Division Environment and Infrastructure
TERNA Wind Energy Programme

Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

23 Country Analyses
Chapter Mexico

Eschborn, September 2007

gtz

commissioned by:

Federal Ministry
for Economic Cooperation
and Development

Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

23 Country Analyses
Chapter Mexico

Eschborn, September 2007

Published by:
Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH
Division Environment and Infrastructure
PO Box 5180
65726 Eschborn
Germany
Internet: http://www.gtz.de

Edited by:
Angelika Wasielke
Tel. +49 (0)6196 79-1224
Fax +49 (0)6196 7980-1224
E-mail: angelika.wasielke@gtz.de

Authors:
Projekt-Consult GmbH
Dipl.-Ing. Detlef Loy

Design:
Open Ffm.
www.open-agentur.de
Verena Siebert

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.

2. The sole authorised user of this study for all forms of use is the GTZ. Duplication or reproduction of all or part of the study (including transfer to data storage media) and distribution for non-commercial purposes is permitted, provided the GTZ and the TERNA Wind Energy Programme are named as the source. Other uses, including duplication, reproduction or distribution of all or part of the study for commercial purposes, require the prior written consent of the GTZ.

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:

Deutsche Gesellschaft für Technische
Zusammenarbeit (GTZ) GmbH
Postfach 5180
65726 Eschborn
Germany

Dr. Rolf Posorski
Tel. +49 (0)6196 79-4205
Fax +49 (0)6196 7980-4205
E-Mail: rolf.posorski@gtz.de

Angelika Wasielke
Tel. +49 (0)6196 79-1224
Fax +49 (0)6196 7980-1224
E-Mail: angelika.wasielke@gtz.de

Tim-Patrick Meyer
Tel. +49 (0)6196 79-1374
Fax +49 (0)6196 7980-1374
E-Mail: tim-patrick.meyer@gtz.de

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	30,360	15.1	26,055	12.8	31,504	15.1	27,609	12.6
Geothermal							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]

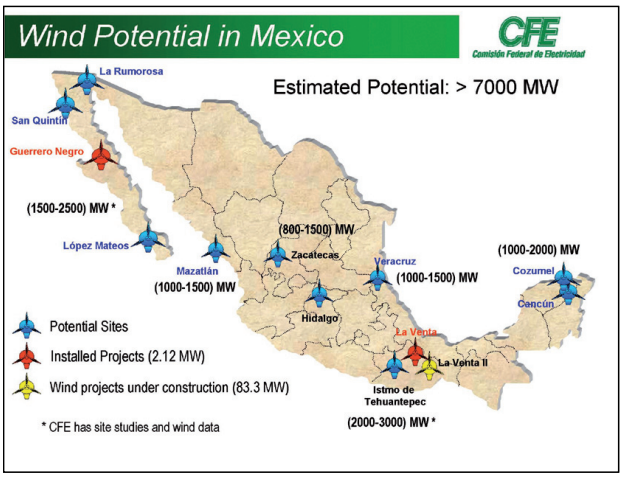

Fig 1: Wind potential by region; Mexico[37]

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

7.7 Information Sources

- Arvizu, José L., Saldana, Jaime L.:
  Central Eléctrica de Biogas de Bioenergía de Nuevo León, in: Boletín IIE, Enero-Marzo 2005
- Asociación Nacional de Energía Solar (ANES):
  Resumen Ejecutivo del Estudio de Mercado de las Fuentes de Energía Renovable en el Sector Agropecuario, Mayo de 2006
- Borja Díaz, Marco A. et al. (Instituto de Investigaciones Eléctricas):
  Primer Documento del Proyecto Eoloeléctrico del Corredor Eólico del Istmo de Tehuantepec, 2005
- Comisión Federal de Electricidad – CFE:
  Programa de Obras e Inversiones del Sector Eléctrico 2005-2014, Documento Ejecutivo
- Comisión Federal de Electricidad – CFE:
  Programa de Obras e Inversiones del Sector Eléctrico 2007-2016, 2006
- Comisión Nacional para el Ahorro de Energía (CONAE):
  Guía de gestiones para implementar en México plantas de generación eléctrica que utilicen energías renovables, 2004, www.layerlin.com
- Comisión Nacional para el Ahorro de Energía (CONAE)/GTZ/SENER:
  Alternativas Financieras para la Promoción del Uso de Calentadores Solares de Agua (CSA) en el Sector Doméstico Mexicano, October 2006
- Comisión Reguladora de Energía (CRE):
  Guia para solicitar permisos de generación, exportación e importación de energía eléctrica, n.d.
- Comisión Reguladora de Energía (CRE):
  including various two-monthly bulletins ("info-CRE") from the regulatory authority CRE (www.cre.gob.mx)

50 Fideicomiso de Riesgo Compartido.

- Energy Information Administration (US Department of Energy):
  Country Analysis Briefs Mexico, December 2005

- Geothermal Resources Council (GRC):
  30 Years of Geothermal Electric Generation in Mexico, in: GRC Bulletin September/October 2003

- GVEP:
  In-depth analysis of case studies on Rural Electrification in Mexico, November 2005

- Instituto de Investigaciones Eléctricas (IIE):
  Boletín, Octubre-Diciembre del 2003: Generación distribuida

- International Energy Agency (Cooperative Programme on Photovoltaic Power Systems):
  Mexico, Photovoltaic technology status and prospects, Contribution to the Annual Report 2005 (by Electrical Research Institute IIE) (www.iea-pvps.org/ar05/mex.htm)

- National Renewable Energy Laboratory (NREL):
  Wind Energy Resource Atlas of Oaxaca, August 2003

- Red Mexicana de Bioenergía:
  Libro Blanco de Bioenergía en México, Junio 2005

- Secretaría de Energía:
  Programa Sectorial de Energía 2001-2006

- Secretaría de Energía:
  Prospectiva del Sector Eléctrico 2006-2015, México D.F. 2006

- Secretaría de Energía:
  Quinto Informe de Evaluación del PROSENER (Programa Sectorial de Energía), 2006

- Secretaría de Energía:
  statistics about the electricity sector

- Secretaría de Energía:
  Subsecretaría de Planeación y Desarrollo Tecnológico, Balance nacional de energía 2005, México 2006

- Secretaría de Energía/GTZ:
  Energías Renovables para al Desarrollo Sustentable en México – Renewable Energies for Sustainable Development in Mexico, Enero 2006

- Secretaría de Energía/GTZ:
  Fuentes Renovables de Energía, Noviembre 2006

- Secretaría de Medio Ambiente y Recursos Naturales/Institut Nacional de Ecología:
  México Tercera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático, Octubre 2006

- Universidad Autónoma Metropolitana (UNAM):
  Una visión al 2030 de la utilización de las Energías Renovables en México, 15 de agosto 2005 (including numerous relevant studies in the annex)

- World Bank:
  GEF Project Brief on a proposed loan and grant from the Global Environment Facility Trust Fund for an Integrated Energy Services Project, February 9, 2006

- World Bank:
  Project Appraisal Document (PAD) on a proposed grant from the Global Environment Trust Fund for a Large-Scale Renewable Energy Development Project, June 8, 2006

7.8 Contact Addresses

Asociación Nacional de Energía Solar A.C. (ANES)
Calzada Acoxpa no. 524 Desp. 506-B
Col. Prado Coapa
14350 México, D.F.
Delegación Tlalpan
Tel./fax +52 (55) 56 84 41 62
E-mail: anescomite@anes.org
www.anes.org

Comisión Nacional para el Ahorro de Energía (CONAE)
Rio Lerma 302
Col. Cuauhtémuc
06500 México, D.F.
Delegación Cuauhtémuc
Tel. +52 (55) 30 00 10 00
www.conae.gob.mx

Comisión Reguladora de Energía (CRE)
www.cre.gob.mx

Comisión Federal de Electricidad (CFE)
www.cfe.gob.mx

Luz y Fuerza del Centro (LFC)
Melchor Ocampo 171
Col. Tlaxpana
Delegación Miguel Hidalgo
11379 México, D.F.
www.lfc.gob.mx

Instituto de Investigaciones Eléctricas (IIE)
Gerencia de Energía No-Convencionales
Av. Reforma 113
Colonia Palmira
62490 Temixco, Morelos
Tel./fax +52 (777) 362 38 06
genc.iie.org.mx/genc/index2.html

Secretaría de Energía (SENER)
Insurgentes Sur No. 890
Col. Del Valle
03100 México, D.F.
Tel. +52 (55) 54 48 60 12
Fax +52 (55) 54 48 60 13
E-mail: f.barne@energie.gob.mx
www.energia.gob.mx

Centro de Investigación en Energía (CIE-UNAM)
Privada Xochicalc s/n
62580 Temixco, Morelos
Tel. +52 (777) 325 00 52
Fax +52 (777) 325 00 18
www.cie.unam.mx

GTZ-Cooperación Técnica Alemana
Promoción de Energias Renovables (Promover)
c/o Edificio SENER – Secretaría de Energía
Av. Insurgentes Sur 890, 9o piso, oficina 0902
Col. Del Valle
03100 México, D.F.
Tel. +52 (55) 50 00 60 00 ext. 1088
Fax +52 (55) 50 00 60 00 ext. 2160
E-mail: bernhard.boesl@gtz.de
www.gtz.de/mexico

Deutsch-Mexikanische Industrie- und Handelskammer (CAMEXA)
Cámara Mexicano-Alemana de Comercio e Industria, A.C.
German Centre
Av. Santa Fe 170
Col. Lomas de Sta. Fe
01210 Ciudad de México, D.F.
Tel. +52 (55) 15 00 59 00
Fax +52 (55) 55 96 76 95
E-mail: ahkmexiko@compuserve.com.mx
www.camexa.com.mx

Mexican Embassy in Germany
Klingelhöferstr. 3
D-10785 Berlin
Tel. +49 (30) 269 323-0
Fax +49 (30) 269 323 325
E-mail: mail@embamexale.de
www.embamex.de

German Embassy in Mexico
Horacio 1506
Colonia Polanco
11510 México, D.F.
Tel. +52 (55) 52 83 22 00
Fax +52 (55) 52 81 25 88
E-mail: embal@mail.internet.com.mx
www.embajada-alemana.org.mx

DNA/COMEGEI (SEMARNAT)
C. Miguel Angel Cervantes Sánchez
Director General Adjunto para Proyectos de Cambio Climático
Blvd. Adolfo Ruíz Cortines 4209, piso 4
Fracc. Jardines en la Montaña
14210 México, D.F.
Tel. +52 (55) 52 90 09 87 (dir.)
Fax +52 (55) 56 28 07 94
E-mail: miguel.cervantes@semarnat.gob.mx
www.semarnat.gob.mx
(Secretariat of the Environment)

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 geothermal energy. The chapters on each country are rounded off by information about rural electrification.

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH

Dag-Hammarskjöld-Weg 1-5
Postfach 5180
65726 Eschborn
T +49 (0)61 96 79-1303
F +49 (0)61 96 79-80 1303
I http://www.gtz.de