain concessions from the responsible authority, the Board of Investments (BOI). Such concessions include:

- Deferring payment of income tax for 4-6 years
- Exemption from tax and customs for imported plant components
- Tax concessions on purchase of local goods
- Employment of foreign personnel
- Simplification of customs clearance

Clean Development Mechanism

The Philippines ratified the Kyoto Protocol in October 2003. Responsibility as the Designated National Authority (DNA) has been assumed by the Philippine Department of Environment and Natural Resources (DENR). As such, it acts among other things as the final approving authority in a 4-stage process that has been set up at the national level to assess and approve CDM projects.

By the end of 2006, the DENR had submitted 31 CDM projects to the international Executive Board (EB), the majority of them being renewable energy projects. Among the most recent projects submitted are a biomass project on energy recovery from rice husks with an annual CO_2 savings potential of 44,680 tonnes and a 40-MW geothermal project with an annual CO_2 savings potential of 174,900 tonnes. The greatest potential for CDM projects is considered to be in the field of renewable energy sources – in particular, in the use of hydropower, wind power and biomass.

Several institutions are supporting the DENR within the framework of the national CDM activities. These include for example three CDM Technical Evaluation Committees (TECs), which – as expert committees for the environment (including waste), forestry and energy – examine to what extent the CDM projects submitted actually satisfy the nationally defined criteria for CDM projects. The DOE performs this task for the energy sector. The DNER receives assistance in implementing national CDM projects from among other things a CDM help desk.[26]

25 In February 2006, a draft bill was proposed to the government, which had in fact reached the Senate by the end of January 2007 but had not yet been passed.

26 Further information on the national CDM activities is available at www.cdmdna.emb.gov.ph or in the CDM Country Guide for the Philippines (published by the Japanese Institute for Global Environmental Strategies) at www.iges.or.jp/en/news/topic/0512cdm.html

22.5 Status of Renewable Energy Sources

In 2005, renewable sources of energy accounted for a share of 42 % of primary energy consumption. The most significant part of this was the traditional thermal utilisation of firewood and agricultural wastes in households and trades or crafts.

One particular feature of the portfolio of renewable energies used to generate electricity in the Philippines is the intensive use of geothermal energy and hydropower. Power stations that operate using these two energy sources generated one-third of the total power generated in 2005, while the use of wind power, biomass and solar energy for power generation accounted for an exceedingly small share of just 0.03 %.

	Potential	Installed capacity 2005 [MW]	Installed capacity 2013 [MW]
Geothermal	4,790 MW	1,978	3,131
Hydropower	No data	3,222	5,468 (by 2014)
Wind power	70,000 MW	25	417
Solar	5.1 kWh/m^2	1	130–250
Biomass	250–350 mill. barrels oil equivalent/ year	No data	
Marine energy	170,000 MW	0	
Total		5,226	9,147

Tab. 3: Potentials, installed capacity and planned expansion of renewable energy sources; Philippines; 2005, 2013; MW[27]

Ambitious expansion targets

The DOE has defined ambitious expansion targets for the next 10 years. The Philippines aims to become the world number one in the exploitation of geothermal energy and the number one in Southeast Asia in the use of wind energy, and the country also aims to almost double its hydropower capacity by 2013. The exploitation of marine energy is supposed to contribute to power supplies in the long term.

Hydropower

Hydropower is the second most important domestic energy source for electricity generation. Measured against the total installed capacity of 3,222 MW at the end of 2005, the share accounted for by small-scale hydropower up to 10 MW is relatively small. At the present time, 53 small (mini) plants (100 kW-10 MW) with a total capacity of 89 MW and more than 100 micro systems (< 100 kW) are in operation.[28] The increase in installed capacity of more than 700 MW between 2002 and 2005 can primarily be traced back to the construction of additional large hydropower stations.[29] Apart from that, a 12-kW plant that supplies 150 households with electricity was installed in Saloy in May 2004 by a rural cooperative.

27 Source: Department of Energy, 2006

28 Classification of hydropower plants in the Philippines: pico hydro: < 1kW; micro hydro: 1 to 100 kW; mini hydro: 101 kW to 10 MW; small hydro: 10 to 50 MW; large hydro: > 50 MW.

29 Among these are two large hydropower plants that were put into service in 2004: the 345-MW San Roque station in Pangasinan and a 350-MW station in Laguna.

The political goal of increasing installed capacities by 780 MW to 5,468 MW by 2013 is primarily to be achieved through the development of small and mini hydropower plants.[30] Several organisations from the Philippines and elsewhere have conducted site analyses and investigated the unexploited potential for small-scale hydropower installations:[31] it is estimated that 1,850 MW of capacity in mini hydropower plants and 28 MW in micro hydropower systems could make an additional contribution to power supplies. According to forecasts by the Department of Energy, the growth in capacity of small-scale plants will amount to 160 MW by the end of 2009 and to 457 MW by 2025.

Five government-funded mini hydropower projects with capacities of between 350 kW and 2.5 MW are currently in the process of being implemented. With the support of the Development Bank of the Philippines (DBP), the construction of a 400-kW plant for supplying electricity to 1,000 households in Kaling province is to begin in the spring of 2007. Start-up is planned for spring 2008.

The DOE is planning to utilise wave and tidal energy in future; the potential has been estimated at 170 GW. Developments in this regard, however, are still in the initial phase.

Mini Hydroelectric Power Incentive Act and other promotion

The Philippine government spelled out its objective of promoting the involvement of the private sector in mini hydropower projects in a law that came into force in 1991.[32] Project developers can take advantage of various reduced tax rates as well as tax and customs exemptions. Because of complex approval procedures, however, only a small number of projects have been implemented in recent years.

Technical and/or financial cooperation for small-scale hydropower projects is also offered by the Development Bank of the Philippines (loans) and the Renewable Energy Project Support Office (REPSO-Philippines) in the form of feasibility studies and schemes for participation in equity capital.

Wind energy

The utilisation of wind power for generating power is still a very fresh concept in the Philippines. That said, few now doubt the potential of wind energy as a new energy source for the country. The wind power potential, calculated to be at least 70,000 MW,[33] and the dispersed geography of thousands of islands make wind power seem not only a cost-effective alternative to diesel generators in isolated systems but also an economic option for feeding power into the grid. Location-specific information on the respective wind potentials has been published by the Department of Science & Technology in the form of a wind atlas.[34]

The most commonly seen use of wind power is for water pumps, driven by windmills. According to information from the DOE, 368 such systems were in place at the end of 2001. In addition to a few small wind power generators in the form of isolated systems, there are now also a number of larger installations. The first privately operated wind-diesel system went into service in August 2004 as a hybrid project. This was followed in June 2005 by the first 25-MW wind farm, comprising 15 wind turbines, which was constructed on the coast of Ilocos Norte in Bangui by the Northwind Power Development Corporation, a joint venture between Denmark (40 %) and the Philippines (60 %). This wind farm is connected to the island's main transmission grid by means of a 60 km-long transmission route and guarantees 40 % of the regional electricity supply, that is power for more than 500,000 people.

30 Environmental concerns and the high cost of large dams led to this decision.
31 These include the National Electrification Administration (NEA) and the National Power Corporation (NPC), which has identified over 1,000 locations, and the US National Renewable Energy Laboratory (NREL).
32 Republic Act No. 7156, "An Act Granting Incentives to Mini-Hydro-Electric Power Developers and for Other Purposes". Assistance can only be claimed by enterprises or organisations that are 60 %-owned by Philippine citizens. Installations with a capacity of between 101 kW and 10 MW are promoted.
33 A study conducted by the National Renewable Energy Laboratory (NREL) in the USA identified wind power potential with a total capacity of 76,000 MW. According to this study, the best wind resources, including suitable locations for wind farm projects with total outputs of between 40 and 60 MW, are to be found in the north and northeast of the country.
34 Within the Department of Science and Technology (DOST), the Council for Industry and Energy Research and Development (PCIERD) is responsible for the wind atlas: www. pcierd.dost.gov.ph. The wind atlas can also be downloaded from the Internet from NREL: www.nrel.gov/wind/pdfs/26129.pdf.

No other such projects have been implemented to date. The slow development of the wind power sector in the Philippines can essentially be put down to the lack of a legal framework targeted specifically at promoting commercial development of wind power on a large scale. High hopes are currently being placed in the enactment of the planned law on renewable energy.

Expansion plans

The Energy Development Corporation of the Philippine National Oil Company (PNOC-EDC), which is primarily active in the field of geothermal energy, intends to concentrate more on advancing the construction of grid-connected wind farms. For some years, the company has been planning the construction of a 120-MW wind farm on the northern coast of Luzon, with construction to be conducted in three separate phases. In the first phase a 30-MW wind farm is to be built with the financial backing of JBIC (Japan Bank for International Cooperation).[35] In addition, Smith Bell Rosco plans to build a 30-MW farm in San Carlos City on Negros.

To attract private companies to the business, the government identified 16 sites with a total potential of 345 MW and put them out to tender in June 2004. Three local companies from the Philippines were awarded contracts to develop a number of these sites – six in all, with a total capacity of 140 MW. A further 16 sites were approved for development at the beginning of 2006.

Biomass

Despite biomass accounting for a share of 30.8 % of the national energy supply in 2005, hardly any use has been made of biomass for generating electricity in the Philippines so far. It is predominantly limited to its traditional uses, namely, cooking and heating. Thanks to the enactment of a new law in July 2006,[36] the production of biofuels has received new impetus for growth.

The main forms of biomass that lend themselves to power generation are bagasse, rice husks and coconut residues. Power stations with a capacity of at least 540 MW could be run with the bagasse obtained from the processing of sugar cane. The use of rice husks could make a contribution of 360 MW to power generation. Coconut residues would allow the operation of combined heat and power (CHP) stations with an output of 20 MW.

Current activities

Various examples of planned activities for utilising these potentials can be found, amongst other places, on the island of Negros. This includes a 30-MW bagasse-fuelled combined heat and power plant operated by First Farmers Holding Corporation (FFHC), which is supplied with residues from the corporation's own sugar mill and from other mills in the region. Apart from supplying its own needs for electricity and steam, the project aims at feeding surplus electricity into the Luzon-Visayas grid. At the centre of the planned San Carlos Renewable Energy Project is an 8-MW power plant for generating electricity from bagasse.[37]

At present, 653 biogas systems based on animal dung are in use. Plans are being drawn up for a biogas project on the Paramount Pig Farm close to Luzon, whose power has until now been provided by a diesel generator. Two 75-kW generators will convert the generated biogas into electricity and cover the farm's entire needs for power. The project was registered with the international CDM Executive Board at the end of January 2007.

35 The original goal set by PNOC EDC to put the first 40-MW wind farm into service as early as 2004 could not be met due to a significant increase in the costs originally estimated for the project at the beginning of the planning phase.

36 The Biofuels Act (Republic Act 9367) passed in 2006 is targeted at reducing the nation's dependence on oil and its CO_2 emissions. The act contains development incentives, such as an exemption from value added tax on local and imported equipment, systems and raw materials. Furthermore, it stipulates the admixture of 5 % bioethanol to petroleum sold between 2006 and 2008 and 10 % up to 2010.

37 The two projects are also intended to earn emission rights within the framework of the Kyoto Protocol.

In addition to the growing commitment of the Philippine National Oil Company, with its bioenergy spin-offs, the Energy Development Corporation (PNOC-EDC) and Alternative Fuels Corporation (PNOC-AFC), a small group of suppliers of corresponding technologies has formed.

Solar energy

According to investigations by the US National Renewable Energy Laboratory (NREL), which has prepared a solar atlas for the Philippines, the average daily solar irradiation is 5.1 kWh/m^2.

The dispersed geography of the numerous islands presents good opportunities for the use of PV systems. Until now the applications that have found use are mostly decentralised, such as for telecommunications facilities, water pumps, lighting and battery chargers, for example.[38]

Bilateral cooperation

A large proportion of the projects for rural electrification on the basis of isolated PV systems are based on bilateral development cooperation. In the past, GTZ has, for instance, supported rural solar projects in the Philippines installing solar home systems (SHSs) and solar-powered water pumps. The Netherlands is also promoting the use of solar energy as part of the PNOC solar home system project, in which 15,100 households are to be supplied with power. By the end of the first quarter of 2006, 9,191 SHSs had been installed. The Solar Power Technology Support (SPOTS) project, which is supported by among others the Spanish Mix Credit Facility, aims to provide power to 40 rural communities in Mindanao. By mid-2005, 5,435 PV systems had already been installed, the majority of them in households. Almost 500 systems were also installed in schools and health centres and for providing water supplies.[39]

Grid-coupled solar power plant

The largest grid-coupled solar power system in any developing country has begun operation in the north of Mindanao. It has an installed capacity of 950 kW. The scheme was supported by the World Bank/GEF. The pilot installation is supplying electricity in hybrid operation in conjunction with a 7-MW hydropower plant.

Production location for solar technology

According to the government's intentions, the Philippines is to become a significant location for PV technologies. The first manufacturer to open a production plant for solar cells was Cypress Sunpower in 2004. While the company began with an annual production capacity of 25 MW (8 million solar cells), it is already counting on an increased production figure of 150 MW for 2007.

Geothermal energy

Geothermal heat is the most important domestic resource used for generating electricity and has been used since 1977. The installed capacity of 1,978 MW is to be boosted to 3,131 MW by 2013. The potential as yet undeveloped is estimated to be just under 3,000 MW.

The development of geothermal potential has so far been the reserve of primarily two companies: the Energy Development Corporation of the Philippine National Oil Company (PNOC-EDC) and Philippine Geothermal Incorporated (PGI), a subsidiary of the American company Union Oil of California (UNOCAL). These two companies have secured the development rights for many attractive locations. The state-owned utility (PNOC-EDC) alone plans to build installations with a total capacity of 330 MW by 2010.

38 According to information from the DOE, approximately 8,944 solar home systems (SHSs) had been installed by the end of 2005. The provisional goal of 15,100 SHSs is supposed to be achieved in 2007. (DOE PEP 06 3) The commercial potential is estimated to be for 500,000 systems. 119 systems with a capacity of 94 kW_p have been installed for supplying power to telecommunications facilities, and some 130 systems (180 kW_p) for water pumps and irrigation. Other applications, such as for battery chargers, together account for a capacity of roughly 50 kW_p.

39 Other bilateral solar power projects: the Alliance for Mindanao Off-Grid Renewable Energy programme (AMORE) with US support, and the Philippine Rural Electrification Service project (PRES), through which the French government is supporting the provision of electricity to 18,000 households in Masbate.

Act on Exploration of Geothermal Resources

Presidential Decree No. 1442 governs the involvement of private actors in the geothermal energy sector.[40] Investors are granted exploration rights for geothermal fields by being issued with a service contract. Apart from that, they benefit from incentives such as exemption from all taxes (with the exception of income tax) or the possibility to write off capital goods over a period of 10 years. In return, the investors must pay duties amounting to 40 % of their net proceeds to the state.[41] The willingness of private investors to invest in the geothermal sector is on the increase.

Current activities

In the course of the national privatisation process, the Philippine government plans to sell the 685-MW Tiwi-Makban power station. Currently under construction are two power stations whose operation will be subject to the rules of the new Electricity Act and which therefore will be run as "merchant plants": whereas previously all independent power producers were forced to sell their electricity to the state-owned NPC, the operators of the two new geothermal power stations are free to choose their own customers.[42]

22.6 Rural Electrification

Thanks to the great efforts that have been made in recent years to develop rural electrification, the number of non-electrified villages has fallen from 4,600 to 2,500 of the total of 42,000 villages (barangays[43]) between mid-2003 and mid-2006. According to the government's current plans, 90 % of all Philippine households are to be electrified by the end of 2007[44] and all villages electrified by the end of 2008 – for the most part by means of expansion of the supraregional grids. For the majority of these households and a large number of the villages, however, isolated solutions are the only solutions that come into question due to their peripheral location. 484 villages have been electrified by employing systems based on renewable energy sources, such as photovoltaics and mini hydroelectric power.

Electrification programmes

A new version of the Rural Electrification Programme has been running since April 2003.[45] It aims to achieve full electrification of villages already categorised as electrified, but in which there are still various households without access to electricity. In addition, several bilateral and international assistance programmes are contributing to the provision of rural electricity supplies in the Philippines.[46]

The updated Missionary Electrification Development Plan (MEDP) for 2006-20010 serves as the future strategy paper for the electrification of regions that can mainly be supplied only by localised energy systems. The MDEP is a sub-programme of the national Power Development Plan (PDP), which is targeted at developing the entire national power supply system. The MDEP is updated every year by the DOE.

40 Presidential Decree No. 1442 "An Act to Promote the Exploration and Development of Geothermal Resources".
41 As such, the previously highly restrictive provisions of the decree, by which at least 60 % of the net proceeds accruing from the enterprise has to be paid to the state have been revoked.
42 One power station (40 MW, commissioning planned for spring 2007, Philippine National Economic Development Authority (NEDA) 06) is situated on Mount Kanlaon in the province of Negros Occidental, the second power station (20 MW, commissioning planned for 2008, German Office for Foreign Trade (bfai) 2006) in the city of Palinpinon. The orders for building the power stations were awarded to a Japanese company by PNOC-EDC. Japan Bank for International Cooperation (JBIC) is supporting the construction of the Kanlaon power station with a loan of US$ 82 million.
43 Barangays are the smallest administrative bodies at the local level and generally comprise 100 to 500 households.
44 The deadline has been brought forward in the past years from 2017 to 2007.
45 The forerunner of this programme was the O'llaw Programme ('gift of light' programme) that ran from January 2000 to March 2003.
46 The World Bank and the Asian Development Bank (ADB) in particular are supporting the Philippines in rural electrification.

The Rural Power Project of the World Bank is supporting the electrification of 10,000 households with solar and isolated systems over a five-year period by granting a loan amounting to US$ 10 million. 1,000 systems were installed by mid-2005.

The Development Bank of the Philippines (DBP) implemented a Regional Power Plan (RPP) in order to enable rural consumers to gain access to the main electricity supply. In January 2005 the bank made a budget totalling US$ 1 billion available for the promotion of specific projects.

Three Philippine NGOs[47] launched a 100 Villages Campaign in 2006. During the course of the next 5 years, this campaign is intended to give 100,000 inhabitants of villages in the Philippines among other things access to electricity by means of micro hydropower stations and solar energy systems.

Institutions

The National Electrification Administration (NEA) is a key organisation in execution of the electrification programme. Its primary task is to provide financial, technical and institutional support to the Rural Electric Cooperatives (RECs), which are the bodies chiefly responsible for electricity supplies in rural areas. According to the Reform Act EPIRA, the Small Power Utilities Group (SPUG) of the NPC assumes a major role in the provision of electricity in areas where there is no grid connection.

According to national plans, the supply of electricity to previously non-electrified communities is to be facilitated by private actors to a greater extent than before. The starting signal for measures of this kind was given in 2005 with the opening-up of the first "first wave" regions of NPC-SUPG for private sector activities. Within the framework of a promotion programme (2003-2011) aimed at strengthening the Philippines' private sector, GTZ is providing support in particular to poorer sections of the population of the Visayas group of islands to help them develop their entrepreneurial potential, among other things by simplifying access to medium- and long-term loans.

Model region Negros Occidental

The island province of Negros Occidental is intended to become a model region for the use of renewable forms of energy and thus serve as an example for other regions. In addition to the construction of a 30-MW wind farm, there are plans for a 40-MW geothermal power station, micro hydropower installations, battery charging stations and a combined heat and power plant fuelled by bagasse.

Exchange rate (6.2.07):
1 Philippine dollar (PHD) = 0.01593 euro (EUR)

47 The three NGOs Yamog, SIBAT and AIDFI want to use this campaign to replicate their previous successes with regional renewable energy projects at national level.

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23 Viet Nam

23.1 Electricity Market

Installed capacity

At the end of 2005 the total installed capacity of the state-owned power utility, Electricity of Viet Nam (EVN), and independent power producers amounted to 11,340 MW. Independent power producers accounted for about 22% of the total. The availability of some power stations is low, however, due to their age.

From the late 1980s to the early part of the current decade, hydroelectric schemes made up more than 50% of the installed power generating capacity. Since 2003, the central role of hydropower as a primary energy source has been supplanted by fossil energy sources: natural gas, coal and oil. It is nevertheless expected that hydropower will continue to occupy a dominant position in the future. Viet Nam is a net energy exporter and is likely to remain so until 2020. Viet Nam has offshore oil and gas resources in the south of the country, coal in the north[2] and hydropower potential that has so far been only partially exploited along the mountain range stretching from north to south.

Year	Hydropower		Coal		Oil (thermal power stations)		Gas turbines (natural gas and oil)		Diesel		Independent power producers		Total
	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW
2001	4,145	50.5	645	8.0	198	2.4	2,322	28.0	296	3.5	612	7.5	8,227
2002	4,187	48.0	1,245	14.0	198	2.0	2,322	26.0	296	3.0	612	7.0	8,860
2003	4,155	42.0	1,245	12.6	198	2.0	2,489	25.1	288	2.9	1,521	15.3	9,896
2004	4,155	36.6	1,245	11.0	198	1.7	2,939	25.9	285	2.5	2,518	22.2	11,340
2005	4,155	36.6	1,245	11.0	198	1.7	2,939	25.9	285	2.5	2,518	22.2	11,340

Tab. 1: Installed capacity; Viet Nam; 2001-2005; MW, %[1]

Power generation

In 2005 electricity generation reached 52 TWh, about 70% higher than the figure for 2001. The share of total generation contributed by independent power producers was just over 21%. This growing share in recent years is primarily attributable to the commissioning of two natural gas-based power stations at the Phu My Power Generation Complex.[3] The category of independent power producers (IPPs) encompasses all plants owned by private foreign companies, domestic enterprises or joint ventures (including with EVN). By 2010 Viet Nam would like to raise the proportion of power generation capacity provided by independent producers to at least 30%.

1 Source: EVN 2006.
2 The coal deposits are concentrated mainly in Quang Ninh Province, in the north-east of the country.
3 Two plants, Phu My 2.2 and 3, were financed by foreign consortia.

Year	Hydropower		Coal		Oil (thermal power stations)		Gas turbines (natural gas and oil)		Diesel		Independent power producers		Total
	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%	TWh
2001	18.21	59.5	3.21	10.5	1.11	3.7	5.84	19.1	0.10	0.3	2.13	6.9	30.6
2002	18.19	50.8	4.88	13.6	1.01	2.9	9.50	26.5	0.10	0.3	2.1	5.9	35.8
2003	18.97	46.5	7.22	17.7	0.89	2.2	12.13	29.7	0.05	0.1	1.56	3.8	40.8
2004	17.64	38.2	7.20	15.2	0.60	1.3	14.88	32.2	0.05	0.1	6.08	13.1	46.2
2005	16.13	31.0	8.13	15.6	0.68	1.3	16.21	31.1	0.04	0.1	10.87	20.9	52.05

Tab. 2: Power production by generating source; Viet Nam; 2001-2005; TWh, %[4]

Power transmission and distribution

A 500-kV transmission line in the north-south direction serves as a backbone for central electricity supply. Because of the rapid growth in demand for power, a second 500-kV line running parallel along a large section has been built; it was completed in 2006.[5] By 2015 it is planned that the 220-kV and 110-kV transmission grids should be expanded by about 4,500 km and 4,700 km respectively. Expansion of the transmission network up to 2010 is being supported by the World Bank with a loan of US$ 200 million. The Asian Development Bank (ADB) is financing expansion of the transmission and distribution network in the north of the country with a US$ 360 million loan.

Cross-border electricity trade with the neighbouring countries of Cambodia, China and Laos has so far been possible to only a limited extent owing to inadequate or non-existent transmission capacity, but according to the World Bank such trade will play a key role in future in view of the anticipated deficit in domestic production. A 2,000-MW supply contract with Laos has already been signed. The electricity is supposed to be transmitted via several 500-kV lines from 2008 onwards. Since August 2004 Viet Nam has also imported electricity from China via various 110-kV transmission lines. By the end of 2006, imports from China had amounted to 1 TWh. Through the further expansion of transmission capacity, imports are set to grow to between 1.2 and 1.3 TWh per year.

Degree of electrification

The existing power transmission and distribution grids reach approximately 93.5% of the population. Some 5.5 million of the total of 84 million Vietnamese still have no access to electricity. For a large proportion of the remaining households, it is probable that electrification can only be achieved through off-grid supply schemes.

Electricity consumption

From 2000 to 2004, the amount of electricity sold to end customer rose from 22.4 to 39.7 TWh (not including IPPs).[6] The two groups primarily responsible for the increase in consumption were households and industry. Per capita electricity consumption remains at a low level, at about 500 kWh (2005), despite the demand for electricity tripling over the past decade. Demand in the Hanoi and Ho Chi Minh City conurbations is far above demand in rural areas. Power consumption in the central area of the country in particular lags well behind that in other parts. As a result of successes in rural electrification and the growth in urban population, some 30 million new electricity customers were added between 1996 and 2004.

4 Source: EVN 2006.
5 This is the section between Pleiku in the centre of the country and Phu Lam north of Hanoi.
6 EVN does not include the independent power producers in the statistics for power purchased according to end customer.

Year	Households		Commerce/Other		Industry and construction		Agriculture		Total
	TWh	%	TWh	%	TWh	%	TWh	%	TWh
2000	11.0	49.0	1.9	8.0	9.1	41.0	0.4	2.0	22.4
2004	17.7	45.0	3.5	9.0	17.9	45.0	0.6	1.0	39.7

Tab. 3: Power consumption by consumer category (EVN, not including IPPs); 2000, 2004; TWh, %[7]

For 2006, EVN was expecting demand to be around 60 TWh. Because of the lack of generating capacity, about 2.4 TWh would have to be imported. By 2009 there are expected to be serious disruptions to power supplies, especially in the north of the country.

According to the draft of the sixth energy sector development plan, demand for electricity will grow by about 15 to 16% per year up until 2010. In the period from 2011 to 2015 the anticipated rate of increase is 11%, with a downward trend. According to information from the Ministry of Industry, domestic production will not be able to meet the demand for power even in the medium term. It is estimated that total demand in 2010 will amount to 93 TWh, while only 85.8 TWh can be produced in the country itself. By 2020, if the trend continues unchanged, the power deficit will have grown to 36 TWh.

Power losses

Over the past decade it has proved possible to reduce the substantial technical losses in transmission and distribution from 21.4% in 1995 to 12.2% in 2004. There is still further potential for reducing losses, however. The figure could be pushed to below 10% by improving power factors, transformers and transmission cabling. At the end of 2006 the Prime Minister set a target of reducing power losses to 8% by 2010. Non-technical losses, including the theft of electricity, are relatively low in comparison with other countries.

Electricity prices

Electricity prices have remained unchanged since 2002. The widely differentiated consumer tariffs make a distinction above all in the production and service sector between a standard tariff and a (high) peak rate and a (low) off-peak rate. The peak rate is about three times higher than the off-peak rate. A comparatively small difference is made between the purchase of high voltage and low-voltage current.

7 World Bank, 2006.

Households	VND and euro cents/kWh			
Year	Since 2002		From 2007	
Currency	VND	€ ct	VND	€ ct
First 100 kWh	550	2.70	550	2.70
+ next 50 kWh	900	4.42	1,100	5.39
+ next 50 kWh	1,210	5.94	1,470	7.21
+ next 100 kWh	1,340	6.57	1,600	7.85
+ over 301 kWh	1,400	6.87	1,720	8.44
+ over 401 kWh	–	–	1,780	8.73

Tab. 4: Excerpt from the EVN electricity tariffs for households; VND/kWh; euro cents/kWh[8]

The plan to raise electricity prices, signed by the Prime Minister on 4 December 2006, envisages staged tariff increases in the period up to 2010. According to this, the price of electricity will rise from an average of 3.84 euro cents/kWh (VND 783/kWh) in 2006 to 4.13 euro cents/kWh (VND 842/kWh) from January 2007, an increase of 7.6 % over the previous year. Originally the price rise was to have been pushed through a year prior to that. Under the new scheme, the standard tariff remains unchanged and only the peak rate is raised by 20 %. In January 2008 the average electricity price is to be increased to 4.37 euro cents/kWh (VND 890/kWh). From 2010 onwards the price of electricity is supposed to find its own level on the market, within the limits specified by the regulator.

One of the goals that the government is pursuing through the increase in electricity prices is to close the gap to long-term marginal costs and thereby make the Vietnamese electricity market more attractive to private foreign investors, with the aim of being able to satisfy rapidly rising demand.

Electricity prices in rural areas

Rural municipalities that obtain power from the public power grid continue to pay a standard nationwide rate of 3.43 euro cents/kWh (VND 700/kWh). To cover distribution costs, however, the government also allows for a certain leeway up or down.[9] In the long term, though, according to the new electricity law (see below) any existing cross-subsidies between the urban and rural population are supposed to be phased out. At present, between 55 % and 75 % of the cost of electricity in rural areas is met by subsidies.

Expansion planning

Between 1995 and 2004 demand for electricity grew at an annual rate of around 15 %, almost twice as fast as general economic growth. In the light of persistently strong economic performance, the power sector is looking to further expand generating capacity. EVN assumes that at least 1,700 MW of new capacity would have to come on-stream every year in order to meet demand. Revising the estimates for the development of the energy sector given in the fifth plan, which were too low, even in 2004 EVN expected that capacity would have to be expanded to about 25,500 MW by 2010 and to 42,000 MW by 2020. The national Master Plan on the development of power generating capacity provides for 35 large power plants to be built between 2001 and 2010.

Serious shortfalls in electricity supply have already occurred, in the summer of both 2005 and 2006.[10] According to information from EVN it will only be possible to meet two-thirds of demand in 2007. This means that some 500-570 MW of output will be lacking this year, which in part is supposed to be made up by imports. According to the draft of the 6th master plan, investment amounting to almost US$ 80 billion will be required in the electricity sector by 2025.

8 Sources: 2002 figures: World Bank, 2006. 2007 figures: VietNamNet Bridge (http://english.vietnamnet.vn/).
9 According to EVN, 98.9% of rural municipalities obtain electricity at a price below VND 700 per kWh.
10 In order to secure electricity supply through to the end of the dry season in April, the Hoa Binh and Thac Ba power plants were able to provide only a limited amount of water for agriculture from their storage reservoirs. Many rice farmers had to put off the start of sowing as a result.

23.2 Market Actors

Since the new Electricity Law came into force in 2005[11] the Vietnamese electricity market has been undergoing a period of upheaval, which not least has had an effect on the structure of the largest market player, the state-owned enterprise EVN. EVN was founded in 1995 as a nation-wide power supplier after the transmission grids in the north and south were linked up. The company's financial accounts are strictly separated from the national budget. Apart from funds for resettlement in the case of hydropower projects, the organisation does not receive any form of state subsidies for investment or day-to-day operations. It is only in relation to rural electrification that EVN is granted loans on better-than-usual terms.

Eight subsidiaries with their own separate spheres of activity deal with the transmission and distribution of electricity. Of these, three companies operate on the regional level (PC1 in the north, PC2 in the south, PC3 in the central region) and five in the country's major cities (PC Hanoi, PC Ho Chi Minh City, PC Dong Nai, PC Ninh Binh and PC Hai Phong). In seven provinces, mainly in the south, there are also distribution companies at the provincial and district level.[12] EVN is answerable to the Ministry of Industry (MOI), which is in charge of energy policy and planning.

Independent power producers

Decree 45/2001/ND-CP granted both Vietnamese and foreign investors the possibility of feeding into the national power grid as independent power producers, provided they have a power purchase contract with EVN. The contract must be negotiated with EVN on a bilateral basis. EVN attaches importance to ensuring that the results of the negotiations are treated confidentially. The remuneration ranges between 2.3 and 3.6 euro cents/kWh, as laid down by the Ministry of Industry. The number of independent power producers will rise in future because of the further phasing-out of restrictions on private investors.

The sale of shares in power plants from EVN holdings presents another possible means for private investors to participate in the market. In the power generation sector, EVN intends to concentrate in future on power plants with a capacity of over 100 MW. Smaller plants are to be financed through private investors.

Other Actors in the Energy Sector

Regulatory authority

The liberalisation of the electricity market will bring with it important tasks for the new regulatory authority, which will answer to the Ministry of Industry. The key functions planned for the authority include the licensing of market operators, advising the Ministry of Industry on matters concerning market and industry structure, laying down the price structure and ensuring there is sufficient production capacity. The Electricity Law has not defined the regulatory framework in any great detail. The date when the regulatory authority is due to commence its work has not yet been fixed.

23.3 Legal Framework

Energy and electricity market policy

The government tries to anticipate developments in the energy and electricity sector within the framework of master plans. The plans cover a period of ten years, and incorporate a forecast for the coming 20 years. The fifth master plan deals with the development of the energy sector in the period 2001-2010 and gives a forecast through to 2020. It was revised early on, in 2003, on account of power consumption already being above expectations. Further modifications were implemented through Decision No. 176/2004/QD-TTg. The sixth master plan is presently being drawn up with support from the Japanese development agency JICA.[13]

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11 For more details see section headed Legal Framework.
12 EVN plans to create a national integrated power grid by 2020 by connecting the individual regional power grids.
13 Originally it was to be introduced by the government by the end of 2006 and was to be valid for the period from 2006 to 2015. By the spring of 2007, however, the new plan had not yet been approved by the government.

The focus of attention in this is to be placed on the development of hydropower, the commercial exploitation of gas and coal resources, the development of alternative energy sources and stimulation of electricity imports from Laos and China. At the provincial level the responsible People's Committees also draw up regional plans, which must be in conformance with the national objectives.

New Electricity Law

In the past, necessary decisions on the electricity sector were taken by the Prime Minister through ad hoc directives. The new Electricity Law, which is meant to introduce changes in the power sector in both the operational and regulatory sphere, was adopted in November 2004 and entered into force in July 2005,[14] thus launching a far-reaching programme to reform the energy sector. The objectives of the new legislation include the diversification of investment and the establishment of a competitively organised market. Aspects that have so far not been regulated are the form that the spot market for electricity should take, the specific role and organisational structure of the regulatory authority, and the terms for licensing the market actors.

The new Electricity Law implies the separation of the production, transmission and sales spheres. In the field of production, the power stations owned by EVN are to enter into competition with independent power producers step by step. In the first phase of the liberalisation process the independent producers are not participating in competition because they have purchase contracts negotiated bilaterally with EVN. In future the power stations will feed into the transmission grid under the supervision of a National Load Dispatch Centre (NLDC). The mechanisms of a freely organised market are to be trialled in the production sector early on, starting at the beginning of 2007. According to the latest deliberations in December 2006, the generating plants in which EVN holds 100 % of the shares are to be the first to participate directly in market action so as to be able to gather experience of the free market. It is intended that this should reduce production costs and selling prices. Plants belonging to IPPs and the Phu My Power Generation Complex[15] on the other hand are to submit price quotations through electricity trading companies.

The monopoly position of the state-owned enterprise is only to be maintained for large hydropower plants, future nuclear power plants and the electricity transmission sector.[16] The various transmission companies at the regional level, which are all wholly owned by EVN, will be merged in the coming years to form an independent state-owned transmission company. The restructuring programme for EVN is due to be completed in 2008. In the first phase of liberalisation only EVN will be able to purchase electricity from the producers, acting as a single buyer.

The liberalisation of the electricity market will extend over two decades and be implemented in several stages. In the production sector, full competition between state-owned power stations and plants belonging to independent power producers is supposed to be established by 2015. According to government plans it is also intended that a wholesale market will be set up in the period between 2015 and 2020. After 2020 a spot market is to be created on which electricity can be traded on an hourly basis and the price of electricity finds its own level according to supply and demand.

Participation of foreign investors

A government decree (Decree No. 95/2001/QD-Ttg) in June 2001 gave foreign investors the opportunity to acquire financial interests in the power generation sector (up to 20 % of total capacity). The first foreign capital investments in two large-scale power generation projects were approved in May and September 2001. Plants 2.2. (Électricité de France) and 3. (BP) at the Phu My Power Generation Complex have been in operation since 2004; each has a capacity of 720 MW. Foreign participation is welcome in the shape of IPPs, BOT contracts or joint ventures with national companies. Foreign investment is seen as desirable within the framework of the new Electricity Law, and in particular joint ventures between Vietnamese companies and foreign investors.

14 Decrees 105 and 106 from 2005 specify how the new legislation is to be translated into practice.

15 The Phu My Power Generation Complex is the largest power station in the south of the country, with a total installed capacity of 3,800 MW. Two plants (Phu My 2.2 and 3) are owned by private investors.

16 See Decree No. 176/2004/QD-TTg. No precise details of the size of the hydroelectric schemes are given.

Impediments to private capital

Private capital investments have been hampered in the past by, among other things, protracted, complicated and opaque approval procedures, shortcomings in development of the legal system (particularly with regard to contractual provisions), disadvantages as compared with state enterprises in obtaining loans, for example, and an unfavourable position in negotiating tariffs with EVN. In principle the framework conditions have changed for the better as a result of the new Electricity Law, but how the liberalisation plans are actually put into practice remains to be seen.

23.4 Policy Promoting Renewable Energy Sources

With Decision No. 22 in 1999[17] the Vietnamese Government established the first policy framework for using renewable energy sources for power generation and rural electrification. This decision assigns a special role to the use of renewable energy sources (whether or not the facilities are connected to the grid) according to the principle of minimum cost.

According to this decision, the local authorities in mountainous regions and on islands that still have no link to the national electricity grid are called upon to submit plans for electrification using local, decentralised generating units. In this regard the government supports both domestic and foreign investment in autonomous island-mode supply, provided the rated capacity is below 5 MW. The plans have to be accepted by the People's Committees at the provincial level. Depending on the scale of the project, lower-level authorities may also be responsible for taking the decisions.

Renewable Energy Action Plan (REAP)

An essential basis for developing renewable energy sources in the electricity sector is the Renewable Energy Action Plan (REAP), a key planning and strategy paper jointly prepared by EVN and the Ministry of Industry with financial and technical assistance from the World Bank and other donors in 1999/2000. To improve the application of renewable forms of energy in the power sector, REAP identifies five fields of action requiring national and international finance for improvement or implementation:

- Policy for renewable energy sources and institutional development
- Individual systems for households and institutions (including social institutions or also small manufacturing enterprises)
- Isolated municipal grids based on hydropower
- Power supply from grid-linked renewable energies
- Technology/market development and resource assessment[18]

REAP envisages a 10-year programme divided into two phases of five years each, coordinated by the Ministry of Industry and with the involvement of the World Bank. In an initial step the necessary political and legal foundations will be laid, a fund set up for the use of renewable energy in remote areas and the requisite personnel and technical capabilities strengthened.

In a second step specific projects will then be implemented, such as the installation of pico hydropower and photovoltaic systems for households and municipalities, the use of small-scale hydropower installations for supplying whole villages and the establishment of grid-linked facilities using renewable forms of energy. Altogether, REAP estimates the cost of all the various planned measures to be about US$ 240 million, of which some US$ 180 million is to be allocated to investment in grid-connected facilities.

17 Decree No. 22-1999/CP-TTg.
18 Detailed reviews were prepared on the five individual aspects based on numerous background studies.

In the field of individual systems, REAP places the main emphasis on pico hydropower and small photovoltaic systems for off-grid applications where power consumption is low. Of 750,000 households that are not expected to be connected to the EVN grid in the next 10 years, approximately 200,000 lend themselves to supply from such facilities. There are additional needs in schools, health centres, water supply and communications. Particular interest is shown in increasing the share of domestically produced pico hydropower systems and in stabilising the commercial supplier and service infrastructure. Altogether there is expected to be a total installed capacity of between 4 and 12 MW in the first 5 years and another 15 to 33 MW in the second 5 years.

REAP assigns renewable energies a major role in supplying power from small-scale generating companies to the EVN grid or the regional distributors' networks. These small power producers could be public-owned enterprises (provincial government, municipalities) or come from the private sector. A general guideline for the payment of these small suppliers (Small Power Purchase Agreements) has not, however, entered into force yet, so at present individual agreements have to be made.

Clean Development Mechanism

Viet Nam ratified the Kyoto Protocol in September 2002, one of the first Asian countries to do so. The body responsible for CDM affairs (the Designated National Authority) is the International Cooperation Department (ICD), which is answerable to the Ministry of Natural Resources and Environment (MONRE).[19] The National Executive and Consultative Board (CNECB) was established in April 2003, with members representing various ministries under the chairmanship of MONRE. The role of the CNECB is to advise MONRE on the development and implementation of CDM projects. The Board meets three times a year.

In recent years various capacity-building programmes have been initiated with the object of boosting the efficient and swift implementation of CDM projects. Along with government institutions, these are also meant to build the capacity of private actors to put the Clean Development Mechanism into practice. By the end of 2006, two CDM projects had been registered with the UNFCCC. In February 2006 a project was accepted to extract gas as a by-product of offshore oil production off the southern coast. The only renewable energy project to be included so far is a hydropower scheme in the north of the country rated at 2 MW, registered in June 2006.[20] A further four projects have now been registered with the Vietnamese DNA, two in the field of hydropower and two relating to energy efficiency.

19 Cf. in this connection the official document 502/BTNMT-HTQT dated 24 March 2003.
20 For a more detailed description of the projects see http://cdm.unfccc.int/Projects/MapApp. As at: 26.12.2006.

23.5 Status of Renewable Energy Sources

Viet Nam offers a variety of possible options for the exploitation of renewable energies. The country has rich potential in terms of the use of hydropower, wind power, biomass and solar energy. The central utilisation of large-scale hydropower alone accounts for more than a third of all power generated, but still only part of the available hydropower resources are currently exploited. Small-scale hydropower, wind power and solar energy already make an important contribution to decentralised electricity generation in regions with no connection to the grid.

Hydropower

Viet Nam's hydropower potential is estimated at approximately 300 TWh/year. Of this, some 80 TWh/year is economically exploitable. Accordingly, only approximately a quarter of the economic potential of hydropower has been utilised so far. Apart from a few exceptions, the as-yet unused potential lies in the development of medium-sized or small plants with a capacity of less than 1,000 MW. In the coming years it is intended that in particular the mountainous centre of the country should be used to generate electricity from hydropower. According to the national power development plan, a total capacity of 5,000 MW is to be installed there by 2010. By 2020 the aim is to have a capacity of 13,000-15,000 MW available through the use of hydropower.

Viet Nam has good production capacity at its disposal in the hydropower sector. The Institute of Materials Science (IMS) at the Vietnamese Academy of Science and Technology has designed innovative small hydroelectric power systems which are also suitable for export. System components for small and micro hydropower plants with a capacity of up to 2 MW are also produced.

Small and micro hydropower

The current applications span a broad range from micro hydropower systems to supply individual consumers to large-scale hydropower stations. Wide experience has already been gained in micro and small hydropower in Viet Nam and there are many manufacturers available, although product quality is in need of improvement.[21] At present between 100,000 and 150,000 households obtain power from micro hydropower systems. The output of these systems is generally between 100 and 1,000 W. A further 20 MW is available to supply isolated grids, while about 60 MW is fed to the central grid from (commercially run) small-scale hydropower plants with capacities ranging from 100 to 7,500 kW.[22] It is estimated that small and micro hydropower plants produce between 7 and 10% of the country's total hydroelectric output. In 2006 there were 126 small-scale hydropower projects registered with the Ministry of Industry, with a total capacity of 2,100 MW. The draft of the sixth Master Plan envisages an additional 408 projects in small-scale hydropower, with a total capacity of 2,925 MW.

Isolated grids

In future, the expansion of hydropower use in the lower capacity range is primarily intended to promote the construction of isolated networks run by small providers, cooperatives or municipalities, and which in addition to general power supply will help to speed up expansion in the productive sector in particular.

Small-scale municipal hydropower

To date, small-scale municipal hydropower based on isolated grids has been installed at more than 300 locations with an aggregate capacity of about 70 MW, while individual plants of between 5 and 200 kW are largely situated in the northern and central parts of the country. However, about 200 of these systems, mostly serving isolated grids, are not in operation due to quality and maintenance problems and a lack of financial resources.

21 The following sizes of plant are distinguished: pico hydro: 100 to 1,000 W; micro hydro: 1,000 W to 5,000 W; mini hydro: 5 to 100 kW; small hydro: 100 kW to 10 MW. Some other classifications are used internationally; for example, pico and micro systems are often used to mean the same thing.

22 Above all in Ha Giang, Cao Bang, Quang Nam and Quang Ngai Provinces.

Many of these facilities were financed with foreign assistance with no account being taken of responsibility for operation and maintenance to assure sustainability. Only a few municipal plants also feed electricity into the grids operated by EVN or the regional distributors. Estimates of the potential for municipal use range between 300 and 600 MW.

Technical potential for small-scale hydropower

Various sources put the technical potential for small-scale hydropower with a plant capacity of up to 10 MW at between 0.8 and 1.8 GW. There are presently only a few hundred mini and small hydropower plants with capacities of 5 kW to 10 MW. The potential for grid-connected small hydropower plants alone is estimated at 0.4 to 0.6 GW and can in part be tapped by improving existing generating facilities.

Micro and pico hydropower

Micro and pico hydropower systems with a capacity of less than 5 kW have proliferated greatly since the 1990s, in particular, due to improved trade relations with China, where such equipment is produced cheaply. This is especially so in the northern provinces. Micro-class systems (1-5 kW) are manufactured by various companies in Viet Nam.[23]

Viet Nam has one of the world's largest sales markets for pico systems with an output of up to 1 kW, approximately 100,000 to 150,000 having been sold commercially to date. Currently some 40,000 systems are sold each year, about half to replace existing facilities, and are mainly used to supply individual households or small production centres. About 90 % of these systems are imported from China. According to REAP, systems rated from 100 to 500 W are sold at prices of between US$ 50 and US$ 100. However, these systems are relatively operator-intensive, lack electrical control circuitry and have an operating life of only 1 to 3 years. A number of them are also used as battery chargers in interconnected neighbourhoods. The total market is estimated at approximately 200,000 systems.[24]

Wind energy

Thanks to its geography – a 3,000 km-long coastal strip and its location in the monsoon belt – Viet Nam can draw on considerable wind power resources, although so far these have been barely harnessed at all.

Wind data

A relatively rough picture of the regional distribution of wind power potential is provided by the Wind Energy Resource Atlas of Southeast Asia, published in 2001. The study, which is largely based on meteorological data[25] in conjunction with a simulation model and not on individual site measurements, identifies suitable windswept regions primarily in the mountainous terrain on the border with Laos and in the coastal provinces south of Da Nang and north of Ho Chi Minh City. Altogether, for approximately 30 % of the land area wind energy potential is assessed as sufficient (6-7 m/s mean wind velocity at a height of 65 m) and for another 8.6 % it is rated as good to very good (over 7 m/s).

As yet there are no other systematic analyses of wind energy potential. Site measurements were taken in the course of project planning on the south-eastern coast near Nha Trang and on two islands close to Haipong (Bach Long Vi) and Ho Chi Minh City (Thanh An). A study by the Institute of Energy identifies nine islands with wind speeds of 4.1 to 7.1 m/s at a height of 10 m. According to Nguyen[26] there are 31,000 km^2 of territory suitable for generating electricity from wind energy, and in fact the local conditions in an area of about 865 km^2 are so good that generating costs can be expected to be below 6 US cents/kWh.

23 Advisory services for grid-connected small-scale systems are provided by the Hydro Power Center, which belongs to the Vietnam Institute for Water Resources Research. The HPC manufactures both small and pico systems itself.
24 In the short term, therefore, about 50 %–75 % of the market volume has already been exhausted. Due to the short lifetime of the systems, however, there will continue to be a corresponding demand in future as well.
25 ASTAE (2001), Wind Energy Resource Atlas of South East Asia. www.worldbank.org/astae/werasa/windenergy.htm
26 See Nguyen, 2007.

Wind energy use

Viet Nam can look back on a long tradition of utilising wind energy, although this was limited to small-scale facilities. So far, only a small number of relatively large wind or wind-diesel systems have been installed in localised systems. Smaller wind energy installations are more broadly disseminated. At the end of the 1980s the main focus was on developing systems for households with outputs of 150 to 500 W, under a variety of research programmes.

In the past, small-scale wind generators have been developed in particular by the Research Center for Thermal Equipment and Renewable Energy (RECTERE) at the University of Technology in Ho Chi Minh City. To date about 900 systems have been installed, with individual ratings of 150 to 200 W. These systems have mainly been put up in rural regions, and 90% of the cost is financed by state funds. Only 10% of the systems have been purchased by end customers. As part of the rural electrification programme, the Institute of Energy (IE) was commissioned by the Ministry of Industry to investigate the use of wind energy installations in rural areas and on islands. The systems built by IE are each rated at 150 W and have so far been installed at 30 locations. The Hanoi University of Technology has erected 30 systems with the same rated output.

At the time of writing, only one grid-linked wind power plant had been installed. The 800-kW system from the Spanish manufacturer Gamesa began operation in November 2004. The average wind speed at the site on the island of Bach Long Vi in the South China Sea is 7.2 m/s. This pilot plant was financed from government funds. Apart from a lack of technical know-how, the absence of a regulatory framework is inhibiting the construction of any larger wind farms. According to the fifth Master Plan on development of the energy sector of 2001, the rate of remuneration set by EVN was often below 4 US cents/kWh, consequently deterring investors.

Several wind farms are currently at the planning stage. These include a 50-MW wind farm in Binh Dinh Province, in the centre of the country, which is to be financed by the Danish development assistance organisation DANIDA and will comprise turbines from the German manufacturer Enercon. The wind farm is due to begin operation as soon as 2007. In March 2006 it was also announced that another 50-MW wind farm is to be built in Binh Dinh by a German-Vietnamese joint venture[27] with the aid of a US$ 65 million loan from KfW Entwicklungsbank (KfW development bank). The turbines for this scheme are also supposed to come from German producers and start generating electricity from mid-2007. As well as these, a 15-MW wind farm in Qui Nhon Province and a standalone 625 kW system in Ninh Thuan are at the design stage. The Vietnamese government envisages the building of about 400 MW of wind power capacity by 2020 within the framework of the fifth Master Plan.

Biomass

About half of national primary energy needs are met with bioenergy. In rural private households, the share of biomass in the form of fuelwood, charcoal, straw, farm residues and other organic waste amounts to as much as 80%-90%. These sources of energy are largely used for cooking and heating water. Thermal use is also made of biomass in the industrial sector; for example rice husks are used in brickmaking. Further biomass resources could also be developed in particular for combined heat and power plants, using sugarcane bagasse and residue and rice husks.

27 Phuong Mai Wind Power JCS and European Provider Network GmbH.

Power generation from biomass

According to the fifth Master Plan on development of the energy sector, an additional 250 to 400 MW of electrical output is to be made available from biomass plants by 2010. Of this, 70 to 150 MW could be obtained from generation from rise husks, 150 to 200 MW from bagasse, 30 to 50 MW from waste and other biomass products and five MW from wood residues.[28]

Most of the 42 existing sugar mills, only three of which so far feed electricity into the public grid under individually negotiated agreements, are situated south of Da Nang. Total electrical output amounts to 150 MW. Rice husks have not been used for power generation so far. According to the Institute of Energy, an estimated 2.5 million t of rice husks are available for energy recovery. The potential is put at between 70 and 150 MW. The fact that the waste is widely dispersed does make it much more difficult to use, however. Altogether, Viet Nam has more than 100,000 rice mills, although only about 50 are located in the main growing region of the Mekong Delta with a throughput of more than 5 tonnes per hour. This would be enough for the economic operation of power generating sets of 500 kW or more.

The 3,000 or so biogas installations that are mostly installed in the region of the Red River (northern Viet Nam) and in the Mekong Delta are only used to a relatively small extent for off-grid low-output power generating sets. A major barrier cited is the cost factor, which is said to prevent rural households from purchasing these facilities without subsidies. Also, it is mostly more efficient to put biogas to direct use in productive sectors for thermal purposes.

Apart from the Institute of Energy, those mainly involved in designing, producing and installing biomass facilities have been the Viet Nam Boiler Company (Hanoi), the Research Centre for Thermal Equipment and Renewable Energy (Ho Chi Minh City) and the Can Tho University in the Mekong Delta.

Solar energy

South and central Viet Nam have good and constant solar irradiation conditions with 4.0 to 5.9 kWh/m^2 per day, while the north is subject to pronounced seasonal fluctuations (2.4 to 5.6 kWh/m^2).[29] The number of hours of sunshine ranges between 1,800 and 2,700 per year.

Utilisation of solar energy

Solar energy is mainly used for the decentralised generation of electricity. At the end of 2004, the total capacity of all photovoltaic systems in Viet Nam was approximately 1,100 kW$_p$. Most of the systems are rated at between 50 and 1,000 W$_p$. PV systems are used in the telecommunications sector and in shipping (around 440 kW$_p$). Also at the end of 2004 there were 47 systems installed for battery charging, of the order of 500 to 1,000 W$_p$. Systems in the range from 250 to 500 W$_p$ are primarily used in hospitals, cultural centres and municipal facilities. The number of systems installed in such locations is estimated at 570. Micro systems with capacities of between 50 and 70 W$_p$ are used by households. In the past five years an estimated 1,270 systems have been installed in the household sector in the southern part of the country alone. All in all there are estimated to be 2,800 systems in operation in this sector. Photovoltaic modules are usually imported, although some system components are also produced locally.

Photovoltaic panels began to be used as early as the mid-1980s, when the National Center for Scientific Research installed several systems near Ho Chi Minh City. An initiative launched by Fondation Énergies pour le Monde (Fondem) brought electrification to fifty villages in the Mekong Delta through solar power. In the communities concerned, small PV systems each with a capacity of 1.5 kW were installed on schools, hospitals and residential buildings. A project initiated in 2000 which received half of its funding from Fondem and a quarter each from the provinces and the operators led to the installation of 550 solar power systems by 2005, each rated at 2 kW. Systems with a total capacity of 19 kW were installed as part of another project in the mountainous province of Dak Lac.

28 Duc Cuong, 2004.
29 In the north of the country there are four seasons, while in the south there is only a rainy season and a dry season.

The cost of the systems, which are rated at between 50 watts and 2 kW, was shared between the German Federal State of North Rhine-Westphalia (60 %) and the Vietnamese Ministry of Natural Resources and Environment (40 %). The only larger PV system so far is a 100-kW facility installed with Japanese assistance and combined with a 25-kW hydropower plant, used for electrification of a remote community.

The equipping of rural households with solar home systems is mainly promoted by Selco-Viet Nam, a subsidiary of the American Solar Electric Light Company, which has been engaged in Viet Nam since 1998. A key role is also played here by the Vietnamese Women's Union, which has been actively engaged from as early as 1993 in harnessing solar energy for households not connected to the mains supply. By the beginning of 1997 it had put about 240 systems into operation with technical assistance from Solarlab and financial support from the American Solar Electric Light Fund. A total of 600 systems have been installed in another large-scale project with Selco-Viet Nam.

Over the coming years it is intended that solar home systems should be further disseminated through two major projects. One project on photovoltaics for rural areas and ethnic minorities has already been approved by the government and is meant to supply electricity to 300 rural communities, with a budget of US$ 30 million.[30] The project is scheduled to run for three years. In addition, 30,000 solar home systems are to be installed within the framework of the Renewable Energy Action Plan. The budget available for this amounts to US$ 9.6 million for ten years.

The use of solar energy for heating and cooling is less widespread. Water-heating systems are used in about 1,200 households (2-4 m^2 collector area) and 60 municipalities (10-50 m^2 collector area). There are also systems in operation for the drying of industrial and agricultural products.[31]

Geothermal energy

The geothermal potential in Viet Nam has hardly been explored to date. According to the latest findings there are 269 locations suitable for the direct utilisation of geothermal heat, with a surface temperature of over 30 °C and a total capacity of 649 MW_{th}.[32] The geological conditions in the centre of the country could permit the operation of geothermal power plants producing 100 to 200 MW. According to the fifth Master Plan about 200 to 400 MW of geothermal capacity is supposed to have been developed by 2020. As of the end of 2006, however, there were no electricity-generating plants in operation.

23.6 Rural Electrification

Degree of electrification

78 % of the population of Viet Nam live in rural areas. At the end of June 2006, 91.5 % of all rural households[32] or 97.8 % of all rural communities had access to electricity. On the whole the quality of power provision in rural regions is lower than that in urban areas as there is a greater frequency of power failures and the voltage level is not stable.

The government's current plan for rural electrification envisages that 95 % of all households are to have an electricity supply by 2010. After the electrification plan is implemented, more than 1,000 remote communities and villages with about 500,000 households and another 2.5 million households in scattered rural settlements will still be without a grid connection. By 2020 the proportion of households with an electricity supply is supposed to be increased to 100 %.

30 US$ 20 million will be provided by Finnish official development assistance.
31 Source: Nguyen, 2005.
32 Source: Lund et al., 2005.
33 This means 12.3 million of a total of 13.5 million households.

Policy guidelines

Policy guidelines on rural electrification were adopted by the Ministry of Industry at the beginning of 2000. These specify the principles for diversified participation of new (foreign and local) power suppliers through creating incentives for local power supply and the promotion of localised electricity generation. The intention is to both expand networks and install off-grid systems for rural supply according to the principle of minimum costs.

Opportunities for renewable energies

Some households in rural regions can only be served cost-efficiently by using decentralised renewable energy sources (US$ 400-500 per connection). These are mainly to be found in 1,100 communities comprising a total of 750,000 households and three million inhabitants which will remain out of reach of the national power grid in the short to medium term and which therefore will have to rely on localised solutions.

Potential has been identified in particular in the expanded use of pico hydropower systems for single houses or settlements in the northern mountain regions and the central coastal zones of the country, and in the dissemination of photovoltaic systems in the central highlands and the Mekong Delta.

Aims of the Master Plan

The current Master Plan for developing the power sector[34] sets the following targets to be achieved by 2010:

- Additional supply of 1,500 municipalities through grid expansion
- Electrification of a further 400 remote municipalities, primarily in the northern mountain regions and in the central highlands, with localised systems using renewable energies and diesel

Rural Energy I project

Implementation of the Renewable Energy Action Plan (REAP) in rural areas is substantially supported by the World Bank. The Rural Energy I project was launched at the end of 2001 and ran for a period of five years.[35] By the end of 2004 over 976 municipalities were supposed to have been connected to the public electricity grid in the context of the project, thereby supplying electricity to an additional 500,000 people. By mid-2006 it had not yet proved possible to achieve this target in full. At that time only just under 900 municipalities had received access to electricity for the first time. In conjunction with electrification, two or three people in each municipality underwent training to perform routine jobs and maintenance on the local distribution network. The utilisation of renewable energy sources, above all hydropower, was driven forward by the shaping of standard contractual arrangements with small producers concerning the feeding of power into the grid.

Rural Energy II project

A follow-on project to implement the second REAP phase was launched in 2004, namely the Rural Energy II project. The project officially commenced in October 2005 and will run until the end of 2011. It is being supported by a US$ 220 million loan from the World Bank. A grant of US$ 5.25 million was made available by the GEF.[36] By 2012 it is intended that 2.5 million people will benefit from the activities in 1,200 communities, half of which at present have no access to electricity.

The local power distribution companies are also to be converted into legally recognised entities, and regional actors are to be better integrated into the plans to bring about rural electrification. Rural electricity cooperatives are to be set up in order to enable the local population to take over management of local networks.

Exchange rate (7 January 2006):
10,000 Vietnamese dong (VND) = 0.4906 euro (EUR);
1 US dollar (USD) = EUR 0.7694

34 Master Plan of Power Development for 2001–2010.
35 The project has been granted a loan of US$ 150 million from the International Development Association (IDA).
36 See Document of the World Bank, Report 29860-VN, October 2004.

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There is great potential for generating electricity from renewable energy sources in many developing and emerging countries. Obstacles to the exploitation of such sources and to the involvement of foreign investors include a lack of knowledge of framework conditions in the energy industry and insufficient transparency with regard to the prior experience and interests of national actors. This fourth, updated and expanded edition is aimed at overcoming barriers such as these.

The electricity markets and their respective actors are investigated for 23 countries in various regions: Latin America, Africa – Middle East and Asia. The country studies analyse the energy-policy framework conditions and closely examine the status of and promotion policy for electricity generation on the basis of hydropower, wind power, solar power, biomass and geo-thermal energy. The chapters on each country are rounded off by information about rural electrification.

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