Producing Electricity from Renewable Energy Sources:
Energy Sector Framework in 15 Countries in Asia, Africa and Latin America

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Producing Electricity from Renewable Energy Sources:

Energy Sector Framework in 15 Countries in Asia, Africa and Latin America

Part of the supraregional TERNA Wind Energy Programme

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Background to the New Edition of the Study

Structural changes in the energy sector, accompanied by liberalisation of the relevant markets, have been continuing in many developing and more advanced countries in recent years. Growing demand for electricity and the ongoing climate debate are increasing the level of interest in technologies for generating electricity from renewable energy sources in these countries.

The rapid expansion of the use of wind power and solar energy in Germany is a subject that is being followed with interest, even outside Europe. It is apparent in this case that, by creating the framework conditions and targeting appropriate promotion measures, politics is capable of setting the trend towards exploitation of renewable energy.

The German and European market acts as the motor for a wind energy industry differentiated according to the principles of division of labour, and provides an indispensable background of experience. In the long term, however, the level of growth in this sector seen over the past decade in the German domestic market is not sustainable. Project developers are therefore initially turning their attention to off-shore projects, other parts of Europe, and the Mediterranean states. The same is true of the large market for other renewable energy technologies which are increasingly being used in developing and more advanced countries, particularly in the field of rural electrification. Although there is recognition of the considerable potential of non-European countries, a lack of knowledge of the framework conditions prevailing in the energy industry in those countries together with a lack of transparency with regard to the prior experience and interests of the national actors forms an obstacle to gaining a foothold in this sphere.

This study aims to make it easier to gain such a foothold. It is based on the first edition dating from the spring of 1999, which was in great demand from the group of export-oriented suppliers, project developers, finance houses and operating companies involved in renewable energy technologies. In order to keep the study up to date, GTZ commissioned a revision and expansion of the study in the summer of 2001. The choice of countries was based in particular on the interests of the wind power sector, this being the most important export branch at present.

The information on the following eight countries was revised: Brazil, Argentina, China, Turkey, India, South Africa, Morocco and Jordan.

The following countries were included in addition: Chile, Colombia, Mexico, Dominican Republic, Cuba, Tunisia and Kazakhstan.

The following four countries were included in the first edition only: Egypt, Indonesia, the Philippines and Thailand. Information about these countries (status as of February 1999) can be downloaded from the Internet at the following address: http://www.gtz.de/wind/deutsch/studie.htm.

The study provides information about the crucial framework conditions for supplying electricity from renewable energy sources to public supply networks. It also looks at country-specific programmes and projects aimed at decentralised electricity generation without a connection to the public grid.

Once again GTZ commissioned the engineering consultancy Loy Energy Consulting to undertake the revision of the study – the company that was responsible for producing the first edition.
Collecting the relevant data and information entailed consulting the ministries and regulatory authorities responsible for energy, project executing agencies, the chambers of foreign trade and commerce and embassies of the countries concerned, GTZ experts in Germany and other countries, the Federal German Agency for Foreign Trade and Payments and national and international promotion institutions. This research was supplemented by evaluating other sources of information, such as conference papers, specialist publications, official documents and presentations on the internet.

Sincere thanks are due to the following companies for their kind financial assistance: E.ON Energie AG, GEO Gesellschaft für Energie und Ökologie mbH, InnoVent GmbH, Nordex AG, Overspeed GmbH & Co. KG, REpower Systems AG, P&T Technology AG, Siemens AG, Umweltkontor Renewable Energy AG and WindSolar AG.

Eschborn, January 2002

Legal Information

1. The data used in this study are 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 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 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 TERRA 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 GTZ.
The TERNA Wind Energy Programme

Specialised knowledge and experience are needed to determine what wind energy resources a country possesses and to identify suitable locations. Technical and economic analyses are also impossible without the acquisition of such information. These analyses in turn serve as the basis for negotiations on financing, because capital and lenders are available for wind power.

This was why the Federal German Ministry for Economic Cooperation and Development (BMZ) set up the TERNA (Technical Expertise for Renewable Energy Application) wind energy programme in 1988. In order to compensate for the lack of available knowledge, the programme is targeted at providing technical advice and support. It is intended to enable prospective operators of wind farms in developing and more advanced countries to assess the technical and economic potential of wind power projects and to develop promising schemes to the stage where they are ready for implementation. Thus in the long term it contributes to improving the supply of energy to the population.

The project is being implemented by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). The BMZ is financing the measures, but in view of their supraregional nature it is not using funds from the country quotas that are agreed separately with the various partner countries. From the standpoint of the partner countries, therefore, TERNA provides additional resources which are dedicated specifically to wind energy.

The programme promotes wind power projects that operate in grid-coupled operation. A capacity of at least 10 MW is used as a guide value. The sites must be in windy regions with access to an electricity grid. There are no restrictions on the choice of countries, although the emphasis is plainly on states where the framework conditions are adequate to provide for economic operation of the installations. Small-scale individual facilities or isolated wind-diesel systems are not promoted, nor are projects of an R&D nature.

TERNA pursues the goal of initiating wind power projects in the megawatt range. In order to achieve this, the programme passes on the necessary knowledge about planning and implementation to potential operators. It is therefore aimed at conventional energy supply companies (public utilities) just as much as at independent investors and private electricity producers (IPPs) as possible operators of wind farms.

The programme offers its partners comprehensive know-how and experience. In order to initiate projects, favourable sites must be identified. Wind measurement and site selection procedures come into play here. This step is followed by practical planning of the installations, in which the design and cost-effectiveness need to be analysed. TERNA also provides advice to project developers on financing matters. The assistance is provided by experts with experience in the relevant fields.

In successful cases, TERNA can thus accompany investment-ready wind farm projects as far as the tendering or contract award stage. The programme does not then become involved in the financing itself. However, TERNA does aim to build bridges to available financing instruments provided by national and international donors.

The services offered by TERNA cover the transfer of know-how relating to siting, planning, implementation and technical and administrative regulatory matters. The partners and GTZ choose the appropriate measures from the set of TERNA instruments to complement the experience already available to them. In particular, the areas of possible cooperation are as follows:
Preparation:
  Support for wind measurement campaigns, installation of wind measurement instruments, evaluation of data, advice on siting

Transfer of know-how:
  Running training programmes (workshops) for partners’ experts; subject matter: wind measurement, assessment of potential, wind farm configurations and connection to the grid

Planning:
  Calculation of investment and project costs, performance of economic feasibility studies and risk assessments

Initiation:
  Provision of advice to public bodies on inviting tenders for wind farm projects; preparation of project documents for applications for assistance funds

Further information and advice about the programme is available from the GTZ (on the Internet: http://www.gtz.de/wind). Applications for a specific project must be submitted to the German Embassy by the responsible ministry in the country.
Electricity Market

Total electricity generating capacity at the end of 2000 was 24,209 MW. Of this, some 13,593 MW was provided by thermal power stations (mainly on a natural-gas basis), 9581 MW by hydroelectric plants and 1018 MW by nuclear power stations, along with 0.6 MW by geothermal power plants. More than 8000 MW of this has been brought on-line since 1992, when liberalisation of the electricity market began, including an increasing number of gas-fired power stations in recent years. Domestic demand for electricity at peak load times is a maximum of 12,300 MW, meaning that there is excess capacity which in future is to be used in part for supplying consumers in southern Brazil. However, annual growth of 2.5 – 6 % is also expected for the Argentine market, and because of maintenance deficiencies some of the country’s power stations are currently not available.

Argentina is self-sufficient in oil and gas and is also in the process of increasing exports of these energy sources, above all to Brazil and Chile. The country also has large hydropower resources and a small number of domestic coal deposits.

The effect of Act 24.065 of 16.1.1992 ("Electricity Act") and the associated implementing provision (Decreto 1398/92 of 6.8.92) was to split up the previously state-owned and centralised electricity sector in Argentina (north of Patagonia) into the separate areas of generation, transmission and distribution and to introduce stage-by-stage privatisation.

In order to control electricity trading that was not covered by bilateral agreements, a new private company was founded (CAMMES = Compañía Administradora del Mercado Mayorista Electrico Sociedad Anónima) in

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1 Of these, 974 MW pumped storage power stations
3 Argentina has the largest proven gas reserves in South America after Venezuela. The oil and gas extraction company YPF (Yacimientos Petrolíferos Fiscales) is the second largest company in the Latin American region, and since its merger with Repsol one of the 100 largest companies in the world (http://www.repsol-ypf.com/eng/home.asp).
4 ENRE acts as an intermediary in conflicts between the utilities and attends to the implementation of federal laws and directives and to the conclusion of concession agreements. In addition, it formulates standards for the distribution of electricity, sets maximum prices for transmission and distribution and supervises the generating companies and CAMMESA.
which the large-scale consumers and the state also own stakes alongside the new companies in the fields of generation, transmission and distribution (with largely foreign equity participation). The main tasks of CAMMESAs are to regulate supply and demand (load distribution) according to the principle of lowest (short-term) marginal costs, to determine transmission costs and other fixed costs and to ensure that there is sufficient reserve capacity.

The final obstacles for foreign investors were also removed with the enactment of Decree 1853 in 1993. With just a few exceptions, since then it has been possible for foreign owners to take full ownership of Argentine companies and for profits and capital to be exported freely.

Apart from two nuclear power stations, there are now only one large pumped storage power station and two binational hydroelectric plants in state hands.

In technical terms the supply of electricity is based on two separate grid systems, the Sistema Argentino de Interconexión (SADI), which operates in the north and in the Argentine heartland, and to which the generating companies of the MEM (Mercado Eléctrico Mayorista) electricity market belong, and an isolated grid system in Patagonia (Sistema Interconectado Patagónico (SIP)), to which the generating companies of the MEMSP (Mercado Eléctrico Mayorista Sistema Patagónico) belong. Both grids are supervised by CAMMESAs. As well as this there are power stations that are connected to the grid system but are not involved in market activities. Another group comprises independently operating generators who only meet local demand and who do not supply electricity to the grid (see Tab. 1).

At the end of 2000 altogether 44 electricity-generating companies, 13 autogenerators, 57 distribution companies, 8 supraregional transmission companies and 1891 large-scale consumers were registered in the two grid systems. All electricity generators have fundamentally free and equal access to the grid.

Trading in electricity from the public grid takes place through bilateral contracts between generators and distributors or bulk purchasers, as well as through seasonal purchasing contracts (forward deals) and a short-term spot market.

### Table 1

<table>
<thead>
<tr>
<th>Generators</th>
<th>MW</th>
</tr>
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<tbody>
<tr>
<td>MEM</td>
<td>21,695</td>
</tr>
<tr>
<td>MEMSP</td>
<td>891</td>
</tr>
<tr>
<td>Networked power stations</td>
<td>626</td>
</tr>
<tr>
<td>Isolated power stations</td>
<td>997</td>
</tr>
</tbody>
</table>

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*Large-scale consumers are consumers purchasing at least 2,000 MWh/a.*

*For further tasks of the company see Articles of Association of 10.7.92.*
market with hourly-changing prices under the supervision of CAMMESA. Roughly 57% of the electricity in MEM is traded on the spot market.

On account of the considerable competition and low energy procurement costs, electricity prices fell by on average more than 50% in the first six years after 1992. Since 1999, however, an increase in prices has been observed once again. In 2000 the average spot market price in the MEM market (demand and energy price, not including Patagonia) was US$ 27.6/MWh, while the total market price (i.e. including fixed contracts) on the wholesale market was US$ 31.9/MWh.  

At the local level an important role in the Argentine supply structure is played by cooperatives (municipal utilities) which have their own generation facilities or which purchase the electricity from the public grid at market conditions.

Renewable Energy

Wind Energy

Argentina has very sizeable wind energy potential, although this mainly applies to the southern part of the country (Patagonia). This area of the country is only thinly populated and is far away from the conurbations and industrial centres. Moreover, the southern power grid has so far only been inadequately linked to the northern grid.

Of all the countries of South America, Argentina has the most experience with the use of wind energy along with Brazil, although at approximately 25.5 MW the presently installed capacity of wind energy conversion systems (W.E.C.S.) is still modest (see Tab. 2). Almost all wind projects have been financed with a high level of foreign involvement (predominantly Danish and German) and are operated by local authority cooperatives.

The comparatively low wholesale prices for electricity must be seen as the greatest obstacle to the use of wind. In 2000 the purchase prices for the distribution companies, averaged over the year, were between $ 27.4 and $ 48.4/MWh.

Despite the relatively unfavourable conditions in the energy industry on account of low-priced fossil energy sources, in some cases there have been plans in place for years for large-scale projects primarily in the central province of Buenos Aires and in the southern provinces of Patagonia. In recent years several plans for large schemes have been submitted; their chances of implementation, though, are still uncertain. However, the intention of the

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7 Current data on prices and other statistical data can be obtained via the Internet under http://www.energia.mecon.gov.ar.
government to connect the Patagonian grid system to the central supply system via a high-voltage transmission route could contribute to overcoming existing impediments. The upcoming trade with CO₂ certificates could also provide stimulus for some of the projects.

<table>
<thead>
<tr>
<th>Location</th>
<th>Province/State</th>
<th>Operator</th>
<th>No. of W.E.C.S.</th>
<th>Inst. Capacity (MW)</th>
<th>Date commissioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rio Mayo</td>
<td>Chubut</td>
<td>DGSP Pcia. Chubut</td>
<td>4</td>
<td>0.12</td>
<td>2/90</td>
</tr>
<tr>
<td>C. Rivadavia</td>
<td>Chubut</td>
<td>PECORSA SCPL</td>
<td>2</td>
<td>0.50</td>
<td>3/94</td>
</tr>
<tr>
<td>Cutral Co</td>
<td>Neuquén</td>
<td>COPECO</td>
<td>1</td>
<td>0.40</td>
<td>10/94</td>
</tr>
<tr>
<td>Punta Alta</td>
<td>B.A.</td>
<td>Coop. Punta. Alta</td>
<td>1</td>
<td>0.40</td>
<td>2/95</td>
</tr>
<tr>
<td>Pico Truncao</td>
<td>Santa Cruz</td>
<td>E. Pcial. S. Pub.</td>
<td>10</td>
<td>1.00</td>
<td>dismantled</td>
</tr>
<tr>
<td>Rada Tilly</td>
<td>Chubut</td>
<td>COAGUA (Coop. de Servicios R.T.)</td>
<td>1</td>
<td>0.40</td>
<td>3/96</td>
</tr>
<tr>
<td>Tandil</td>
<td>B.A.</td>
<td>CRETEL</td>
<td>2</td>
<td>0.80</td>
<td>5/96</td>
</tr>
<tr>
<td>C. Rivadavia</td>
<td>Chubut</td>
<td>SCPL de C. Riv.</td>
<td>8</td>
<td>6.00</td>
<td>9/97</td>
</tr>
<tr>
<td>Darregueira</td>
<td>B.A.</td>
<td>Coop. Darregueira</td>
<td>1</td>
<td>0.75</td>
<td>9/97</td>
</tr>
<tr>
<td>M. Buratovich</td>
<td>B.A.</td>
<td>Coop. M. Buratovich</td>
<td>2</td>
<td>1.20</td>
<td>10/97</td>
</tr>
<tr>
<td>Punta Alta</td>
<td>B.A.</td>
<td>Coop. Punta Alta</td>
<td>3</td>
<td>1.80</td>
<td>2/95 and 12/98</td>
</tr>
<tr>
<td>Claromeco</td>
<td>B.A.</td>
<td>Coop. Claromeco</td>
<td>1</td>
<td>0.75</td>
<td>12/98</td>
</tr>
<tr>
<td>Pico Truncao</td>
<td>Santa Cruz</td>
<td>Municipalidad de P.T.</td>
<td>2</td>
<td>1.20</td>
<td>2/2001</td>
</tr>
<tr>
<td>C. Rivadavia</td>
<td>Chubut</td>
<td>SCPL de C.Riv.</td>
<td>16</td>
<td>11.20</td>
<td>as of 8/2001</td>
</tr>
</tbody>
</table>

Tab. 2
Wind turbine generators for generating electricity in Argentina

In autumn 2000 it was announced that it is planned to build wind energy conversion systems with a total output of up to 240 MW in the province of Buenos Aires. The largest project is a 140 MW wind park near Bahia Blanca, and there are also another 5-8 schemes in the megawatt range that are to be built at various locations around the province. Altogether 180 MW is already in the process of gaining approval. Erection of the wind machines was expected for November 2001, and was to be carried out by an as yet unnamed European company in cooperation with domestic industry. The development is taking place at the end of a five-year study phase in which 17 locations in the region were examined in detail. The measured wind velocities are on average between 7.0 and 10.7 m/s. However, implementation is dependent on a provincial law that was to be passed already in March 2001. This regulation would oblige local distributors to purchase surplus electricity from the wind farms. As well as this, the provincial government would be required to provide special credit lines.

The Spanish wind power plant manufacturer Gamesa and the power cooperative COAGUA have joined forces to develop 50 MW of wind power for the town of Rady Tilly in the province of Chubut. It was originally intended

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8 Windpower monthly, 1/2001, p. 10
that 7 MW should be installed as early as 2000 by the Argentine subsidiary company Gamesa Energía Austral, but building had not yet begun in 2001 either. The entire wind farm is scheduled to enter service in 2006. Gamesa Energía Austral has an 84 % share in the scheme, and COAGUA holds the remainder. The purpose of the project is to reduce the costs to the town of purchasing electricity from the grid.

Also in the province of Chubut, under a contract with the town of Comodoro Rivadavia signed in August 2000, Gamesa supplied the turbines for another project by the local operator Sociedad Cooperativa Popular Limitada (SCPL) for 11.2 MW, which began entering service in August 2001. The electricity is used exclusively for supplying Comodoro Rivadavia and benefits from government promotion regulations (see later in this section).

In early 2001 the Spanish companies ENDESA and Elecnor announced their intention to install a total of 3000 MW in the southern Argentine provinces of Rio Negro, Chubut, Neuquén and Santa Cruz by the year 2010, with a total investment of US$ 2.25 billion. With this in mind, a joint subsidiary company Energías Argentinas S.A. (Enarsa) was founded at the end of 2000.

An initial project phase with approximately 280 MW is planned for Chubut and Neuquén, and is to be implemented jointly by Enarsa, Elecnor and the ENDESA subsidiary MADE. The first tranche comprises 70-100 MW, divided between two wind farms near Puerto Madryn in Chubut and 10 MW wind parks at San Carlos de Bariloche in Rio Negro and at Cutral Có – Plaza Huincul in Neuquén. A 150 to 200 MW wind farm at El Chocón in Neuquén is intended to supplement the hydroelectric plant run there by ENDESA.

This would be the first phase of a further commitment that Elecnor has agreed with the provincial government of Neuquén and which covers 600 to 800 MW over the next 10-12 years. Installation of the plants is to begin as soon as a power purchase agreement has been concluded with the local distributor Epen.

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9 The 16 turbines will be erected at Cerros Arenales (6), Chenque (2), Viteaux (4), Hemite (3) and at a major highway intersection (1) and will supplement the existing Antonio Moran wind farm, which presently contributes 8.5 % of electricity supplies to Comodoro Rivadavia.

10 Endesa currently generates 25 % of Argentina’s electricity requirements. It is also the majority sharehold in one of the two distribution companies in Buenos Aires and owns a large minority interest in the other company.

11 Probably to supply part of the needs of an aluminium factory there. Elecnor has already carried out wind monitoring for the installation of 14 turbines, which are intended to generate 10 to 12 MW.

12 For further details see Windpower monthly, August 2000, p. 4 and December 2000, p. 39. Relevant wind studies in Neuquén should have been completed by the end of 2000.
Hydropower is mostly used in large barrage projects. So far small hydroelectric plants make up only approximately 50 MW of the installed capacity. The use of geothermal sources for generating electricity is currently being tested for the first time; the potential is high. Solar electricity generation, with an installed capacity of roughly 2 MW, is used especially in rural regions in micro installations (see below). Particularly in the central rural regions there is considerable potential for the use of biomass, for example in the sugar and alcohol industries.

### Rural Electrification

In view of the continuing shortage of supply of electricity to rural areas (some 7% of the population had no electricity connection in 2000), national and provincial governments have put in place programmes to promote electrification which are financed from a dedicated fund. Because it is often impossible to connect to the public power grid on account of the difficult transmission conditions, there is increased interest in dispersed solutions for remote regions, including renewable forms of energy. As a rule, though, the output level required to meet the demand is low, so that primarily small electricity generating facilities are called for.

In 1995 the Argentine government (Secretaría de Energía) set up the national programme for rural electrification PAEPRA (Programa de Abastecimiento Eléctrico a la Población Rural de Argentina). Within six years, 314,000 households with 1.4 million people and some 6,000 public facilities (schools, health centres, police stations etc.) in 16 provinces were to be provided with electricity by extending the public grid or by means of standalone solutions.

The programme includes the granting of subsidies to private licensees who, after a tendering procedure, guarantee to supply rural regions while taking the lowest state grants, even if this means having to use options that are not connected to the grid. Licensing agreements are concluded for a term of 15 years, but they can be renewed twice after further invitations to tender. The electricity tariffs are set every two years so as to leave the suppliers with an adequate rate of return.

The first two provinces where the rural electricity market was licensed according to this model were Jujuy (company: EJSEDSA\(^{13}\)) and Salta (company: ESEDSA, subsidiary of the Spanish utility Unión Fenosa) in the north west of the country. Electrification is primarily being carried out on the basis of separate grids or individual supply solutions with fossil energy sources (diesel generators) and renewable energy sources. In March 1998 roughly

\(^{13}\) Subsidiary of the privatised distribution company EJDESA in the same province.
half of the customers of EJSEDSA were supplied by diesel generators, the others in approximately equal parts by micro hydropower and PV systems\textsuperscript{14}. By the end of 1999 more than 40 % of the customers, of which by then there were over 3000, had an individual or collective solar power installation.

As an extension to PAEPRA, a new component was introduced in 1999/2000. This was a specific programme for the use of renewable energy in rural electrification (Proyecto de Energias Renovables en Mercados Rurales – PERMER). To begin with, PERMER is to concentrate on scattered settlements, residential buildings and facilities, initially in eight provinces which already have a suitable set of legal provisions on rural electrification on the basis of licences\textsuperscript{15}. In the other provinces the scheme offers provision in particular for technical assistance on the introduction of licensing agreements for the rural electricity market and the performance of market studies.

The six-year project entails estimated costs of US$ 120.5 million, to which the World Bank (US$ 30 million loan), GEF (US$ 10 million grant), the Argentine electricity development fund FEDEI (Fondo Especial de Desarrollo Eléctrico del Interior, US$ 26.5 million in subsidies), the licensees (US$ 44 million) and the users themselves (US$ 10 million) are to contribute. The consumers are responsible for the installation costs and pay a flat-rate monthly fee that will cover roughly 40 % of the initial costs and expenditure on maintenance and batteries over the licence period of 15 years. Additional subsidies that are paid to the poorest segments of the population in order to reduce their monthly outgoings will diminish in the course of the licence period.

During the first phase of PERMER it is intended that some 87,000 households and 2000 public facilities will be equipped to obtain electricity for lighting and communications. All in all it is planned to increase the degree of electrification to 95 % by 2010. Solar home systems have priority. However, with the GEF contribution it is also intended to run trials on a model basis of individual wind power systems in two or more communities of 40 to 50 houses each, as well as a biomass project.

**Legal Provisions and Incentive Systems**

Act 25.019 dealing with arrangements for wind and solar energy was enacted by the State President in November 1998 after previously being approved by parliament, above all as a result of an initiative by Greenpeace Argentina and the commitment of a number of senators. The decision to pass such a law had been a matter of dispute for a long time, because gen-

\textsuperscript{14} In 1999, 556 households and 43 schools were equipped with PV systems of various sizes in this service area.

\textsuperscript{15} In December 2000 an initial agreement was signed between the Energy Secretariat and the provinces of Chubut, Rio Negro, Mendoza, San Luis, Corrientes and Tucumán.
Generally the dominant view is that all subsidies for the energy sector should be removed.

The Act stresses the national interest of generating electricity from wind and solar energy, and for the first time introduces a subsidy of 1 US cent per generated kilowatt-hour at the national level, which will be paid for 15 years. It also makes it easier to pay the value-added tax on capital investment in this field by extending the time allowed, and fixes other tax burdens for a period of fifteen years. If possible, the price of the electricity purchased under this scheme is to be set at the same level as that from run-of-river power stations (not including reservoirs).

It was only after considerable delay that implementing provisions pertaining to the law were introduced in December 1999. To date, however, these have not yet been put into practice.

The Act will be able to trigger new impetus in the wind sector in particular, provided that the promotion can be combined with good site conditions, favourable prospects for financing and comparatively high purchasing costs for conventional electricity. However, cooperatives can only supply electricity directly to consumers if they were already operating as producers at the time when the electricity market was deregulated. Otherwise the electricity must be sold to the local electricity distribution company at the current market price. Niche markets are opening up, however, for example for autonomous supply to large-scale customers, such as companies in the industrial sector or households within fenced-off private housing developments.

Additional assistance at the provincial level for electricity generated from wind energy by the payment of 0.5 or 1.0 US cents per generated kilowatt-hour is so far only provided in the southern province of Chubut (Patagonia) and in the province of Buenos Aires. The subsidy payment is dependent on the percentage share of local production as a proportion of total investment. Since January 2001 this minimum percentage has been 30 %, and it will be raised to 60 % in January 2003 and 80 % in 2005. From January 2007, all production must be local.

In other parts of the country there are also similar initiatives under way, although their prospects are somewhat uncertain. In the past, state assistance has mainly been limited to preparatory measures supporting the conducting of wind potential studies or research activities.

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16 Decreto P.E.N. Nº 1.597/99
17 According to information from Erico Spinadel/AAEE.
18 According to Erico Spinadel/AAEE, the implementing regulation is not yet in force in the province of Buenos Aires.
19 For more details see for example Decree 1716 of 26.6.92 and Law 11.723 of 9.11.95 of the Provincial Government of Buenos Aires.
There are no other special arrangements for electricity from renewable energy sources. Some local authorities which have their own power supply cooperatives, however, do provide plots of land and infrastructure for wind energy projects on highly favourable terms. Legal requirements under building and planning law are enforced much less strictly than in Germany.

Exchange rate (10.12.2001):
1 Argentine peso = US$ 1 = € 1.12
(fixed link to US dollar)

Information Sources


Decree 1398/92 of 6.8.92 on implementation of Law 24.065 of 16.1.92 dealing with reform of the electricity sector


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Department of Energy (Energy Information Administration), Country Analysis Briefs: Argentina, August 2000


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BRAZIL

Electricity Market

The Brazilian electricity sector is divided into the state holding company Eletrónorte, an operating company for the nuclear power stations and three large electricity generating companies as subsidiaries\(^\text{21}\), along with a relatively large number of distribution companies at the regional level, i.e. mostly at the level of the federal states, and a range of locally oriented public utility companies in the larger cities\(^\text{22}\). Only some of the regional and municipal utilities have their own generating capacity; otherwise, therefore, they purchase their electricity from the central electricity generators.

For some years now the Brazilian electricity market has been undergoing a process of complete change. The intention was that, after completion of restructuring, a largely privatised, liberalised and competition-oriented service sector should emerge from a supply sector that was originally in the form of a state monopoly.

In 1990 the national privatisation programme was launched (Programa Nacional de Desestatização, Law No. 8.031), which also included provision for the privatisation of segments of the electricity generation and distribution industry that were under the authority of Eletrónorte. An initial step in this direction was taken in 1995 with the privatisation of Escelsa.

At the beginning of the nineties the Brazilian electricity sector was on the verge of collapse on account of excessive debts and a shortage of capital for further expansion. Between 1991 and 1995 the volume of investment in the electricity industry fell steadily, from US$ 8.8 to 4.3 billion. Instead of the required 2,500 MW/a of new power station capacity, only little more than 1000 MW/a was actually built; numerous construction projects were abandoned during the building phase.

In 1995, licence laws 8987/95 and 9074/95 created the basis for a fundamental reform, which was targeted in particular at privatisation of the distribution and generation sector and at the establishment of new regulatory bodies.

At the end of 1997, after a lengthy build-up period, the new independent regulatory authority ANEEL (Agência Nacional de Energia Elétrica) was es-

\(^{20}\) Operated jointly with Paraguay.

\(^{21}\) Furnas, Chesf and Eletronorte.

\(^{22}\) The three largest of these municipal and regional supply companies do, however, contribute almost 40 % of the electricity generated in Brazil.
Its tasks primarily comprise the granting of licences for electricity generation and distribution, the setting of tariffs and determining of permits for access to the grid, and further subdivision of the electricity sector into three areas: generation, transmission and distribution.

Further foundations were put in place with Law 9648/98 and Decree 2655/1998 on the establishment of the Operador Nacional do Sistema Elétrico (ONS - comparable with the Argentine CAMMESA), which began work on 1.3.1999, and on the creation of a wholesale market for electricity (MAE - Mercado Atacadista de Energia). ONS makes sure that participants in the market have non-discriminatory access to the interconnected grid system (Sistema Interligado Nacional – SIN) and takes care of balancing between supply and demand. The generators, distributors, electricity traders, large-scale consumers and representatives of other consumer groups all have a share in this private-law company.

All in all, therefore, despite certain initial difficulties, the Brazilian electricity sector is moving towards becoming a copy of the Argentine model. From 2006 onwards, the electricity market should be based solely on the pillars of bilateral contracts (85 to 90 % of the total amount of electricity) and a short-term spot market for surplus electricity.

Despite the fact that its areas of responsibility have been trimmed back as a result of the removal of a large part of the generation sector, the role of Eletrobrás remains significant. Thanks to its technical and organisational competence it is still responsible for higher-level energy planning. In the meantime it also carries out important tasks as a banking institution for the electricity sector.

In mid-2001, total Brazilian generating capacity amounted to 74,368 MW (not including autonomous supply, see Tab. 3). Of 23 hydroelectric plants whose construction was interrupted in 1995, 15 with a total capacity of

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23 On the basis of Law 9.427/96. The structure and duties of ANEEL are described in detail in Decree 2.335 dated 6 October 1997.

24 Only a few suppliers are fully active in all three areas, however, for example CEMIG in the state of Minas Gerais.
16,000 MW were completed by the year 2000. The annual growth in capacity between 1996 and 2000 therefore amounted to an average of 2,900 MW, while in the period between 1986 and 1995 it was less than half of this figure.

Of the installed generating capacity at the end of 2000 totalling around 73 GW, however, only just under 66 GW was operated on the grid. Roughly half of the thermal power stations did not feed into the national transmission network.

Approximately 92% of the electricity generated in 2000, some 360 TWh (not including autonomous supply), is based on hydropower; the rest comes from thermal power stations fired by coal and gas and from two nuclear reactors. As a result of newly developed gas fields in the country and a gas pipeline from neighbouring Bolivia\(^\text{25}\), the proportion of thermal power stations is likely to increase considerably in the coming years.

In 2000 alone, overall electricity consumption rose by 4.3% compared with the previous year to reach a total of 332 TWh, of which the licensed distribution companies and electricity traders supplied 307 TWh. Within this increase, the growth in trade and industry was particularly marked. Some of the increase is also attributable to the connection of new consumers through the extension of the grid in rural areas as part of the national Luz no Campo programme.

The electricity demand of the (industrial and commercial) autonomous suppliers amounted to just over 25 TWh in 2000, i.e. almost 8% of total consumption. In geographical terms, electricity consumption is mainly concentrated on the south-eastern region with the industrial conurbations, where some 60% of all of the electricity was consumed.

Only 5.4 TWh was consumed in 2000 in the separate grids that above all supply the urban centres in the north of the country (with Manaus as the largest consumption unit). The situation in smaller communities, which often generate electricity using diesel generators, is generally described as insecure on account of the obsolete plant technology used.

Since the early seventies, the growth in electricity consumption has regularly been appreciably above the rate of growth in gross national product. Even economic crises have not been able to curb this trend to any significant extent. In the light of the current electricity crisis (see below) and the economic weakness of neighbouring Argentina, however, the forecasts for the 10-year period from 1997 to 2007, which assumed an average growth in

\(^{25}\text{The pipeline crosses the south of Brazil and also runs close to the heavily populated and industrialised regions of São Paulo.}\)
consumption of 5 % p.a., are hardly likely to be realistic any more.\textsuperscript{26} According to estimates, total consumption of 590 TWh is assumed for 2010.

ANEEL Resolution 278/00 stipulates that no electricity generator (the same applies to electricity distributors) is permitted to control more than 20 % of the total capacity of the national grid, or more than 25 % of the southern grid system and 35 % of the northern grid system.

In August 2001 Eletrobrás had more than 39 % of the total capacity at its disposal, its subsidiary companies CHESF almost 15 %, Eletronorte just over 13 % and Furnas some 7.4 %, meaning that the state share in production still made up roughly two-thirds of installed capacity. The sale of these three large electricity generating companies, which in principle cover the entire territory of Brazil, has yet to take place.

There are 59 distribution companies in Brazil. By the end of 2000, 18 were privatised (two of them from federal ownership), representing a share of 80 % of total national electricity consumption. Further companies were to be sold in 2001.

Licences to distributors are granted on the basis of public auctions. Distributors have a right of precedence in supplying consumers in their supply area, although large-scale consumers can also enter into contracts with other suppliers.

Regulation 2003 of 10th September 1996 gave independent electricity producers and auto-generators the right to operate. Licence Law 8987/95 had already given every consumer with an installed load of more than 10 MW\textsuperscript{27} the right to choose its electricity supply company itself.\textsuperscript{28} The license holders are obliged to transmit the electricity against a transit tariff, which is calculated anew in each individual case according to uniform principles laid down by ANEEL. The limit for the free choice of suppliers was to be lowered to 3 MW in the year 2000, and it is expected to be removed completely in 2003.

In absolute figures the amount of electricity generated by autonomous supply roughly doubled over the past decade, and within this period in some cases grew by leaps and bounds in certain years.

Importing and exporting of electricity and the associated construction of transmission lines and other installations must be approved by ANEEL. Since July 1999 approval has been granted for the importing of 5,420 MW, including 5050 MW from Argentina, 300 MW from Bolivia, 70 MW from Uru-

\textsuperscript{26} In its 10-year plan, Eletrobrás assumes growth to a level of 95,700 MW and considers an expansion in capacity of 3,640 MW/a to be required.

\textsuperscript{27} A further condition is that the supply must be provided via at least a 69 kV connection.

\textsuperscript{28} New consumers with purchased power of only 3 MW, or if supplied from hydropower only 500 kW or higher.
guay and 50 MW from Paraguay. Practical use of these permits, however, is not keeping up with expectations. It is assumed that only approximately 3,900 MW of the approved volume will have been utilised by the end of December 2003.

An initial block of 50 MW was imported from Paraguay in July 1999. As well as this there is a transnational connection to Argentina, via which 1000 MW can be imported to Brazil. Other supplies from Argentina and Uruguay were expected to follow in 2001.

In February 2000 the Ministry of Energy (MME) launched the priority programme for thermal power stations (Programa Prioritário de Termelétricidade – PPT), which provided for the construction of 49 power stations with a total capacity of some 20,000 MW by the end of 2003 in order to add cost-effective generating sources close to the centres of consumption. In a revised version of these plans, the MME has in the meantime scaled down this objective to a target of 15 power stations with a total of 6423 MW.

In 2000, average electricity tariffs were at a level of US$ 59/MWh and therefore only 10% higher than 10 years previously, and considerably below the prices seen in the mid-nineties. The average tariffs for the domestic sector were US$ 85/MWh, while those in the industrial sector were US$ 39/MWh.

**Electricity Crisis**

The Brazilian electricity system, which is primarily based on hydropower, is traditionally designed to cope with variations in annual rainfall. The low levels of growth in capacity in the early nineties, however, drastically reduced the safety margins. The additional building in the second half of the past decade has not been able to keep pace with the quickening of economic growth in the same period, either. The transition to a liberalised and privatised electricity market has contributed to the situation where planned power stations have not been connected to the grid within the scheduled time.

As a result of reduced precipitation, reserves of water in the artificial lakes above all in the north-east but also in the south-east and mid-west fell to unusually low levels in the first months of 2001. Towards the end of the rainy season in April, the reservoirs were filled to only little more than a third of their capacity.

As a consequence, temporary power cuts or unintentional overloads occurred in the affected regions. In response the government set up an emergency group to safeguard power supplies (Câmara de Gestão de Energia /}

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29 In this examination of the situation on a dollar basis, the fluctuation of the exchange rates is of course also significant. In domestic currency a continuous rise in prices has been recorded.

30 In fact a continuous decline in water levels in comparison with the same month in the previous year has been observed since 1997.
CGE – Energy Management Committee) and from the beginning of June 2001 imposed drastic measures to reduce electricity consumption. The package of measures includes tariff surcharges for exceeding certain monthly consumption limits and the threat of temporary disconnection from power supplies if the obligatory savings are not achieved. On the other hand, however, bonuses are also granted if the savings targets are reached.

The crisis affects both households and industrial and commercial consumers, who have to reduce their electricity consumption by about 20 %. In certain cases, though, some power consumers, mainly industrial, have switched to private power plants. It has already been decided that the power-saving measures are to remain in force beyond 2001.

As a further consequence of the electricity crisis, at the supply level the Structural Programme to Expand the Supply of Electricity 2001-2003 (Programa Estruturado de Aumento da Oferta) was adopted in the summer of 2001. This programme provides for short-term expansion of available output by the end of 2003 by almost 20,000 MW through additional building of mainly thermal and hydroelectric plants (see Tab. 4). In addition, new dispersed and renewable energy sources are to be developed.

<table>
<thead>
<tr>
<th>Structural Programme to Expand the Supply of Electricity</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large hydropower (21 plants)</td>
<td>1,237</td>
<td>3,513</td>
<td>3,053</td>
<td>7,803</td>
</tr>
<tr>
<td>Thermal power stations (15)</td>
<td>1,517</td>
<td>2,226</td>
<td>2,680</td>
<td>6,423</td>
</tr>
<tr>
<td>Import (6)</td>
<td>1,048</td>
<td>988</td>
<td>800</td>
<td>2,836</td>
</tr>
<tr>
<td>Small hydropower</td>
<td>47</td>
<td>400</td>
<td>400</td>
<td>847</td>
</tr>
<tr>
<td>CHP with bagasse</td>
<td>160</td>
<td>300</td>
<td>500</td>
<td>960</td>
</tr>
<tr>
<td>Wind/PV</td>
<td>50</td>
<td>500</td>
<td>500</td>
<td>1,050</td>
</tr>
<tr>
<td>Total</td>
<td>4,069</td>
<td>7,927</td>
<td>7,933</td>
<td>19,919</td>
</tr>
</tbody>
</table>

Tab. 4 Structural Programme to Expand the Supply of Electricity, 2001 to 2003

In addition, 4000 MW of mobile generating capacity is to be acquired through an international call for tenders in order to be able to respond at short notice to shortages in meeting demand for electricity in a crisis.

The package of schemes to cope with the electricity crisis also includes a set of measures to improve energy efficiency and to substitute the use of electricity with other forms of energy. For example, in future increasing use is also to be made of solar collectors for heating water, for which government aid is to be provided.

31 The separately listed combined heat and power plants are primarily (as is also the case in many other countries) industrial power stations in which the heat is used in the production process.
Apart from the northern region (Amazon states), which accounts for only 2% of national electricity consumption, all parts of the country have recently been linked to each other through a national interconnected grid system. However, the sales market is mainly concentrated on the regions of the south and mid-west, where almost 80% of the generated electricity is consumed. A lack of transmission capacity, particularly in the south and southeast, is one of the reasons for the electricity crisis.

**Renewable Energy**

The use of renewable energy has traditionally enjoyed a high status in electricity generation and in rural power supply in Brazil. In the urban and industrialised centres, however, there is little visible evidence of the renewable resources that are available in abundance. Despite official declarations of intent to develop these resources (in particular solar, wind and biomass), efforts in the field of research and development and in application-oriented implementation remain cautious. Although there have been many rounds of debate and scattered examples of commitment and know-how, only initial signs of coordinated and properly targeted policy have been seen, but in the light of present requirements regarding the provision of power this may soon gain momentum.

**Wind Energy**

Although wind energy conditions are classed as good to very good, especially on the coasts in the north-east and in the south of Brazil, use of wind energy for electricity generation is still in its infancy.

That said, most of the windy areas have in the meantime been well surveyed and documented, among other factors thanks to international aid programmes. As long ago as 1990/91 wind measurements were taken at three coastal locations in Ceará within the framework of GTZ’s TERNA programme in conjunction with COELCE, revealing excellent wind potential with a high degree of constancy. After lengthy preliminary work, a wind atlas for the relevant regions was presented in 2001 by the Reference Centre for Solar and Wind Energy CRESESBS³³ at the Research Centre for Electrical Energy (CEPEL), which was based on measurements by various utility companies and other actors. According to this, the theoretical wind energy potential is 143.5 GW, and the amount of electricity that can be obtained from this is 272 TWh/a.

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³² Particularly worthy of mention here is the "Permanent Forum for Renewable Energy", which is also supported by the Ministry of Energy, and to which all well-known institutions belong; it has been inviting participants to a large gathering every year since 1994. In 1995 this forum formulated a guiding recommendation on the development of renewable energy in the "Brasília Declaration".

³³ Centro de Referência para Energia Solar e Eólica Sérgio Brito
There are also undoubtedly important centres of know-how for future development already in place in the form of the test centre for wind turbines in Recife (since renamed as the Brazilian Centre for Wind Energy) set up with Danish assistance, and the previously mentioned CRESES in Rio de Janeiro. Meanwhile, academic institutions in other federal states are also taking an increasing interest in this subject and are contributing to the training and upgrading of experts. In the past, training measures for Brazilian experts in energy and finance have been implemented repeatedly with German assistance (Carl Duisberg Society and the German Wind Energy Institute).

<table>
<thead>
<tr>
<th>Location</th>
<th>State</th>
<th>Output (MW)</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prainha</td>
<td>Ceará</td>
<td>10.0</td>
<td>Wobben</td>
</tr>
<tr>
<td>Taiba</td>
<td>Ceará</td>
<td>5.0</td>
<td>Wobben</td>
</tr>
<tr>
<td>Morro do Camelinho</td>
<td>Minas Gerais</td>
<td>1.0</td>
<td>CEMIG</td>
</tr>
<tr>
<td>Palmas</td>
<td>Paraná</td>
<td>2.5</td>
<td>COPEL/Wobben</td>
</tr>
<tr>
<td>Recife</td>
<td>Pernambuco</td>
<td>0.3</td>
<td>UFE/CFEE</td>
</tr>
<tr>
<td>Fernando de Noronha</td>
<td>Pernambuco</td>
<td>0.225 Wind/Diesel</td>
<td>ANEEL-CBEECUFPE</td>
</tr>
</tbody>
</table>

To date, however, only a few examples with significant output have been visibly put into practice (see Tab. 5), including two from the scheme financed by the German Eldorado programme, one rated at 1 MW in the state of Minas Gerais and one at 1.2 MW in the state of Ceará. As well as these, at the end of 1998 and beginning of 1999 two wind farms entered operation near Fortaleza (state of Ceará), with 5 (Taiba) and 10 MW (Prainha) respectively, for which the electricity supply company Coelce together with the federal state guaranteed a long-term return above the level considered usual at the time. The German company Enercon and its Brazilian subsidiary Wobben Windpower were awarded the contract to build and operate both projects after an international call for tenders, and the German Investment and Development Society (Deutsche Investitions- und Entwicklungsgesellschaft - DEG) financed the schemes with low-cost loans. A small wind farm with 2.5 MW was completed in Palmas in 1999.

The contract to purchase wind power produced by Enerbrás, a subsidiary of the Portuguese company Enervento, at Pecém in Ceará from wind turbines...
with a total output of 6 MW was signed at the end of June 2001. Operation is scheduled to commence in December 2002. The contracted purchase price amounts to R$ 68.78/MWh (currently € 31.64/MWh) and is therefore considerably above the average price for electricity from hydropower, which is given as R$ 22 (€ 10.1).

Financed by Japanese development funds, for several years now in Ceará the utility company Coelce has been engaged in the preparation of two wind farms at Paracuru and Camocim, each rated at 30 MW. Prequalification for these plants took place in early 2001. Both projects are to be handed over ready for operation as turnkey systems, and subsequently operated by Coelce.

The efforts being made in the north-eastern states in particular to detach themselves gradually from the dominance of hydropower are opening up new prospects for wind energy. The electricity crisis in 2001 has also had the effect of speeding up the decision-making process at the political level.

As part of its measures to encourage the short-term expansion of electricity generation, CGE introduced an emergency programme for wind energy (Programa Emergencial de Energia Eólica – PROEÓLICA) on 5.7.2001 with Resolution 24. The aim is to install 1,050 MW of wind energy conversion systems by the end of 2003.

<table>
<thead>
<tr>
<th>Commissioned before....</th>
<th>Payment rate (VN) x factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.12.2001</td>
<td>1.2</td>
</tr>
<tr>
<td>31.3.2002</td>
<td>1.175</td>
</tr>
<tr>
<td>31.6.2002</td>
<td>1.15</td>
</tr>
<tr>
<td>30.9.2002</td>
<td>1.125</td>
</tr>
<tr>
<td>31.12.2002</td>
<td>1.1</td>
</tr>
</tbody>
</table>

The payment to be made by Eletrobrás or a company associated with it over 15 years is based on the maximum price that may be applied for wind power supplied to end customers in the tariff decision according to the stipulation by ANEEL (Valor normativo – VN). At the beginning of 2001 this maximum price was US$ 57.15/MWh. Higher rates apply over the first two years (see Tab. 6). The additional costs are apportioned to the electricity distributors by Eletrobrás in accordance with their proportion of supplies. Implementing provisions relating to this resolution were expected by the end of 2001.

ANEEL is currently examining wind power projects with output extending to more than 3000 MW, which according to plans by the investors are to be installed by 2004 (see Tab. 7). By far the greatest number of these projects is concentrated in the north-east of Brazil, and within that region at coastal lo-
There are also efforts, not included in the above table, to construct installations in the state of Rio de Janeiro. There it is above all the French company SIIF Énergies\(^\text{37}\) and the American company SeaWest that are attempting to gain a foothold. Locations are being explored, and long-term measurements are being taken at several places. The national oil company Petrobrás is showing great interest and intends to set up wind farms with a total of 90 MW by 2005. By December 2001 two pilot schemes of 3 MW each were to have been set up, one in Rio Grande do Norte and one in the state of Rio de Janeiro.

Similarly there have been expressions of intent in the state of Santa Catarina to install a first wind farm with a capacity of 12.5 MW. A contract to that effect between the regional electricity distribution company Celesc and the manufacturer Wobben was signed in June 2001.

The operator Fuhrmet Energy Brasil, a subsidiary of the German turbine manufacturer Fuhrländer, already has a generating licence for 25 MW for a location in the municipality of Beberibe in Ceará state. It is intended to link the erection of plants scheduled to start up as early as March 2002, with the establishment of a production facility in Ceará.

In mid and late December 2001, ANEEL granted electricity generating licences amounting to almost 3700 MW in 43 wind farms in response to applications from various operating companies (see list in Appendix). The sites of the proposed installations are concentrated in the federal states of Rio Grande do Norte and Ceará.

As far as the operating companies are concerned the production licences are primarily to be seen as options, with correspondingly long time periods allowed for implementation. It remains to be seen whether the options will indeed be subsequently taken up and the corresponding plants constructed.

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\(^{37}\) A certain holding in Siif is owned by the French company EdF, which at the same time is the parent company of the main supplier Light in Rio de Janeiro.
Hydropower

The theoretically available hydropower potential is quoted as being 260 GW, and is concentrated mainly in the northern region (Amazon basin) and the south-east of Brazil. About a quarter of this potential is currently being exploited. In practice it is possible to tap only a relatively small proportion of the total volume of energy beyond that obtained from the hydroelectric plants already in operation, because the intervention in nature needed to build reservoirs, especially in the flat lands of the north, is indefensible in most cases. In the south and south-east, on the other hand, more than 50 % of existing capacity is already being exploited today.

Hydroelectric plants between 1 and 30 MW are classified as small hydropower plants, and provided the associated reservoir is not larger than 3 km² they require only a simple licence, which is granted to the first suitable applicant (see ANEEL Resolutions 394 and 395/1999). In exceptional cases, however, public auctions may also be held. Licences are granted for a length of time that allows reasonable refinancing of the investment, but for no more than 35 years.

Small hydropower plants are primarily concentrated in the mountainous regions in the south and south east of the country (see Tab. 8).

<table>
<thead>
<tr>
<th>Region</th>
<th>Output (in MW)</th>
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<tbody>
<tr>
<td>South</td>
<td>287.5</td>
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<tr>
<td>South-east/mid-west</td>
<td>498.0</td>
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<td>40.8</td>
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<tr>
<td>North-east</td>
<td>75.8</td>
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<tr>
<td>Total</td>
<td>902.1</td>
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Tab. 8
Small hydropower plants in operation

The Structural Programme to Expand the Supply of Electricity 2001-2003 (Programa Estruturado de Aumento da Oferta) provides for the construction of 21 large (over 100 MW) and medium-sized (30 to 100 MW) hydroelectric plants with an output of roughly 7,800 MW. The PCH programme (small hydroelectric plants between 1 and 30 MW) includes provision for the additional construction of 847 MW. Of this, 47 MW was to have gone online in 2001, followed by 400 MW in each of the two subsequent years.

Incentives for small hydropower were put in place in particular through the adoption of ANEEL Resolutions 394 and 395:

- Only 50 % of the normal tariffs are to be paid for electricity transmission and distribution.
- A 100 % allowance is granted for small hydropower plants that enter operation by 2003.
- Exemption from compensation payments for submerged land.
Consumers with demand of 500 kW or more can negotiate free contracts.

The programme for the development and commercialisation of electricity from small hydroelectric plants (PCH-COM) was launched in July 2000, with the intention of building new plants of this type with a connection to the grid or reviving existing plants. Eletrobrás guarantees that the electricity will be purchased, while the state development bank BNDES finances up to 80% of the investment costs through loans.

**Biomass**

Brazil has extensive biomass reserves which can be made available for the purpose of energy generation. The most familiar example of the exploitation of renewable energy sources (apart from the use of hydropower) is the Álcool programme, in which petroleum for the transport sector is substituted by alcohol on the basis of sugar cane – a programme that has been running since the early eighties. This programme is still supported by considerable levels of state subsidy because the oil price has not risen to the extent necessary to make this alternative fuel economically viable.

To date, the use of biomass for electricity generation has mainly been restricted to the use of bagasse from the sugar and (associated) alcohol production industries for autonomous supply. In São Paulo state alone, there is an installed capacity of 600 MW in plants of this type for electricity generation and the production of heat.

In future, however, surplus electricity is also to be made available to the public grid to an increasing extent as a result of improvements in efficiency. The operational programme for company-owned combined heat and power plants on the basis of residues from sugar production was launched with this in mind in May 2001. In order to promote investment confidence, the national development bank BNDES will meet up to 80% of plant costs through loans. The structural programme mentioned above includes provision for the construction of additional capacity of 960 MW in the sugar and alcohol industry by 2003, although it is also intended to use natural gas as well as biomass. If plants are supplied solely from residual products from sugar cane it must be borne in mind that the generating capacity is available only during the few months of the year in which sugar is produced.

At the same time the development of other biomass resources is under discussion, and to some extent has already been implemented on a small scale. Apart from organic constituents of domestic refuse, attention is also being directed towards residues from other agricultural products, such as cocoa husks and coffee shells, and towards oily fruits, which could play a part above all in the rural electrification of the north and north-east, among other areas.
For the southern states of Santa Catarina, Paraná and Rio Grande do Sul alone, the technical electricity generation potential that could be utilised in the short term through the use of residual wood, rice husks and constituents of sugar cane is estimated at several hundred megawatts. The theoretical potential if other agricultural residues were included is far higher.

**Solar Energy / Rural Electrification**

On account of the size of its territory, low population density in large parts of the country and serious poverty in rural regions, Brazil still has a high proportion of non-electrified communities\(^{38}\). No precise figures are available, but it is assumed that between 10 and 15 % of the total Brazilian population has no access to electricity (whether from the grid or from a municipal autonomous supply)\(^{39}\).

In order to remedy this situation, at the end of 1994 the electrification programme PRODEEM (Programa para o Desenvolvimento da Energia nos Estados e Municípios) was launched by presidial decree.\(^ {40}\) The programme is coordinated by a subsection of the Ministry of Energy (DNDE – Departamento Nacional de Desenvolvimento Energético) and primarily aims to provide communal facilities or institutions such as schools, health centres and churches with equipment for generating electricity from renewable energy sources. Other key areas of activity are projects which can contribute to improving the income situation, for example with irrigation systems in agriculture, or which supplement diesel generators in standalone installations.

A further aim was to contribute to social and economic development through the extensive involvement of other governmental and non-governmental partners with comparable objectives. In this way the programme was intended to play a part in bringing about an integrated approach with the inclusion of local partners.

In practice, solar energy in the form of PV systems became the only energy source, whereas water or wind resources, for example, have so far not featured at all. It must be emphasised that solar home systems (SHS) for supplying individual private households have not received any promotion as

\(^{38}\) Non-electrification must be taken literally in this connection, because in most cases there are not even diesel generators available for basic autonomous supply, and often only batteries are procured for basic needs (e.g. the operation of radios). The term communities here relates to local communities whose inhabitants often live in a widely dispersed pattern over a large area but who do not necessarily own their own land individually. In Brazilian usage therefore people often tend to speak of “propriedade”, i.e. “property”.

\(^{39}\) In various publications a figure of roughly 20 million people is quoted. According to the census carried out in 2000, the total population of Brazil was 169.5 million. WEC/FAO state that less than half of the rural population in the north east have any supply of electricity. Moreover, in many regions the existing electricity supply is frequently interrupted and therefore only active intermittently.

\(^{40}\) In the second half of 1999 the name was changed to “Energy for All”, but despite this it is still mainly referred to as PRODEEM. In the state of Pernambuco the programme that is run jointly with the national government goes by the name of “Luz do Sol” (which is not to be confused with the project of the same name run by the Teotônio Vilela foundation in the state of Alagoas).
part of PRODEEM to date.

The cost of the PV modules, inverters, charge regulators, batteries and pumps, and of international transport, is borne by MME. As a counterpart contribution, the federal states, local authorities or responsible prefectures (regional governments) are expected to assume the cost of national transport, installation and installation materials (lamps, fuse boxes, cables, switches, plugs) and of upkeep (maintenance/repair).

In the past, however, it is in particular the long-term care of the installations that has proved to be a problem, as the prefectures have generally not satisfied their obligations, users have mostly not been called upon to make payments for operational maintenance, and ownership of the facilities has remained unclear. Exceptions to this rule are the installations in the area covered by the supplier CEMIG in Minas Gerais, which arranges for these to be fitted and maintained by its own technical personnel.

Apart from the active and financial involvement of the federal states and local authorities, the programme sets great store by the involvement of public utilities, banks and other domestic and foreign financiers. All in all, since the start of the programme several hundred systems have been installed. Precise statistics on the total number of systems installed in the past years and still in operation are not available, however.

International invitations to tender are conducted by MME, with the aid of CEPEL, for the central procurement of the necessary components. Results of an extensive invitation to tender for continuation of the programme in 2002 and beyond were announced in December 2001.

In December 1999 the Brazilian government launched the “Luz no Campo” programme. This scheme, which is mainly financed from a levy on the electricity tariffs (Reserva Global de Reversão – RGR), is intended to see to it that electricity is supplied to roughly 1 million rural households and buildings within four years. The programme is administered by Eletrobrás and is supposed to be networked with the country-wide programmes PRODEEM, PROCEL (for saving electricity) and Comunidade Solidária.

A total of R$ 1.77 billion is available from the RGR, which is passed on to licensed regional public utilities and rural electricity cooperatives on a credit basis. The loans are granted at a low (for Brazilian circumstances) interest rate of 5 %/a and have to be repaid within seven years.

The cost of connecting rural households is calculated to be between R$ 1000 and 2000 (DM 1100 to 2200), which is roughly equivalent to the connection costs for a solar home system. Preferential conditions are pos-

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41 Presidial Decree of 2.12.1999

42 Further details of the promotion conditions are given in the “Manual de Habilitação” published by Eletrobrás in January 2000.
sible for the disadvantaged regions of the north, north-east and mid-west, so as to bring about a considerable increase in the low level of electrification found there.

The decree does not specify what type of electrification is involved. As well as extending existing networks, it is also possible to choose distributed solutions on the basis of fossil fuels or renewable energy. The interest of the major utility companies, however, is presently directed almost exclusively towards expansion of the grid, so in future too it is expected that a continuing proportion of communities/buildings will not be connected to the grid.

At the end of 1999 the Alvorada scheme (Plano de Apoio aos Estados de Menor Desenvolvimento Humano) was launched at the federal level. This earmarked the provision of funds to finance measures aimed at raising living standards in the least developed regions of Brazil for the period 2000-2002. Alvorada is to harmonise the ongoing or planned individual actions carried out by several ministries in the fields of health care, agricultural development, water supply, social welfare work, education etc. In order to supply energy to remote rural communities, it is planned to install about 12,500 solar power systems for schools and health centres under the leadership of the Ministry of Energy. The respective regional governments are responsible for implementation on location.

Independently of the national programme described above, it was contractually agreed in the course of the privatisation of the respective regional utilities in the state of Pernambuco and in Ceará to invest 2% of annual turnover (in Pernambuco equivalent to R$ 13 million in 2000) for the electrification of rural areas (in Pernambuco from 2008 onwards the amount will be only 1%).

Some states, in some cases supported by foreign donors, are implementing their own programmes for solar electrification, even if these are on a comparatively modest scale. One relatively major project involving licensing for an entire supply region is planned in the state of Bahia.

Interest in setting up distributed energy systems has diminished considerably since the utilities have been transferred into private ownership, to the extent that currently these are not making any investment in off-grid installations on the basis of renewable energy sources. On the contrary: the roughly 373 solar home systems installed with American support (DoE/NREL) in 1993 in Pernambuco and the 404 solar home systems and 15 PV installations for water pumps distributed as part of the German Eldorado programme in 1995 are largely left without adequate maintenance, even though the users contribute small sums of money for that purpose.

43 The target areas include rural districts and microregions in a total of 14 federal states, including all states in the north-east and the Amazon region.
Since 1996 Brazil has been involved in the international SolarPACES project (Solar Power and Chemical Energy Systems) project via the research establishment CEPEL (Centro de Pesquisas de Energia Elétrica). There have been no specific deliberations on the construction of solar-thermal power stations.

**Incentive Systems**

As already explained, in recent years the legal foundations have been put in place to clear the way for independent power producers and autonomous suppliers. These have free access to the interconnected network system and to the distributors’ networks if they pay the transmission costs. ANEEL drew up a comprehensive set of rules on how to calculate these costs in 1998, which is used to determine the transmission price for each individual case depending on the particular parameters (transmission distance, voltage level, quantity of electricity etc.). Law 9.648 of 27.5.1998 stipulated that when hydropower is used in output units between 1 and 30 MW the transmission tariffs must not exceed 50% of the prices normally applied.\(^4\)

Independent power producers can sell the electricity they generate to:

- a licensed electricity supply company (or network operator);
- consumers who are permitted a free choice of their electricity producers according to the minimum demand requirements described above;
- consumers who also purchase heat at the same time (in other words combined heat and power generation);
- consumer cooperatives, with the agreement of the local power utility;
- any consumer who proves that he does not receive a supply from the local power utility 180 days after entering into an electricity supply contract.

Given special licences, autonomous suppliers can exchange electricity with each other or sell surplus electricity to the local power utility. However, the network operator is under no legal obligation to purchase the electricity on offer from either independent producers or autonomous suppliers.

As well as the incentive systems for electricity from renewable energy described above, the following resolutions in particular are worthy of note:

ANEEL Resolution 112 of 18.5.1999 introduced simplified regulations for the approval of small hydropower plants and other installations run on the basis of renewable energy sources, including wind energy conversion systems. The erection and operation of such installations can be licensed by ANEEL.

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\(^4\) It is not yet clear whether this arrangement can also be applied to wind power. It can be assumed, however, that the procedure will be used accordingly in specific cases.
without the need for public tendering procedures.

ANEEL Resolutions 22 and 256 adopted in 2001 defined new methods of calculation and maximum figures for the setting of electricity tariffs by distribution companies. These include special “normative values” (valor normativo) which can be passed on to consumers as limit values for bought-in renewable energy (see Tab. 9). The figures for small hydropower and biomass, however, are still below the level for electricity from thermal power stations (with the exception of national coal).

**ANEEL Resolutions 22 and 256**

<p>| Valor normativo for various renewable energy sources (beginning of 2001) |</p>
<table>
<thead>
<tr>
<th>US-$/MWh</th>
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</thead>
<tbody>
<tr>
<td>Small hydropower</td>
</tr>
<tr>
<td>Biomass / waste</td>
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<tr>
<td>Wind</td>
</tr>
<tr>
<td>Photovoltaics</td>
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</table>

As a result of ANEEL Resolution 245 of 11.8.1999, a fund for the use of fossil forms of energy in isolated networks (CCC), originally set up to cushion the high cost burden in regions remote from the grid, was expanded to include financing of renewable energy sources, provided they replace petroleum products. The fund is presently provided with some US$ 300 million per year.

**Application of CCC to renewable energy sources**

An incentive programme for renewable energy (Programa de Incentivo a Energias Renováveis - PIER) has been a subject of discussion for a long time. The centrepiece of this programme is a revolving fund that is to be fed from various national and international sources of finance. These financial resources, administered by the national development bank BNDES, are intended for use to promote wind energy, solar installations for the provision of heat and electricity, and small hydropower. Some of the money is to be reserved for development and demonstration schemes and for rural projects. The electrification programme PRODEEM is also to be provided with 5 % of the total funds.

**Incentive programme for renewable energy**

The Senate Infrastructure Committee approved the programme at the end of June 2001. It cannot be deduced from this, however, that this financing route will actually be established. In view of the unresolved origin of the necessary funds and the lack of willingness on the part of the Brazilian state to furnish sufficient budget resources of its own for a programme of this nature, it remains uncertain whether this initiative will be implemented in practice.

**Other proposed legislation and state provisions**

As well as this, other proposed legislation is under debate, including a priority programme for developing wind energy in the north east of Brazil (Projeto de Lei 4673/01). Individual provisions at the state level which have been discussed in the past (for example to promote wind energy in Ceará) have so far not been adopted by the respective parliaments.
Brazil will also participate in the multinational Solar and Wind Energy Resources Assessment (SWERA) project, which is also supported by the GEF. In this project it is intended to improve the wind atlas mentioned above and to obtain similar information about solar irradiation as well. The country will be represented by the national space institute in the solar sector, and by the national wind centre in Recife in the wind sector. The research establishment CEPEL will also be involved. The project has been approved and is likely to start in 2002.

Exchange rate (11.12.2001):
1 Brazilian real = € 0.46

<table>
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<th>Operator</th>
<th>Output (MW)</th>
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<th>Locality</th>
<th>Start of operation</th>
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</thead>
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<td>Bahia</td>
<td>Caetité</td>
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http://www.aeb.org.br
Electricity Market

As long ago as the early eighties, the formerly state-owned electricity supply companies were divided up horizontally and vertically and subsequently privatised. The distribution companies were divided according to their regions of influence. However, no exclusive rights to certain regions were conferred when the licences were granted. Free competition in electricity generation and access to the grid was established once and for all in the Electricity Industry Act of 1982.\(^{45}\)

The Comisión Nacional de Energía (CNE) was established as the regulatory supervisory authority, which also watches over the price structure in the fields of generation and distribution\(^{46}\). Today the electricity sector is mainly in private hands, while the state is given a primarily regulatory and monitoring role.

As well as this, as far back as the seventies decentralisation of public administration was introduced, which resulted in the country being divided into 12 regions and the metropolitan area of Santiago.\(^{47}\)

The electricity supply system is divided into two large interconnected grid systems in the north (Sistema Interconectado del Norte Grande - SING) and centre (Sistema Interconectado Central - SIC) of the country, each with several power producers and distribution companies, and two territorial grids or separate supply systems in the south (Sistema Eléctrico de Aysén and Sistema Eléctrico de Magallanes), which are vertically integrated and each operated by a power utility.

At the end of 2000 there was a total of 10,079 MW of generating capacity installed in the public supply sector, of which 6,038 MW comprised thermal power stations and 4,041 MW hydroelectric plants (see Tab. 10). In addition to this there is roughly another 340 MW from autonomous suppliers. The expansion of thermal capacity, in particular, has greatly increased since 1994, when only some 2,000 MW was available. In recent years most of the new power stations entering operation have been gas-fired plants. The SING interconnected network system is based almost exclusively on thermal power stations and exports a considerable proportion of surplus electricity to the central region, whereas the SIC mainly relies on generating capacities

\(^{45}\) Significant parts of the Act were amended and updated in 1998 by a Decree: 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.

\(^{46}\) The electricity tariffs for regulated customers are laid down twice every year (April/October) by the CNE.

\(^{47}\) The regions are numbered consecutively from north to south.
based on hydropower.

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Tab. 10
Installed capacity, generation and electricity sales in the Chilean interconnected network systems

In the year 2000 gross electricity generation in the public supply sector amounted to 39,290 TWh. The rates of growth remain very high, and in the past years they have sometimes exceeded the increase in gross national product. Since 1994 gross electricity generation has grown by an average of 8.5 %/a.

Despite the expansion in capacity, between the end of 1997 and May 1999 a period of extreme drought resulted in a far-reaching supply crisis and rationing of electricity distribution.

As a consequence of this, a new Electricity Industry Act was due to be adopted in November 2001, which sets out the legal basis governing the connections between the various distribution systems and defines responsibilities in the event of a failure of supply. At the same time it is intended to strengthen the customer’s side in cases of conflict.

As an additional consequence, greater exchange of electricity with Argentina is under consideration for the medium term. At present there is only one cross-border connection with the northern grid system. Thought is also being given to a transmission route to Bolivia.

As a result of the lack of precipitation and the growing significance of fossil energy sources, electricity generation from thermal power stations exceeded that from hydroelectric plants for the first time in 1998. In the following year, too, the importance of electricity from hydropower was considerably below the average for the previous years.

Wind Energy

Despite good natural potential in the north and south of the country, the use of wind energy has so far played only an extremely marginal role on account of the liberal energy policy with little tendency towards interventionism. To date, no targeted policy to promote the exploitation of this potential on any major scale has been included in the portfolio of government action, nor is any discernible for the near future. Emphasis on the primacy of competition leaves only limited room for manoeuvre for the exploitation of wind power, for example for supply in remote regions to relieve the high cost of diesel, or in non-electrified rural areas. Despite this, there are approaches in place to at least sound out the options for future applications in more detail and to put pilot schemes and demonstration projects into practice.

The University of Chile published a study of wind directions and velocities at 60 meteorological stations some time ago, in 1992. According to a more recent study by CNE, which was produced within the framework of a cooperation agreement with the USA, almost 3,500 families could be supplied with energy from hybrid wind-diesel plants on the 32 islands of the Chiloé archipelago in Region X. An initial demonstration project of this type has already entered service on the island of Tac. In this case electricity is supplied to 71 residential buildings, a health centre and a school by two small wind generators rated at 7.5 kW each, a battery storage unit and a 12 kW diesel generator via a 13 km-long island network system. Operation and maintenance of the system are the responsibility of a private company, which signed a supply contract initially for 10 years. Significant assistance funds were received from the national fund for rural development and from cooperation aid from the USA.

Other small projects of this nature have been implemented in three settlements in Region IX (Puaocho, Isla Nahuehuapi and Villa Las Araucarias), likewise with US support.

Since 1993 the power utility Edelaysen has had plans for a small wind farm with an output of 2 MW in Balmaceda in Region XI in southern Chile. In this case the wind power is primarily intended to replace electricity that is generated from diesel oil and is associated with high costs because of the long distances for transporting the fuel.

A more recent plan envisages the construction of a wind farm with a capacity of 37.5 MW for autonomous supply of the state copper company CODELCO. Currently wind measurements are being taken at three locations and a

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49 "Wind Energy in Chile: Evaluation of its Potential"
50 Altogether there are more than 32,000 inhabitants with no electricity supply in this region.
feasibility study is being drawn up, which should be completed in 2002.

The Research Center for Energy Industry Resources (CERE) at Magallanes University considers itself best qualified to conduct wind energy studies, although as yet it still has little practical experience.

Other Renewable Energy Sources

In the past, solar energy (photovoltaics) and small hydropower have been almost the only renewable energy sources of all those available to have been used.

For example, three small hydroelectric plants were constructed in indigenous communities on the Bio-Bio river (Region VIII) by CNE in conjunction with regional authorities as part of a demonstration project.

Initial studies indicate that sufficient water resources are available to install additional small hydroelectric plants, above all in the southern regions, VIII to XI. No reliable data about the potential is available, however.

Photovoltaic installations have been used in particular in the form of solar home systems in remote areas of the north as part of the programme for rural electrification (see below). Between 1995 and 1999 almost 1000 residential buildings were fitted with installations of this type 51. Since 1998, GTZ has been running a demonstration project on the use of PV water pumps in agriculture together with the University of Tarapaca/Arica.

Within the scope of a GEF project for which approval is still pending, 6000 PV systems are to be cofinanced in Region IV by 2005. They are to be installed and operated on the basis of a licensing contract.

Despite the prominence of agriculture in Chile, biomass has to date barely been used at all for electricity generation. In collaboration with the environment agency and with support and financing from UNDP/GEF, a project on “Generation of electrical energy by gasification of wood biomass” has been implemented by CNE in the town of Metahue on the island of Butachauques (Region X). A plant with an output of 40 kW was installed, which supplies electricity to 31 families. The plant is run by a cooperative that was founded specifically for that purpose.

The conditions for geothermal energy are also good on account of the volcanic zone in which Chile is situated, but so far this has only been exploited on a small scale in the Metropolitana region (Santiago).

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51 CNE states that between 1992 and 1999 as many as some 2500 individual PV installations were used on residential buildings, schools and health centres.
Rural Electrification

Of the population of roughly 15 million, some 15 % (amounting to 2.2 million) live on the land. In 1994 the rate of coverage of electricity supplies in rural regions was approximately 59 %, while virtually full coverage was achieved in the urban centres.

Against this background, at the end of 1994 the CNE launched the Programa de Electrificación Rural (PER), under which a level of supply of 75 % was targeted by the year 2000. When the new government came to power the programme was extended to the end of 2005, and a coverage rate of 90 % was set as a new target\textsuperscript{52}. As early as the end of 1999 a coverage rate of approximately 76 % was reported. Between 1995 and 1999 a total of around 90,000 households were either connected to the public supply or equipped with individual solutions (usually diesel generators). Altogether US$ 115 million of government funds were expended on this.

After the electrification of another 13,900 households in 2000 and an increase in the coverage rate to 78 %, by the end of the year there were still about 123,000 households without a normal supply of electricity. It is estimated that it could probably be arranged to supply 88,500 of them via the conventional grid while the remaining 48,500 or so households could be supplied either individually or through small isolated networks from renewable energy sources\textsuperscript{53}.

The PER programme is heavily decentralised and leaves it up to the regions to devise, evaluate and finance suitable projects. Each project is subjected to a rigorous assessment in order to determine the level of private investment and the corresponding assistance funds, which are linked to the achievement of positive social impacts.

Local distribution companies have a special part to play by submitting technical proposals. In the event of approval, a licensing agreement is concluded for rural electrification, which commits the electricity supply companies on the part of the local authorities to set up the supply and operate it over a certain period (at least 30 years in the case of distribution networks and at least 20 years in the case of supplies from renewable energy sources).

The investment costs for generating plants and distribution lines are borne by the local governments (60 to 70 %), the distribution companies (20 to

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\textsuperscript{52} Based on a total number of rural households of 622,500 in 2005.

\textsuperscript{53} According to details from a PDF B study in the run-up to a GEF application in 2001, as many as about 75,000 households form a potential market for non-conventional renewable energy sources (including some that at present already have supplies from diesel generators). According to this, solar energy, biomass and wind energy or combinations of these are the main energy sources. Most of these households are in Regions VIII and X.
30 %) and the users (10 %). The electricity customers pay for the meter, the wiring in the houses and for the electricity connection, and can pay the contribution required for this in instalments along with their normal tariffs.

The public funds come from a national fund for regional development (Fondo Nacional de Desarrollo Regional - FNDR), which was set up to promote the regions through various social sector projects. Within the framework of this fund, in 1995 a proportion of the resources was reserved for financing rural electrification (FNDR-ER).

For electrical systems with a power requirement of 1.5 MW or less, the law prescribes the agreement of maximum tariffs between the local administration and the distribution company.

The current phase of the PER programme until 2005 envisages government expenditure of US$ 180 million, which is to be used for the electrification of 98,000 households. As the degree of electrification in the regions is still fluctuating greatly between 64 and 98 %, efforts are being concentrated on the least developed areas in Regions IV and VII to X.

In these plans it is assumed that 90 % of the households will be supplied by extension of the network system, and the remaining 10 % by diesel generators. Increasing use could be made of renewable energy sources as well, however, provided the barriers to their introduction are overcome.

Incentive Systems and Legal Provisions

After what has been said, it will be no surprise that there are no incentive systems for renewable energy sources beyond the promotion of rural electrification. No specific legislation is in place either. Almost all activities in the electricity sector are subject to free competition and have to establish themselves on the market through economic efficiency.

The sole exception is in the field of geothermal energy. In January 2000 a law was passed on the granting of licences for geothermal sources. This law is intended to regulate and promote domestic and foreign investment in this energy sector. Further to this, a decree concerning possible geothermal energy sources was issued in June 2000 on the basis of this law and of studies by the National Geology and Mining Service (Servicio Nacional de Geología y Minería - Sernageomin).

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Electricity Market

With an installed capacity of 319 GW in 2000, China is the second largest electricity producer in the world. 81% of the roughly 1,370 TWh of electricity was generated in conventional power stations, mainly coal-fired, 18% in hydroelectric plants and 1% in nuclear power stations. Less than 1% came from non-conventional renewable energy sources.\(^{56}\)

Since 1999, the trend towards falling growth rates in electricity generation across the country (see Fig. 1) has come to an end, at least for the time being. The reasons for the slower increase in demand for electricity in the nineties were to be found partly in the considerably reduced rate of economic growth throughout the land and partly in the closure of a range of large state enterprises that were operating inefficiently (particularly in the steel industry), which were among the major power consumers in China.\(^{57}\)

\(^{56}\) Source: China Electric Power Information Center, Electric Power Industry in China 2001, Electricity September 2001 Vol. 12, No. 3


\(^{58}\) Source: China Electric Power Information Center, Electric Power Industry in China 2001, Electricity September 2001 Vol. 12, No. 3

\(^{59}\) Source: China Energy Databook, V 5.0; Lawrence Berkeley National Laboratory – Energy Research Institute

\(^{60}\) Source: China Statistical Yearbook 1999; Financial Times, 17 January 2000; "China Energy Market Series 2000". Last Updated on 5/19/00

\(^{61}\) Source: figures for the year 2000 from BTM Consult, International Wind Energy Development, Ringkoebing, Denmark
China still suffers from unequal regional distribution of electricity generation and demand. In some regions of the country, above all in the north and west, overcapacity has been noted since 1997 to an increasing extent, whereas in the prospering coastal regions there have repeatedly been electricity shortages. About 15% of the generating capacity is located in remote areas which are not integrated into the regional network systems. More than half of this is installed in small hydropower plants, a further quarter in diesel power stations.\(^{62}\)

In the course of the nineties, the size pattern among the country’s power stations changed in favour of small plants of less than 50 MW and large plants of over 300 MW. Lower-capacity power stations were built in particular by independent power producers on the basis of power purchase agreements (PPAs).\(^{63}\) This trend was temporarily brought to a halt by a moratorium on the approval of new generating capacity in the light of the unexpected overcapacity.\(^{64}\) Small units with old technology are now increasingly being decommissioned. At the beginning of 2001, around a third each of the country’s power stations were rated at up to 100 MW, 100 to 300 MW and over 300 MW respectively.\(^{65}\) Power stations with a total capacity of 70 GW that are at the planning stage and have already been approved are not subject to the limitation on additional building, which initially applied until January 2002.

Given favourable economic development, a considerable increase in demand for electricity in accordance with the current trend is forecast for the coming years. In line with this forecast, according to the five-year plan the electricity generating capacity is to be expanded to 390 GW by 2005.\(^{66}\)

The SDPC that emerged from the State Planning Commission (SPC) in May 1998 is responsible for drafting the national economic plan, the five-year plan and the national long-term programmes for economic development of the country. As well as this, the SDPC is responsible for among other things the approval of all major projects and all foreign borrowing, and therefore also for all notable energy projects. Finally it is also responsible for the supervision of prices. The parts of the SDPC that are relevant to the electricity sector are the basic industry department (including sections for the coal industry, electricity industry and energy saving as well as renewable energy), the tariff department and the department dealing with the use of foreign capital. In view of its responsibility for planning, investment and prices, the

\(^{62}\) Kurt Wiesegart, Sektoranalyse Stromversorgung. Written for KfW and GTZ, October 2000

\(^{63}\) ibid

\(^{64}\) Source: China Country Analysis Brief; Energy Information Administration, April 2001


\(^{66}\) Source: Wang Zhi Xuan, Durchführung der Strukturadjustierung, saubere Kohletechnologie und Umweltschutz, Chinesisches Deutsches Symposium, SDPC/MWET-NRW, October 2001
SDPC has a key role in the formulation and implementation of energy policy.

Formally the Energy Research Institute (ERI) also belongs to the SDPC, although it exhibits great independence in its research strategy and its role in the debate on energy policy. The Ministry of Science and Technology (MOST) takes an active part in the formulation and implementation of energy policy with research and demonstration projects. The Academy of Science and the Academy of Social Sciences, which have a number of research institutes under their wing, are among the establishments associated with the Ministry.

In view of its responsibility for trade and industry, including the energy industry as a consumer and suppliers of energy and energy technologies, the State Economic and Trade Commission (SETC) is also an important player. The political and supervisory functions of the former Ministry of Electricity Production (MOEP) have remained with the Electricity Industry Department. The Resources Conservation and Comprehensive Utilization Department takes on a major role in developing a national supply of technologies in the field of renewable energy.

The State Power Corporation of China (SPCC) is a state-owned holding company that took over the entrepreneurial tasks of the MOEP, which was dissolved in 1998. At the end of 2000 the SPCC had more than 151 GW at its disposal, i.e. roughly half of the total capacity, in its own plants or subsidiaries. The five regional transmission networks and four non-integrated provincial network systems are operated by SPCC companies. The SPCC owns 26 provincial subsidiaries, and through these also has control over the supply of electricity in the districts. Only the capital Beijing, Inner Mongolia, Guangdong, Hainan and Tibet are supplied by companies in which the SPCC has little or no involvement.

As far as rural electricity supplies are concerned, the Ministry of Water Resources (MWR) is particularly active with small hydropower plants, in addition to the SPCC. In the meantime the MWR has also become involved in the field of wind energy. The Energy Division of the Ministry of Agriculture is also involved in rural energy supplies, although it concentrates on the use of biomass for non-electrical purposes.

As was the case in the previous planning period, in the current (tenth) five-year plan (2001-2005) and within the framework of the strategic “2010 Plan” the Chinese government is standing by coal as the basis for electricity generation. However, priority is to be given to relocating thermal electricity generation to the mining regions of the north-west in order to replace the transport of coal by the transmission of electricity (“Coal by Wire” programme).

At the same time the capacity of hydropower plants is being greatly expanded. Apart from the Three Gorges power station on the Yangtze, which after its completion in 2009 will have a capacity of 18.2 GW on its own, a further five river courses are envisaged for use by power stations with a total
capacity of 50 GW. Most of the hydropower and thermal power station projects are situated in the south-western and northern provinces, as a result of which the requirements for transmitting electricity in the direction of the east and south coasts will be considerably increased.

It is planned to link the five large regional transmission networks and a multiplicity of smaller networks by 2009 and to create a single national grid system by 2020. Investment of US$ 43 billion for expanding the transmission networks and of US$ 22 billion for electricity generation has been earmarked for the period up until 2005. The main emphasis will be placed on the Electricity Transmission from West to East programme.

The ongoing programme to extend rural electricity supplies, which has already achieved an electrification rate of over 98%, will be continued. According to the latest estimates, approximately 7 million households are still without electricity. Future priorities will be directed towards upgrading the rural supply networks and the utilisation of renewable energy for electrification in areas remote from the grid. The expansion of wind energy has been expressly included in the set of targets.

In order to encourage the investment of foreign capital in China’s energy sector, a range of measures have been taken in the past. These measures have included the following:

- Far-reaching reform of the Electricity Act with extensive provisions on foreign investment and on decentralisation of the electricity industry in 1995.
- Founding of the SPCC in 1997.
- Revision of the provisional set of regulations on foreign capital investment and publication of the Regulation for Utilization of Foreign Capital in China’s Power Sector by the Electricity Ministry in August 1997.
- Conclusion of an agreement with the United States of America on trade and investment concessions. Under the terms of this agreement, for example, the levies on capital goods in the energy sector were reduced for foreign investors.
- The establishment of several free-trade zones with clear concessions for foreign investors.

As of the mid-90s the Chinese government only allows the direct investment of foreign capital in the case of electricity generation.

All forms of participation, from small stakes to majority holdings in joint ventures, and also entirely foreign-owned companies, are possible in principle.

68 There is no such agreement with Germany or the EU.
The implementation of projects in the electricity sector as BOT and BOO projects has met with particular interest in recent years. These forms of cooperation are specifically promoted by the SPCC. In the light of the moratorium and poor experience with power purchase agreements (PPA), however, the interest of investors has flagged.

Despite the opening of the Chinese electricity market to foreign capital, according to a US study a range of restrictions is inhibiting the willingness of foreign companies to invest, above all in efficient and therefore lucrative large-scale installations. It is apparent from a number of publications that this situation has changed very little.

The fact that pricing in the Chinese electricity sector is oriented towards subsidies also limits the possibility for foreign commitment. The average regulated consumer prices for electricity vary greatly from region to region. In 2000, the average cost of electricity in Shanghai was Y 515/MWh (7.0 € cent/kWh), while in Guizhou it was only Y 251/MWh (3.4 € cent/kWh). The tariffs are differentiated according to customer groups, with commercial customers at the upper end of the price scale at 7.7 € cent/kWh, industry and households in the middle range, and tariffs for irrigation and in poor regions at the lower end (1.8 € cent/kWh).

The average selling price for electricity from power stations throughout the country is given as Y 300/MWh (4.1 € cent/kWh). However, prices vary between Y 200 and 600/MWh (2.7 to 8.1 € cent/kWh). The selling prices from foreign-financed PPA/BOT plants are at the upper limit of the scale. The purchase prices, to which costs of transmission, distribution, marketing etc. are added, and which in some cases are higher than the end users’ tariffs, can only be explained against the background of the huge shortages of electricity in some regions.

In July 2001 the SDPC announced that the previous method of price calculation that was founded on the cost base of individual power stations was to be replaced by a new model in future. According to this, the average generation costs of competitive plants will be used for setting the prices for newly built power stations. In the case of coal-fired power stations a pay-

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69 Source: Kurt Wiesegart, op.cit.
71 Allan Blackman, Xun Wu (Resources for the Future, discussion paper 98-50), Foreign Direct Investment in China’s Power Sector: Trends, Benefits and Barriers, September 1998
73 Source: Kurt Wiesegart, op.cit.
74 Source: China Daily
back period of 20 years is assumed, while for hydroelectric plants the period is 30 years. On the other hand, the power stations will no longer receive guaranteed returns.

Renewable Energy

In rural areas of China, away from existing supply networks, interest in utilising renewable energy sources is particularly great. In those areas renewable energy offers an economic alternative to supply from the grid and an appropriate, environmentally friendly alternative to diesel-powered plants.

The demand for energy in the remote areas correlates particularly closely with those areas’ potential for solar and wind energy and also small hydro-power, to the extent that these alternative forms of energy appear predestined for the electrification of rural areas of China. The high concentration of supply in some regions even allows the potential of renewable energy sources to be used for grid-coupled electricity generation. This applies in particular to wind energy.

In some fields the state of development in the use of renewable energy for electricity generation is far advanced in China in 2001, while in others it is clearly lagging. As far as grid-coupled utilisation is concerned, the capacity of small hydropower (plants with an output of less than 25 MW) is certainly important (approximately 25,000 MW), but wind energy is still barely significant at all (some 300 MW). Electricity generation from biomass or from geothermal or solar-thermal plants is negligible.

With regard to off-grid use, at present in China there are more than half a million installations in place for supplying electricity to households, divided roughly equally between small-scale windpower, photovoltaic and micro-hydroelectric installations.

A relatively large number of users in small settlement centres are supplied with electricity from renewable energy sources in isolated operation, mainly from small hydropower plants, to a lesser extent also from wind-hybrid installations and in individual cases from PV-hybrid or biomass plants.

At present (2001) there are two significant programmes on renewable energy technologies in off-grid areas, each pursuing different approaches: the Brightness Programme, which is financed by the SDPC with support from several bilateral donors (including Germany, Japan and the Netherlands), and the Renewable Energy Development Program (REDP), which is financed by the SETC with the aid of the World Bank and GEF funds.

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75 Source: GTZ China: Simply Fitting Human Needs, Beijing 2000
76 Source: Department of Basic Industries, SDPC, China New and Renewable Energy; 1999 White Book, April 2000
The aim of the Brightness Programme is to make a decisive contribution to the final electrification of the off-grid areas in the western provinces of China. By the year 2010 it is planned to supply electricity from wind or PV installations to the 23 million people who are currently still without an electricity supply. A capacity of 100 W per inhabitant is planned as a basic provision for this purpose. As part of the programme, border posts, relay stations, supply facilities for oil pipelines and railway signals are all also to receive electricity supplies in these regions.

During an initial programme phase about 8 million people are to be supplied with around 1.8 million individual systems, as well as 2000 villages, 100 border posts and 100 radio stations that are beyond the range of an economic connection to the grid.

Within the framework of the PV component of the REDP (the wind component is mentioned later in this section) a different approach is used which is based on strengthening the existing economic structure. The SETC will grant direct financial and institutional support for local PV companies so that they can procure, install and maintain off-grid PV installations with a total capacity of 10 MWp. These systems are then to be sold to households in rural regions of the western provinces of China.

Whereas the Brightness Programme has already been started, the launch of the REDP is scheduled for early 2002.

The utilisable wind energy potential is estimated to be 250 GW. The building of wind farms is being especially promoted in the north-western steppe regions with sufficient wind resources. About a quarter of the wind energy capacity installed so far in China has been set up with German financing.

In the solar sector German-Chinese cooperation has to date been only on a minor scale. At present, though, a focal area of cooperation is being developed in the decentralised use of solar energy for the electrification of remote regions, which the Federal German Ministry for Economic Cooperation and Development (BMZ) intends to promote with a further € 15 million over and above the € 84.4 million pledged at the end of 2000. Since the end of 2001 GTZ in conjunction with the SDPC has been implementing a programme spreading the use of solar energy and small hydropower plants in the provinces of Qinghai and Yunnan.

The current five-year plan, i.e. up to 2005, envisages the expansion of electricity generation from wind energy to 1.5 GW and from solar energy to 80 MW.

Biomass and small hydropower are also energy sources which, even if to a lesser extent, are ideally suited to the electrification of remote regions which are not connected to the grid. China has gathered many years of experi-

77 Source: bfai Länderreport; China – Länder und Märkte; December 2000
ence in the utilisation of biomass. More than 5 million biomass plants are in operation, although only a small proportion of these are used for the direct generation of electricity. By 2005 the installed capacity for electricity generation on the basis of biomass is to be increased to 80 MW.

The use of hydropower is mainly restricted to the western areas of China. Here too, though, currently only a fraction of the available potential is being used, primarily by large plants. At the end of 2000 the total installed capacity of all hydroelectric plants in China was approximately 79 GW, of which some 25 GW are classified as small hydropower plants. It is planned to increase the installed hydropower capacity to 95.3 GW and 125 GW by the years 2005 and 2010 respectively. Long-term planning envisages hydropower assuming a share of 28% of total electricity generation by the year 2015.

China is participating in the multinational Solar and Wind Energy Resources Assessment (SWERA) programme, supported by the GEF, with which it is intended to improve the general data situation at the regional level. The implementing agency on the Chinese side is the Center for Renewable Energy Development. The project is approved and is scheduled to start in 2002.

**Biomass**

Biomass has been used as an energy source in small furnaces from time immemorial in all rural areas of Asia, and is capable of expansion for electricity generation. There are mainly two methods that come into consideration for larger applications in China: the use of biomass (primarily bagasse) in combined heat and power plants with steam turbines, and the generation of electricity from biogas in gas motors.

For a number of years now it has been common practice in China’s sugar industry to use bagasse for on-site power generation in the larger factories. More than 800 MW is installed in the sugar provinces of Guangdong and Guangxi alone. Feeding surplus energy into the grid, however, is not commonly done in this expanding branch of industry. According to estimates in a World Bank report\(^78\) a potential of 700 – 900 MW of electrical energy would be available merely in the above-mentioned areas and Yunnan, which could be utilised at considerable financial gain.

There are however a number of obstacles impeding the expansion of electricity generation from bagasse, also impeding feeding into the grid:

- The present poor economic state of the Chinese sugar industry, which leaves no room for investment.
- A lack of understanding among managers of sugar mills.
- The lack so far of low-interest, long-term loans for generating

electricity from bagasse (low-interest loans with a duration of 3 years were granted until 1999 for on-site power generation only).

- A low level of payment for the electricity fed into the grid.
- The lack of a standardised set of regulations on electricity supply and payment.
- Not least, the seasonal nature of sugar production (and hence the availability of bagasse), which runs for only about 5 months of the year.

The advancement programme entitled Capacity Building for the Rapid Commercialisation of Renewable Energy (CCRE)\(^79\), set up in March 1999 initially for 5 years, promotes the generation of electricity from bagasse in CHP plant. \(^80\)

China is a world leader in the use of anaerobic biomass gasification plants. Along with millions of small and micro-scale plants, which mainly help to minimise the problems with liquid manure on farms, there are about 150 larger plants in which the organic content of industrial effluent (from the paper, sugar and pharmaceutical industries and from alcohol and food production) is gasified. If only 50% of the industrial effluent were treated, the quantity of biogas obtained would be equivalent to the present level of natural gas production in China.

**Hydropower**

China has the largest hydropower potential in the world at its disposal, mainly concentrated in the west of the country. The great distance from the areas that are rich in hydropower to the industrial conurbations where the electrical energy is needed makes it more difficult to exploit these resources.

Hydropower is mainly exploited in large-scale plants in China. Probably the best-known Chinese hydropower project around the world, because of its gigantic dimensions and the fear of damage to the environment, is the Three Gorges power plant on the Yangtze.

Small hydropower is generally only classified as renewable energy up to a unit size of 25 MW. The plants are mostly located in isolated networks that are operated by MWR. Applications on a smaller scale are also increasingly being supported by the Chinese government, without being directly subsidised by central bodies.\(^81\) Micro hydropower plants with outputs ranging from 100 W to 1 kW have a certain significance in some mountainous regions of China where there is plenty of water. These facilities are built in

\(^79\) [http://www.ccre.com.cn/English/English.htm](http://www.ccre.com.cn/English/English.htm)

\(^80\) Other focal areas of promotion by the CCRE programme are hybrid power plants for the electrification of rural settlements, biogas plants on an industrial scale, solar-thermal water boilers and grid-coupled wind farms

\(^81\) Primarily through preferential treatment at the time of application
small series in China, and thanks to their low price they are also exported. More widespread use is hampered by poor product quality, however.

GTZ is promoting the use of small hydropower in a project entitled Rehabilitation of Small Hydro Power Stations in the AR Tibet.

**Solar Energy**

Although the high cost of systems is an obstacle to a rapid spread in the near future, the generation of electricity from solar energy in large photovoltaic and solar-thermal plants is a highly promising prospect in China in the long term. Small systems for central supply to villages and micro systems for the basic electrification of households (solar home systems - SHS), on the other hand, are already ideally suited to remote regions of China even today.

The development of PV solar cells has a long tradition in China. A solar cell from Chinese production was demonstrated as long ago as 1959. In 1998 there were 7 factories in China manufacturing PV modules with a total output of 2.3 MW. The annual production capacity amounted to 4.4 MW. The price of single-crystalline modules from domestic production in 1998 was Renminbi 40-45/W_p (DM 10.50-11.80/W_p), and that of amorphous module Yuan 24-26/W_p (DM 6.30-6.83/W_p). Imports at that time cost Renminbi 45-60/W_p (DM 11.80-15.76/W_p), but were of considerably higher quality.

In recent years China has made notable progress in the development, testing and market penetration of photovoltaic technologies and thus has laid good foundations for solar energy making a significant contribution to the supply of electricity in China. It has to be said, however, that practical experience does not extend beyond the installation of a large number of relatively small solar power systems (total capacity 13.2 MW_p in 1999, see Fig. 2) for off-grid supplies to telecommunications installations, individual households and small industrial and agricultural operations.
More speedy growth in the number of installed systems, however, is impeded by the following obstacles:\(^{83}\)

- The Chinese government does not provide sufficient funds for further research into and development of PV technology.
- Only state-supported system suppliers enjoy public assistance, and generally speaking loans for system suppliers and installers are rare.
- Domestic production of PV components is based on obsolete technology and is consequently inefficient. It supplies products of poor quality which often do not stand up to international comparison.
- Poor maintenance and service work reduces the useful lives of the systems.
- Joint ventures with experienced foreign solar power companies are not sufficiently supported.
- There are no institutional foundations for granting loans for and financing SHS.

**Geothermal Energy**

Despite considerable resources, the generation of electricity from geothermal sources is underdeveloped in China. The potential that can be used directly for electricity generation because of the high temperatures available (> 150 °C) is estimated at 5.8 GW.\(^ {84}\) Only 30 MW of installed capacity is shared between a geothermal energy power plant with a capacity of 25 MW in Yangbaijing in Tibet and a number of smaller demonstration projects.

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\(^{82}\) Source: Commercialisation of Solar PV Systems in China, Center for Renewable Energy Development (Energy Research Institute), June 2000

\(^{83}\) ibid

\(^{84}\) Source: SDPC (Department of Basic Industry Development), China New and Renewable Energy; White Book 1999
Utilisable potentials are located along the east coast opposite Taiwan (Taiwan Geothermal Zone) and in the Yunnan and Sichuan region in Tibet (Yunnan Geothermal Zone). According to the government’s plans, the potential of the Yunnan Zone is to be developed in the next 10 to 20 years.

**Wind Energy**

The exploitation of wind energy is most promising in China, which is at the head of the world rankings with an estimated windpower potential of 250 gigawatts. Wind farms with a total capacity of almost 264 MW had entered operation by 1999, mainly financed by bilateral trade agreements and foreign loans. In 2000 a further 123 units with a capacity of 76.5 MW were installed, meaning that by the end of 2000, 720 wind energy conversion systems with a total capacity of over 340 MW were in operation (see Table 11).

In the province of Hubei, where wind energy has so far not been used for electricity generation, the exploitation of wind power is seen as an important option for improving regional electricity supplies and for reducing climate-changing gas emissions. Up until 1997 the Wuhan Science & Technology Commission (WSTC), which is responsible for the promotion of new technologies in Hubei, conducted wind measurements at various locations, with the measurements at the Lichuan site promising the greatest potential (average wind velocity over 7 m/s). These wind measurements are not of the necessary quality, however, in terms of completeness and consistency, to allow the proper planning of wind farms.

At the request of the WSTC, within the framework of the TERNA wind programme the GTZ has been supporting the conducting of wind measurements and a feasibility study for a site near to Lichuan in the west of the province of Hubei since mid-2000. If the results are positive, it is planned initially to build a 19.5 MW wind farm, which if appropriate is later to be expanded to 50 MW. The project is likely to be completed by mid-2002. The results of the feasibility study can then be obtained from the GTZ on request.

There are mainly two fields of application of significance for the use of wind power in China:

- the off-grid - or “domestic” sector and
- the grid-coupled - or “wind farm” sector.

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86 The Three Gorges hydroelectric plant on the Yangtze in the same province of Hubei is not likely to improve the electricity supply situation, or only insignificantly, because the electricity generated there is to be fed directly into the interconnected grid systems of the East China Power Company, which supplies the area of Shanghai, among others.
China is the world’s largest manufacturer of small wind power conversion systems (100 – 3,000 W; in the domestic sector) with about 170,000 installed units and a total capacity of 42 MW.

Larger units (100 kW or more) have only been built for about 10 years, either within the framework of joint ventures or under licence. In the past the demand for this type of turbine tended to be rather low, however, because in the 600 – 750 kW class the imported units are less expensive and have the reputation of being of better quality.\textsuperscript{87}

<table>
<thead>
<tr>
<th>Wind farm (Province)</th>
<th>Installed capacity [MW]</th>
<th>Number of turbines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhangbei (Hebei)</td>
<td>9.9</td>
<td>24</td>
</tr>
<tr>
<td>Zhurihe (Inner Mongolia)</td>
<td>4.2</td>
<td>28</td>
</tr>
<tr>
<td>Shangdu (Inner Mongolia)</td>
<td>3.9</td>
<td>17</td>
</tr>
<tr>
<td>Xilinhaote (Inner Mongolia)</td>
<td>1.0</td>
<td>4</td>
</tr>
<tr>
<td>Huitengxile (Inner Mongolia)</td>
<td>36.1</td>
<td>61</td>
</tr>
<tr>
<td>Chifeng (Inner Mongolia)</td>
<td>6.5</td>
<td>9</td>
</tr>
<tr>
<td>Donggang (Liaoning)</td>
<td>12.2</td>
<td>26</td>
</tr>
<tr>
<td>Hengshan (Liaoning)</td>
<td>5.0</td>
<td>20</td>
</tr>
<tr>
<td>Jinchu (Liaoning)</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>Xianrendao (Liaoning)</td>
<td>5.9</td>
<td>9</td>
</tr>
<tr>
<td>Tongyu (Jilin)</td>
<td>7.3</td>
<td>11</td>
</tr>
<tr>
<td>Rongchang (Shandong)</td>
<td>0.2</td>
<td>3</td>
</tr>
<tr>
<td>Changdiao (Shandong)</td>
<td>5.5</td>
<td>11</td>
</tr>
<tr>
<td>Sijiao (Zhejiang)</td>
<td>0.3</td>
<td>10</td>
</tr>
<tr>
<td>Hedingshan (Zhejiang)</td>
<td>10.3</td>
<td>19</td>
</tr>
<tr>
<td>Kuocangshan (Zhejiang)</td>
<td>19.8</td>
<td>33</td>
</tr>
<tr>
<td>Cangnan (Zhejiang)</td>
<td>1.2</td>
<td>3</td>
</tr>
<tr>
<td>Pingtan (Fujian)</td>
<td>1.1</td>
<td>6</td>
</tr>
<tr>
<td>Nanao (Guangdong)</td>
<td>43.3</td>
<td>113</td>
</tr>
<tr>
<td>Huilai (Guangdong)</td>
<td>7.2</td>
<td>12</td>
</tr>
<tr>
<td>Dongfang (Hainan)</td>
<td>8.8</td>
<td>19</td>
</tr>
<tr>
<td>Yumen Gansu (Gansu)</td>
<td>1.2</td>
<td>4</td>
</tr>
<tr>
<td>Dabancheng 1 (Xinjiang)</td>
<td>59.8</td>
<td>116</td>
</tr>
<tr>
<td>Dabancheng 2 (Xinjiang)</td>
<td>11.5</td>
<td>31</td>
</tr>
<tr>
<td>Buerjin (Xinjiang)</td>
<td>1.0</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>263.8</strong></td>
<td><strong>597</strong></td>
</tr>
</tbody>
</table>

In mid-1998 the Xinjiang Wind Energy Company (XWEC) was the first Chinese company to begin production of large wind turbines under licence from the German company Jacobs\textsuperscript{88}, for which it uses a high proportion of locally manufactured under licence from Jacobs.

\textsuperscript{87} Source: China online (http://www.chinaonline.com/); 12 March 2001

\textsuperscript{88} Since 2001 part of REpower Systems AG
produced components. By the end of 2000, 10 plants had been successfully installed and were in operation.

Some provinces in China, for example Inner Mongolia, have well-developed wind energy promotion programmes in place for rural areas which play an important role in the rural electrification of the country.

In 1996 the SDPC launched the Cheng Fengi ("Ride-the-Wind") programme to promote the domestic production of large wind energy conversion systems. The Shuang Jiai ("Double-Increase") programme, on the other hand (also launched in 1996) mainly promotes the construction of large-scale commercial projects.

At the end of 2000 the Asian Development Bank (ADB) launched a programme to promote clean and renewable energy sources. The project has a total volume of US$ 98 million and a credit volume of US$ 58 million. Up until 2003 it will support the construction of three grid-coupled wind farms with a total generating capacity of 78 MW. The planned wind farms are one of 30 MW at Dabancheng (Xinjiang), one of 24 MW at Fujin (Heilongjiang) and one of 24 MW at Xiwaizi (Liaoning). This is the first ADB-financed environmental project in China. It is being cofinanced by the Global Environment Facility (GEF) with a grant of US$ 6 million and an interest-free loan to the same amount. The GEF loan only has to be paid back in full if the project is economically successful.89

Assistance funds totalling more than US$ 500 million have been made available by international donors such as the World Bank, ADB and European governments in recent years for wind power projects alone. Germany has firmly pledged € 30 million for five wind farms and held out the prospect of further loans.90

**Promotion of Electricity from Renewable Energy**

Whereas some fields of application for renewable energy such as the generation of electricity from wind power, or photovoltaic systems in remote areas, or the use of biomass (in particular agroindustrial wastes in combined heat and power plants) can certainly make economic sense, the large-scale utilisation of these sources of energy is rarely competitive without government intervention, given electricity prices from coal-fired plants of less than 3.5 € cents.91

Despite considerable international support, the Chinese government is unable to bring itself to start explicitly promoting the use of renewable energy

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89 Source: Debra Lew, Jeffrey Logan, Incentives Needed to Energize China’s Wind Power Sector, March 2001
90 Source: Frank Sieren, Peinlicher Stillstand, in: Neue Energie, February 2001, p. 74
91 ibid
in the electricity sector. So far there have even been very few moves to create the infrastructural foundations to improve the tapping of these energy sources. There are no special governmental promotion programmes for generating electricity from biomass or decentralised electricity generation from hydropower, apart from a small number of uncoordinated promotion initiatives at the local level. The use of solar energy for the electrification of regions far from the grid is promoted on a decentralised basis by initiatives taken by some local and provincial governments.

The GEF project Capacity Building for the Rapid Commercialisation of Renewable Energy (CCRE) was launched in 1999. With financial support from the Australian and Dutch governments, the project aims to make a contribution to institutional capacity building and the implementation of demonstration projects. As a first step the Chinese Renewable Energy Industries Association (CREIA) was founded, which sees itself as an intermediary between the industry and the authorities and in this role aims to bring national and international project developers and investors together. One of the services that the CREIA offers is a database of the most important national and international projects in the field of renewable energy.\(^\text{92}\)

A set of regulations on connecting wind turbines to the grid was published by the Electricity Ministry of the time as long ago as 1994. According to this, the grid operators are obliged to purchase all of the electricity generated by the installations and to pay for it on the basis of standardised pricing principles. The price, which is negotiated in each individual case, is made up of the gross electricity generating costs, the taxes and levies to be paid and an “appropriate” return. The additional costs incurred by the distribution company through the use of wind-generated power may be passed on in full to the connected consumers throughout the province.\(^\text{93}\)

It should be noted, however, that these arrangements are a directive from central government. Implementation is therefore crucially dependent on the political will of the responsible provincial government. Initial indications that the regulations do not have the desired effect in some cases are the problems faced by the China Renewable Energy Development Project (REDP)\(^\text{94}\) mentioned above, which is supported by the GEF/World Bank.

The project, which was authorised in 1998, is to be restructured before the final signing of the contract with the Chinese government. It became necessary to modify the working plan because the expansion of the wind farms at Huitingxile, Zhangbei and Pingtan with a total capacity of 170 MW, which was to have been promoted by the project, was called into question. In-


\(^\text{93}\) Whereas the World Bank, however, talks of an inadequate return from the sale of wind-generated electricity, in an article in the journal Wind Energie Aktuell (G. Habenicht, China will den Wind ernten im Jahr des Tigers, 4/1998) it is stated “that electricity from wind power represents a lucrative business for the operator” and that the building of wind turbines has received enormous impetus from this.

\(^\text{94}\) http://setc-gef.newenergy.org.cn/english
stead of these three wind farms the intention is now to set up two considerably smaller sites (Chongming and Nanhui in Shanghai) with a total of 20 MW.95

The main cause behind the redesign of the project is the lack of willingness at the provincial level to pay the agreed purchase price for electricity from wind power. It is feared that in the course of the liberalisation of the Chinese electricity market, which aims to divide up the large regional network systems into smaller provincial distribution units, the higher electricity prices from wind farms will have a much greater impact on electricity consumers because they would have to be shared between a considerably smaller number of customers.

Beyond the regulation on the payment for electricity from wind turbines mentioned above, at present there are no comparable arrangements in China for electricity from other renewable energy sources.

The installation of wind energy conversion systems is promoted by the Shuang Jiai (Double Increase) programme, as mentioned in the section on wind energy. Local production of large wind power plants is supported by the Cheng Fengi (Ride the Wind) programme. The Brightness Programme promotes rural electrification through small off-grid electricity generation systems. All three programmes were launched in 1996.

The Chinese administration, however, is having great trouble with the operational implementation of its programmes and individual projects. Huge obstacles in the government machinery, for example, have resulted in only a third of the ambitious targeted objectives of the Ride the Wind project being achieved. Disputes over areas of competence (for example between the SDPC and SETC) and meaningless or currently unattainable regulations and directives make the handling of projects even more difficult.

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Exchange rate (4.12.2001):

100 Renminbi (RMB) = € 13.57

The Renminbi is also known as the yuan or kuai.

1 Renminbi = 10 jiao = 100 fen

95 World Bank Office Memorandum, 1 May 2001, Subject: Restructuring the China Renewable Energy Development Project (CN-PE-46829 and CN-GE-38121)

96 Loans amounting to US$ 30 million have to be administered by the SDPC, which recently has been demanding that 60 per cent of wind turbines must come from Chinese production. Because as yet there are no such turbines available on the Chinese market, importers of wind turbines would have to have blades and gearboxes produced in China. The German Federal Wind Energy Association writes in the February 2001 edition of its journal “Neue Energie” that against the background of the unstable Chinese market at present, barely any well-known wind-turbine manufacturer is willing to bear this enormous investment risk. Only two of these locally produced types of turbine had been installed by the end of 2000: one 600 kW turbine manufactured by Nordex and one 600 kW turbine by Made.
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COLOMBIA

Electricity Market

In 1992 the Colombian electricity industry experienced one of its most difficult years, when the hydroelectric plants failed because of a persistent drought and electricity rationing was the order of the day. Subsequently a reform of the sector was introduced with enactment of the Law on the Organisation of Public Services (Law 142 of 11.7.1994, Régimen de Servicios Públicos Domiciliarios) and the Electricity Law, Law 143 of 11.7.1994 (Ley Eléctrica). The generation, transmission, distribution and marketing of electricity were separated, and the previous regional monopoly of utility companies was broken up. In areas where there is no natural monopoly, in other words in generation and marketing, free competition was introduced, while the other areas are regulated and monitored by the state.

Operators of the interconnected network system, the regional transmission companies (Sistema de Transmisión Regional - STR) and local electricity distribution companies (Sistema de Distribución Local - SDL) therefore have to open their networks to every user and generator (non-discriminatory access).

As well as this, wide-ranging privatisation was introduced which affects all areas of the electricity industry and is not yet completed. The building of additional power station capacity is open to any economic actor within the framework of other legal provisions.

A national commission (Comisión de Regulación de Energía y Gas - CREG) was appointed to take care of regulation of the electricity market. This body regulates the general conditions for the efficient supply of electricity, step-by-step liberalisation of the electricity market through the promotion of competition, the setting of standards for the wholesale market (see below), free network access, transmission and distribution charges, tariffs for regulated end consumers, preservation of consumers' interests and matters pertaining to the vertical disintegration of the electricity industry.

Otherwise the state's tasks are essentially restricted to roles involving planning. The Unidad de Planeación Minero-Energética (UPME) in 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) and 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 stipu-

97 The access conditions for electricity generating companies are given in Resolution CREG-030 of 1996. General information on the legal requirements for regional electricity transmission companies and local distributors is given in Resolutions CREG-003 of 1994 and CREG-099 of 1997.
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

COLOMBIA

Generating companies whose plants supply power to the national interconnected system and have a capacity of at least 20 MW are obliged to participate in the wholesale market (Mercado de energía mayorista - MEM) that has been in existence since 1995\(^98\) and are either included in the load distribution arrangements or not, depending on their prices quoted. There is no preferential treatment for certain types of power station in this context. In order to prevent them gaining a dominant position in the market, no electricity supplier is permitted to provide more than 20% of the total generated quantity, including their capital involvement in other generating companies.

In the MEM the generators are lined up against the electricity traders, who sell electricity on to end consumers. Customers who are classified as large-scale consumers and to whom the regulatory rules therefore do not apply (see below) can take part in the wholesale market by concluding direct contracts with the generating companies.

Plant operators with a capacity of 10 to 20 MW can participate in the MEM voluntarily\(^99\), while those with less than 10 MW are basically excluded from the MEM. All electricity traders who supply electricity directly to end consumers from the interconnected network system are obliged to purchase the electricity through the MEM\(^100\).

Autonomous suppliers can use the interconnected network system to obtain replacement power or additional power\(^101\). Operators of combined heat and power plants can supply themselves or others with electricity and heat for industrial or commercial purposes\(^102\).

Electricity purchases in 2000 were for the most part transacted on the wholesale market through long-term contracts, with about 29% of the purchases also being made on the spot market (electricity bourse). The Colombian spot market is characterised by uncertain and widely fluctuating price situations that are brought about by the great dependence of hydropower on favourable precipitation. In dry years, for example, the average price in long-term contracts is regularly below the prices on the spot market. Because of the plentiful availability of water in 1999, on the other hand, the average price on the spot market fell to 32.7 pesos/kWh (previous year 52.3 pesos/kWh). At that time the average price for contractually agreed electricity supplies was 39 pesos/kWh. At the end of 2000 the spot market price was 55 pesos/kWh, and therefore considerably higher than the prices at the

**References**

\(^98\) Resolution CREG-054 of 1994

\(^99\) Resolution CREG-086 of 1996

\(^100\) Resolution CREG-053 of 1994

\(^101\) Resolution CREG-084 of 1996

\(^102\) Resolution CREG-085 of 1996
start of the year.

In October 2001 the average price for electricity bought under contract was almost 55 pesos/kWh, while the price for spot market electricity fell from a year’s high of 87 pesos/kWh in February 2001 to 47.5 pesos/kWh in October.

The number of unregulated consumers who can enter into free contractual arrangements with their suppliers or meet their requirements through an electricity trader on the spot market increased by 43 % to 1043 in the industrial and commercial sector in 1999 as a result of the change in the law to reduce the minimum demand and purchase. Since 1.1.2000 there has been no regulatory binding for any end consumers with a power demand of at least 100 kW or electricity consumption of at least 55 MWh/month. By mid-November 2001 the number of unregulated consumers had reached 3,118, accounting for more than 25 % of total electricity demand.

The supraregional transmission network (Sistema de Transmisión Nacional – STN) is divided between 12 companies which emerged from the old power utilities in the course of the vertical disintegration process, among them Interconexión Eléctrica S.A. (ISA) with a holding of 73 %. ISA, in which the state still held 76 % of the shares in 1999, is responsible for the coordination, operation and administration of the interconnected network system, as it was the former central grid operating company. Some of the co-owners of STN are also shareholders in ISA (for example EEPPM has 13.5 %). A disposal of state-held shares to strategic investors and to broad sections of the population was scheduled for 2001. The transmission companies are excluded from all forms of involvement in electricity generation or distribution.

<table>
<thead>
<tr>
<th></th>
<th>Public</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generating companies</td>
<td>15</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Transmission companies</td>
<td>8</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Electricity traders</td>
<td>37</td>
<td>65</td>
<td>102</td>
</tr>
<tr>
<td>Distribution companies</td>
<td>25</td>
<td>8</td>
<td>31</td>
</tr>
</tbody>
</table>

The regional and local networks already mentioned above are assigned to the distribution companies, in which electricity generating companies can have a stake of up to 20 %.

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103 Non-regulation for certain consumer groups has applied since 1.1.1997.
104 The other owners are: Empresa de Energía de Bogotá - EEB, Corelca, Empresas Públicas de Medellín - EEPPM, Empresa de Energía del Pacífico - EPSA, Electrificadora de Santander - ESSA, Distasa S.A., Central Hidroeléctrica de Caldwell - CHEC, Centrales Eléctricas de Norte de Santander - CENS, Central Hidroeléctrica de Betania - CHB and Electrificadora de Boyacá - EBSA
At the end of 2000 there were a total of 50 companies engaged in the field of electricity generation, more than 100 in electricity trading, and more than 30 companies in distribution (see Tab. 12). The proportion of private companies involved in electricity generation was 62 % in 1999. In the distribution field the proportion of private companies was 58 %.

Despite the prevailing growth in gas-fired power stations, electricity generation in Colombia is still clearly dominated by hydropower. The influence of the climate on this form of power has a considerable impact on the demand situation and prices.\textsuperscript{105}

Against a total available generating pool capacity of more than 13,000 MW (see Tab. 13), the maximum load in August 2001 was only 7,400 MW. However, in times of low rainfall the available power reserve can fall drastically, to the extent that if there is a revival in electricity demand again it is impossible to rule out the prospect of supply shortages. Because the electricity market recovered only slowly in 2000, however, the suppliers temporarily took individual power station units running on fossil fuels out of operation.

All in all there are 32 large hydroelectric plants and 30 thermal power stations, in some cases with several units, feeding electricity into the interconnected network system.

Among the power stations that are due to enter operation in the period from 2001 to 2004 there are several hydroelectric plants with a total capacity of more than 800 MW and a small number of gas-fired power stations. There are no plans to build additional coal-fired power stations.

The trend in electricity demand has been highly inconsistent over the past decade. After strong growth in the early nineties, the electricity sector grew by an average of only 2.4 %/a in the period from 1995 to 1998. In 1999 the demand for electricity actually fell by 4.1 % compared with the previous year as a result of the economic recession. Consumption only began to rise again in 2001.

\textsuperscript{105} It is true, though, that the dependence on hydropower, which was still over 80 % at the beginning of the nineties, is now much lower. During the past decade only one major hydroelectric plant was built, in 1992, rated at 1150 MW.
Gross electricity generation by the power stations in the interconnected grid system also fell in the period 1998 to 2000, and at 44 TWh in 2000 was only at approximately the level of 1995. Thanks to well-filled reservoirs, the hydroelectric plants contributed 75 % of the generated power, and the thermal power stations 25 % (see Tab. 14).

<table>
<thead>
<tr>
<th></th>
<th>GWh</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydropower</td>
<td>31,853</td>
<td>75</td>
</tr>
<tr>
<td>Thermal power stations</td>
<td>10,443</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>42,296</td>
<td>100</td>
</tr>
</tbody>
</table>

The electricity imports of 77 GWh and exports of 36 GWh in 2000 are low enough to be negligible. The power losses, however, at over 20 %, are plainly too high.

Sales of electricity to end consumers fell by 9.1 % in 1999, reaching 29 TWh. Roughly 50 % of consumption can be apportioned to the domestic sector, although demand from that sector has significantly decreased in recent years106.

The tariffs for end consumers show a highly varied picture. The average electricity tariff for households differs greatly from one supply company to another, despite state control. Whereas – to take an extreme case – Empresa de Energía de Cundinamarca collected 365 pesos/kWh on average from private households in the first half of 2001, the customers of another utility, Empresas Municipales de Energía Eléctrica, had to pay an average of only 112 pesos/kWh. The situation was similar for industrial consumers (which are not subject to any regulation). In that case the utility Compañía de Generación del Cauca charged an average of 95 pesos/kWh in 2000, while the rival company Empresa de Energía del Valle de Sibundoy billed an average of 244 pesos/kWh.

At the beginning of 2001 the Colombian electricity industry once again found itself in troubled waters. Attacks by guerrillas seriously affected the interconnected grid system at several points and led to the system being partially split up into isolated supply islands. Several electricity-exporting regions were cut off from the consumer markets, while some distribution companies are no longer capable of paying their debts to generators. At the same time the persistent problems in electricity supply have been a factor in putting some privatisations temporarily on hold.

106 The statistics reveal a level of consumption for 2000 that is at the same level as 1988. To a relatively small extent, however, a change in the allocation of agricultural consumption may also be responsible for this. The sudden growth between 1999 and 2000 in the field of trade and industry can be put in this connection.
Renewable Energy

The National Energy Plan of 1997 (Plan Energético Nacional) underlines the importance of renewable energy, but at the same time emphasises that so far only very inadequate use has been made of it\textsuperscript{107}. However, these energy sources tend more to be allocated to niche markets, in the field of marginal urban or non-electrified areas or in and around rural and isolated settlements.

A Development Plan for Alternative Energies (Plan de Desarrollo de Energías Alternativas) presented some time ago, in 1995, proposed measures that were intended to help promote the use of renewable energy sources. In practice, however, these announcements did little more than pay lip service, and had no discernible impact. Over the longer term it is likely that non-fossil energy sources will become increasingly significant in the Colombian energy balance because the scope of domestic fossil energy sources (natural gas, in particular) is very limited and the strong rise in demand accompanied by environmental requirements to be met at the same time will make it necessary to adopt alternative solutions.

Apart from the use of hydropower, including on a relatively small scale, the penetration of corresponding technologies in Colombia even in the electrification of rural regions is considerably lower than in other Latin American countries. No doubt the government’s lack of financial leeway has also played a part in this, as has the central authority’s partial lack of control over large rural areas of the country.

There are no statistical records of the use of renewable energy in isolated networks or for autonomous supply (in particular hydropower and the use of bagasse), so no precise details of the extent of the use of the corresponding technologies can be given here. Apart from the hydroelectric plants that supply power to the interconnected network system, there are roughly 250 small hydropower plants with a capacity of less than 10 MW which could be subjected to “repowering” (increase in output through modernisation) in the long term.

Experience with the use of solar home systems or installations exploiting wind energy has only been gained in a few isolated cases. A relatively large photovoltaic system was installed in 1995 in the district of Vichada to supply a small settlement with a school and health care unit. That said, large parts of Colombia have favourable solar irradiation conditions and usable wind potential is available in the coastal regions but also in the uplands.

In 1999 the Ministry of Mining and Energy initiated the implementation of 93 projects for rural electrification through the Institute for the Investigation and Application of Energy Solutions (Instituto de Investigación y Promoción de

\textsuperscript{107} At least in the field of electricity generation.
Soluciones Energéticas - IPSE). These projects concentrate on the expansion of existing networks and the establishment of standalone solutions, for example by installing diesel generators. Between 1998 and 1999 the rate of supply to the population increased from 81 to 84 %. In urban areas the index rose from 93 to 94 %, and in rural regions from 51 to 58 %.

The Colombian government created a framework for promoting the use of renewable energy sources with Law 697 of 3.10.2001. According to this law it is planned to set up a programme for the rational use of energy and the use 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 emphasis being placed on regions that do not have an electricity supply. Companies which manufacture or import components for exploiting renewable energy are to receive particular assistance. It remains to be seen in what way this law will be put into practice through relevant ordinances and resolutions.

At present there are no other incentive systems in force specifically focusing on the use of renewable energy, because the government is mainly relying on competition-oriented policy in the development of the electricity industry. It is still not yet clear, for example, whether tax-relief arrangements for environment-related investment can also be applied to projects in the field of energy generation. Hopes for the future are based above all on international financing solutions within the framework of the industrialised countries’ obligations relating to climate protection (Clean Development Mechanism).

**Wind Energy**

The generating and supply company Empresas Públicas de Medellín (EEPPM) intends to build a wind farm with an output of approximately 25 MW in the Alta Guajira region on the Caribbean coast. The site is in the vicinity of the coal port Puerto Bolívar with access to the national high-voltage system. Wind measurements dating from the 1980s are available, revealing average velocities of more than 9 m/s and relatively even wind distribution, such that an availability of about 40 % is assumed in initial calculations. As well as these favourable factors, however, the very high day-time temperatures and the considerable salt content in the air will also have to be taken into account when it comes to implementing the plans.

The total investment volume is put at approximately US$ 24 million. The electricity generating costs are estimated at around US$ 49/MWh.

Preparation for the scheme, which has been in planning since 1998, is being supported by the GTZ within the framework of the Terna programme. Since May 2000 EEPPM has been operating a wind measurement station close to the intended site. The environmental impacts as well as social and
cultural influences are to be analysed in the context of a feasibility study. The GTZ will advise EEPPM on the selection of the precise site and on assessment of the technical and financial possibilities. It is also expected that proposals to adapt the legal framework will be submitted to the appropriate ministries responsible for energy and the environment and to the regulatory authority CREG. In this connection it will be important, for example, whether existing sets of regulations for small electricity generating plants or run-of-river power stations are transferable to wind energy.

One particular challenge from the Colombian standpoint is the forecast of the generated wind power required for load planning and supply planning.

Exchange rate (11.12.2001):

1000 Colombian pesos = € 0.47

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CUBA

Electricity Market

Electricity supplies in Cuba are based mainly on thermal power stations fuelled by oil, natural gas or bagasse (4,230 MW in 2000\textsuperscript{108}) and on small hydroelectric plants with a total capacity of a little over 57 MW (see Tab. 15). The thermal power stations, of which 20 are under the authority of the state utility company Unión Eléctrica (UNE), 79 are combined heat and power plants under the Ministry for the Sugar Industry and one belongs to an independent producer, produced about 15,000 GWh of electricity, while the 25 hydroelectric plants (of which there is only one large plant with a capacity of 43 MW) produced a total of only 60 GWh\textsuperscript{109}. This meant that after a steep decline in electricity generation in the period from 1989 to 1993, which was mainly attributable to a shortage of fuels and to technical failures in obsolete power station equipment, production had once again reached roughly the level it held before the start of the "special period" (in other words since the collapse of the Soviet Union).

There are no details on hand of the current availability of the installed capacities, but the proportion of power stations that are not operational because of natural ageing, ongoing maintenance work or a lack of spare parts is relatively high. Although the peak load in 1998 was only just over 2000 MW, it was not possible to meet the demand in full.

The technical and non-technical losses in the transmission system amount to more than 20 %. One of the main problems is the lack of maintenance of the plants and the absence of suitable measuring equipment.

Central electricity supplies are supplemented by company-owned power stations for autonomous supply (in particular in the sugar industry) and by a large number of diesel generators and micro hydropower plants,\textsuperscript{110} which are used for autonomous electricity supplies in remote regions and are mainly the responsibility of the local authorities.

As only about 15 % of the island's total demand for crude oil can be met from domestic sources, and the oil, moreover, is of a very poor quality with a high sulphur content, Cuba is heavily dependent on imports – for which con-

\textsuperscript{108} Although the statistics provide no information about this, it can be assumed that these are only the power stations that are used for public supply. A further 150 MW or so in the form of small diesel generator sets and micro hydropower plants for the autonomous supply of remote villages and facilities is not likely to be included.

\textsuperscript{109} The figures quoted are taken from the information system for energy statistics of the Latin American energy authority OLADE. Their reliability must be partly open to question. Other sources quote average annual yields of 80 to 90 GWh for generation from hydropower.

\textsuperscript{110} With a capacity of between 8 and 500 kW.
vertible currency is required. Natural gas is obtained as a by-product of oil production and is subsequently utilised. Because of continuing restrictions on energy consumption and difficulties in procuring spare parts, interruptions to electricity supplies are a repeated occurrence.\footnote{As a consequence of the energy crisis, rising energy procurement costs, the economic burdens arising after the collapse of the Soviet Union and the USA’s blockade policy, energy consumption fell by roughly half from the end of the eighties to the mid-nineties. Between 1989 and 1992 alone, imports of crude oil fell from 13 to 6 million tonnes.}

<table>
<thead>
<tr>
<th>Type of power plant</th>
<th>Public</th>
<th>Auto-generators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal power stations (oil, ba-gasse)</td>
<td>3064.5</td>
<td>849.9</td>
</tr>
<tr>
<td>Hydropower</td>
<td>57.4</td>
<td></td>
</tr>
<tr>
<td>Gas-fired power stations</td>
<td>240.0</td>
<td></td>
</tr>
<tr>
<td>Diesel generators</td>
<td>74.7</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3436.6</strong></td>
<td><strong>849.9</strong></td>
</tr>
</tbody>
</table>

Source: OLADE, SIEE

The main generating, transmission and distribution facilities required for public supply (Sistema Energético Nacional - SEN) belong to the UNE or its subsidiary companies, which in turn is subordinate to the Ministry of Basic Industries; only a small proportion is operated by industrial factories, primarily for autonomous supply. The power stations in the sugar refineries are governed by the Ministry for the Sugar Industry.

The national transmission and distribution network reaches almost all parts of the country, with the exception of areas that are difficult to access because of the topography, offshore islands, and the areas surrounding some sugar refineries where separate grids are operated in some cases.

Building had begun of a nuclear power station, which had been planned with the help of the former Soviet Union, but this will presumably be put on hold indefinitely as the necessary foreign currency is not available to complete it. Two other nuclear power stations which were originally planned are certain not to be built in the foreseeable future.

On the basis of an exchange rate of 1:1 to the US dollar – in practice unrealistic – the electricity prices per kilowatt hour in June 2001 were on average 13.2 US cents for households, 9.5 US cents for trade and services and 7.8 US cents for industrial enterprises. The latter, though, do have to make their payments on a dollar basis in some cases. Tourism enterprises for foreigners are also affected by this rule, and have to pay a comparatively high electricity price averaging 12 US cents/kWh. A progressive tariff was introduced for households with the advent of the energy crisis; this resulted

### Areas of responsibility in the electricity sector

Transmission and distribution network

Nuclear energy

Electricity tariffs for end consumption

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\footnote{As a consequence of the energy crisis, rising energy procurement costs, the economic burdens arising after the collapse of the Soviet Union and the USA’s blockade policy, energy consumption fell by roughly half from the end of the eighties to the mid-nineties. Between 1989 and 1992 alone, imports of crude oil fell from 13 to 6 million tonnes.}
in a dramatic reduction in consumption.\textsuperscript{112}

The degree of coverage of electricity supplies is relatively good, at 96\% of the population. Only about 160,000 households do not have an electricity connection.\textsuperscript{113} Nevertheless, it is pointed out that only some 86\% of the population actually has a satisfactory standard of supply. Many households, for example in the vicinity of sugar refineries or small and micro hydroelectric plants and small diesel generator sets, have to be prepared for severe voltage fluctuations or very limited supply times each day.

In order to improve the supply of electricity and make better use of the natural energy resources in rural areas, therefore, consideration is being given to setting up one or more independent service companies which would be responsible for ensuring adequate equipment and maintenance of all separate grids.

### Renewable Energy

In 1993, and therefore at the height of the Cuban energy crisis, the Council of Ministers and the National Assembly launched the Programme for the Development of National Energy Sources (Programa de Desarrollo de las Fuentes Nacionales de Energía), one of the key areas of which is the exploitation of renewable energy sources. The programme stresses in particular the role of biomass, but it also underlines the need for other forms of energy. Implementation of this programme, which remains in force, is the responsibility of the Ministry of Economics and Planning (Ministerio de Economía y Planificación), although other governmental and non-governmental institutions are also involved.

In November 1994 the Cuban Society for the Development of Renewable Energy Sources and Environmental Protection was founded (Sociedad Cubana para la Promoción de las Fuentes Renovables de Energía y el Respeto Ambiental – CUBASOLAR). In the meantime this has taken on key tasks in disseminating knowledge and information about renewable energy and in cooperation and project development with foreign partners.

As a further measure the Technical University for Renewable Energy (Universidad Técnica de Energías Renovables - UTER) was founded by the Ministry of Higher Education (Ministério de Educación Superior) with the aid of CUBASOLAR in order to train experts.

Cuba is participating in the multinational project “Solar and Wind Energy GEF project SWERA

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\textsuperscript{112} As well as this, since the end of 1997 an energy saving programme has specifically targeted electricity consumption in private households.

\textsuperscript{113} At the time of grid expansion a minimum of 25 electricity customers per kilometer of grid was set as a limit. The costs per kilometer are quoted as approximately US$ 12,500.
Resources Assessment (SWERA)* supported by the GEF, in which it is intended to improve the general data situation at the regional level. The implementing agency on the Cuban side is the Agencia de Ciencia y Tecnología, which reports to the Ministry of Research. The project is approved and is scheduled to start in 2002.

Hydropower

The hydropower potential in Cuba is estimated at 650 MW, with annual power generation of 1300 GWh. This potential is spread between a number of relatively small rivers, and would have to be utilised mainly by the use of additional small and micro hydropower plants. The availability of the power generating plants installed at present is relatively low because of the seasonally fluctuating water levels and competing requirements from irrigation. The only large plant under discussion is an 80 MW project on the rivers Toa and Duaba in the east of the country, although putting this into practice has failed so far because of financial constraints.

Small and micro hydropower plants mainly supply electricity to villages in the mountainous regions. The potential is estimated at 25 MW, distributed between 400 sites. More than 200 of these sites are already being used to supply about 30,000 people and communal facilities. However, because of the limited capacities and the fluctuating availability of water the amount of power used per household is often greatly limited. The other 200 sites are to be developed primarily using systems produced in Cuba.

Biomass

Along with hydropower, the use of biomass for energy purposes is founded in tradition in Cuba and makes a considerable contribution to the energy balance. This is mainly accounted for by the more than 100 sugar factories, which for a long time now have been meeting their needs for heat and electricity by burning bagasse.

In recent times this process has been made more efficient, to the extent even that surplus electricity can be fed into the national supply network. The installed capacity of some 800 MW, however, is only available during the three to four months of the harvest. Despite gradual improvements, there are still considerable reserves in the use of bagasse in combined heat and power plants, which would allow them to make a significantly larger

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114 According to another source, 452 MW with annual generation of 1210 GWh.
115 Of 216 plants, by the end of 1998 only 168 were capable of operation, however, including the above-mentioned 24 small hydropower plants for public power supply. Several plants had been installed without the necessary transmission lines and transformers.
116 Of 156 sugar factories, only 113 were still in operation in 1998, for economic reasons.
contribution to power supplies. A negative factor, though, is the drastic decline in sugar production, which by 1998 was less than half that of 1990.

Other biomass potential that has so far gone partly unused is available through the additional use of plant residues from the sugar harvest and from residues from coffee and rice growing. The industrial production and use of biogas for electricity generation is still only in its infancy, and could be considerably expanded.

A new CHP plant for utilising bagasse and sugar cane straw will be built with financial support from UNDP and GEF, and will comprise an investment volume of some US$ 80 million.

There are studies projecting an increase in generating capacity for biomass from sugar cane cultivation by 500 MW by the year 2010. It is even being suggested as a possibility that by the year 2022 all electricity supplies can be provided on the basis of this form of biomass.

**Solar Energy**

The climatic conditions for utilising solar energy are excellent, with average daily irradiation of 5 kWh/m².

In recent years Cuba has launched a rural electrification programme on the basis of photovoltaics, to which non-governmental organisations and international donors are contributing. It aims in particular to supply the 700 health stations in regions remote from the grid within the framework of a special programme (Programa de Electrificacion Fotovoltaica a las Casas Consultorios del Medico de la Familia) and to provide a basic system for private houses (solar home systems for lighting and communications).

By 2000 about 240 health posts had been equipped with PV systems, as well as remote hospitals, schools and villages. By 2001/2002 all 1800 off-grid primary schools should have received a solar power supply. In order to reduce costs, Cuba is endeavouring to set up its own production of solar cells and modules (by the manufacturing company Industria Electronica de Pinar del Rio).

**Wind Energy**

Cuba has a long tradition of operating wind-driven water pumps produced locally. Of about 9000 systems that have been installed, it is estimated that

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117 According to estimates the electricity generating capacity could be increased by about 10% while maintaining the same level of sugar production, by making better use of bagasse.

118 In Boletin Alerta Informativa, No. 14 (Oct-Dic 2000) the following information is provided: in the 2000/2001 school year 382 of 1962 schools without an electricity supply were electrified, 259 of them with photovoltaic systems. It can therefore be assumed that the above-quoted objective will not be achieved by 2002.
Several hundred small battery chargers with an output of less than 1 kW were also operated before expansion of the national grid began in the 1960s, mainly along the north coast in the eastern provinces. The expansion of the grid together with the availability of diesel generators and cheap fuel greatly reduced the use of wind energy.

It was not until the late eighties that the Research Institute for Solar Energy (Centro de Investigaciones de la Energía Solar - CIES), which had been founded in 1984, and other scientific institutions began once again to develop small wind turbines and windmills for agricultural purposes. In 1991 the National Energy Commission of the time (Comisión Nacional de Energía), with support from Mexican partners, promoted the formation of a wind energy group, which later launched a provisional wind energy programme.

Once again with aid from Mexico, in 1994 CIES began to take wind measurements at 17 locations on the central and eastern north coast. In recent years long-term wind measurements have been carried out within the framework of a project to determine the wind potential at a total of 24 sites by the company INEL (Empresa de Ingeniería para la Electricidad, a subsidiary of UNE) together with CUBASOLAR. The usable wind potential is estimated to be at least 400 MW, but it could also be considerably higher.

In 1999 two wind energy conversion systems of 225 kW each were set up on the island of Turiguánó in the province of Ciego de Ávila as development-aid projects, which are intended to produce some 1000 MWh of electricity annually. In the same year a 10 kW system was erected in Cabo Cruz in the province of Granma. All of these systems feed the generated electricity into the public supply network. In 2000 an autonomous wind-diesel hybrid plant with an output of 10 kW began operation in Cayo Romano.

In April 2001 CIES announced the erection of two wind energy conversion systems in remote rural communities in the east of the country (province of Guantánamo). In one case a wind-diesel hybrid system is to be used, while in the other case a 50 kW installation is to feed power into the local network and help to supply social and communal facilities. Both schemes are being supported by the Spanish foundation LEIA.

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119 In this case, too, the figures quoted differ from one source to another.
120 The number of diesel generators is estimated at roughly 3000, 80 % of which are operated privately.
121 The institutions particularly worthy of mention are the Centre for Appropriate Technology of Camagüey (Centro Integrador de Tecnología Apropiada de Camagüey - CITA), the Study Centre for Renewable Energy Technologies (Centro de Estudios de Tecnologías de Energías Renovables - CETER) at the Instituto Superior Politécnico "José Antonio Echeverría", and the Research Group for Solar Energy (Grupo de Investigaciones de Energía Solar) in Havana.
122 Operational management of the systems, which were manufactured by Ecotécnia in Spain, is taken care of by the Organización Básica Eléctrica Integral (OBEI) in the province of Ciego de Ávila, a subsidiary of UNE.
Framework Conditions

The Cuban government is greatly interested in expanding the use of renewable energy sources and thereby substituting the import of crude oil, at least in part, and stabilising energy supplies as a whole. Until now, though, practical realisation has been mainly limited to small projects for rural electrification and a few larger demonstration schemes with support in the form of considerable assistance from foreign contributors.

Foreign private investment is also welcomed, although in the past such investors have been deterred from making financial commitments because of the system of parallel currencies. The erection and operation of imported wind power conversion systems, for example, can only be economically acceptable if the remuneration for electricity supplies is on a dollar basis. This changeover to payments in foreign currency has already largely taken place in public institutions and in the parts of the economy oriented towards overseas trade. Consideration is therefore being given to developing renewable energy resources with foreign capital for example in tourist regions first, or for supplying selected industrial areas.

Legal provisions (Ley de Inversiones Extranjeras) fundamentally allow foreign capital to become involved in the energy sector. Entirely non-Cuban companies are allowed, as is also the formation of joint ventures with domestic companies in which foreign involvement can make up between 50 and 75%.

In the absence of any applicable regulations, in individual cases a contractual agreement is required with the relevant government bodies. The generation of electricity by the private sector with supply to the public network is only just beginning in Cuba, and is therefore of only limited use as a reference.

In 1998 the first independent power producer supplying the public network began operation, based on a quasi-public company (Energas) for the use of accompanying gas from oil production, in which the UNE and the state oil company Unión Cubapetróleo (Cupet) are involved in addition to the Canadian investor.

In October 1998 a first BOOT contract was signed with a foreign investor for building a power plant with a capacity of 11 MW on the Isla de Juventud, which entered operation in 2000.

An electricity industry law is in preparation which is intended to set out a new legal framework for the electricity sector, and is presumably working towards a single-buyer model.
Official exchange rate (11.12.2001):
1 Cuban peso = US$ 1 = € 1.12

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DOMINICAN REPUBLIC

Electricity Market

Since the early nineties, as a result of the Incentive Law to Develop the Energy Sector (Ley de Incentivo al Desarrollo Energético) nearly a dozen private (mainly American) electricity generating companies have been in operation in addition to the state electricity supply company CDE (Corporación Dominicana de Electricidad), which in the meantime provide more than a third of the installed generating capacity and which all without exception operate thermal power stations. Despite additional building in the power station sector, electricity supplies are characterised by frequent outages and a failure to meet demand. This is attributable to a considerable rise in demand, but is also a consequence of poor payment behaviour in the state sector, where bills from the private electricity supply companies for supplies to the public grid and for state duties and subsidies for certain consumer tariffs have not been paid. A growing burden of debt has therefore prompted the independent power producers to remove capacity from the grid and stop supplying electricity.

Law 141-97 on the reform of public enterprises, which was adopted in June 1997, initiated the privatisation of CDE along the lines of the Bolivian model. All constituent parts of the company with the exception of the transmission lines and the hydroelectric plants were put up for privatisation. Private companies were allowed to take a 50 % share of the capital and to take over operational management of the plants.

The generation, transmission and distribution of electricity were separated. Electricity generation was split into two companies engaged in thermal electricity generation (Itabo and Haina), 50 % of which was subsequently sold, and one company for generating electricity from hydropower. Private-sector involvement in the thermal power stations was also accompanied by the obligation to build an additional 100 MW of capacity per year and to bring the plants up to the World Bank standard within 5 years.

The power distribution grids were successfully capitalised in 1999. A group under the leadership of the Spanish company Unión Fenosa took over the northern and southern grids (Distribuidora Norte / Sur), and the American company AES the eastern grid (Distribuidora Este). Only electricity generation from hydropower remained with CDE.

Electricity generation with an installed capacity of 2,915 MW (as at end of 2000) is largely (84 %) based on fossil energy sources (coal, oil and natural gas).
gas), with the rest (16 % or 472 MW) based on hydropower. In 2000 alone the capacity was increased by about 400 MW, although all newly built plants use oil. Of this total capacity, however, only 2,270 MW was available in December 2000. The maximum required power in December 2000 was 1,670 MW. Despite technical reserves, on average approximately 19 % of electricity demand could not be met in the year 2000.

Net electricity generation in 2000 amounted to 9,522 GWh (compared with 9,032.8 GWh in 1999). Roughly 40-45 % of the generated power is lost as a result of technical and non-technical losses. The rate of unpaid electricity consumption from illegal connections, unapproved further transmission of electricity and poor payment behaviour is extremely high.

Between 1990 and 2000, net electricity generation grew on average by more than 12 % per year. Growth of 6 % over the previous year is expected for 2001.

The high level of dependence on fossil energy sources, which have to be imported, is a burden on the Dominican Republic’s balance of trade. In 1999 about 23 % of the country’s export earnings had to be used for buying oil and petroleum products.124

Despite the state’s debts which remain unpaid, Unión Fenosa and Enron signed an agreement in October 2000 to build a new 500 MW gas-fired power station in Punta Caucedo. AES also intends to build a 300 MW gas-fired power station. CDE itself is currently building a 300 MW CCGT power station at San Pedro de Macoris, which is expected to be completed in the first quarter of 2002.

Regulation of the market is supervised by the Superintendencia de Electricidad. This relates in particular to price supervision for regulated consumers (domestic and commercial), which have to obtain their electricity from the licensed distribution companies. Large-scale consumers, on the other hand, are free to negotiate their power purchasing arrangements with the supplier offering the best price at the time. Since June 2000 there has been a spot market for electricity, through which a small proportion of short-term electricity sales are handled. The marginal costs for short-term electricity supplies (only energy, not demand) were on average roughly US$ 100/MWh in December 2000.

A general electricity act (Ley General de Electricidad, No. 125-01) was approved by parliament and came into force at the end of July 2001. This law is intended to set out the general conditions for further private involvement, to give customers better legal protection against electricity suppliers and to create a flexible wholesale market for electricity. Independent state enterprises will now be created for the transmission system and for operating the

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124 As a result of the high oil prices in 2000, financial expenditure rose by more than US$ 600 million in 1999 to around US$ 1.5 billion.
hydroelectric plants (Empresa de Transmisión Eléctrica Dominicana – ETED and Empresa de Generación Hidroeléctrica Dominicana – EGEHID, respectively). The tasks of rural and marginal urban electrification and coordination of the electricity companies along with the administration and implementation of contracts with independent electricity producers will be brought together in a new company known as Corporación Dominicana de Empresas Eléctricas Estatales (CDEEE), which will replace the previous CDE and at the same time act as a holding company for ETED and EGEHID.

Other key provisions in the new Electricity Act relate to the following areas:

- Ensuring that the spot market takes a share of at least 20 % of all electricity trading;
- Authorisation of power generators to install connecting lines to the interconnected network system or to their own customers (self-sufficient suppliers);
- Limitation of distribution companies’ ownership of generating plant to no more than 15 % of peak load in the interconnected system; renewable energy is excluded from this rule;
- Regulation of the electricity tariffs for customers of the public electricity supply with a maximum connected load of 1400 kW (until 2003, or 200 kW from 2005 onwards), if the customers do not enter into direct contracts with the suppliers;
- Regulation of the transit tariffs for the use of transmission and distribution facilities;
- If the prices and conditions are the same, companies which generate electricity from renewable energy sources will be given preference when it comes to sales and load distribution;
- Such companies will be exempted from national and local tax payments for five years;
- Creation of a national energy commission (Comisión Nacional de Energía – CNE) to develop energy-policy measures and long-term planning of the energy sector;
- Strengthening of the Superintendencia de Electricidad to establish it as an independent, neutral regulatory authority with far-reaching competences;
- 10 % of the fines for the theft of electricity are to be invested in an incentive fund for developing renewable energy.

The duties of the CNE include in particular the elaboration of laws and ordinances, the preparation of forecasts of demand and supply trends and the application of optimised programmes to adjust generating capacities.

Another new body to be set up according to this law is a coordination group (Organismo Coordinador) which above all harmonises the operations of the various power producers and network operators with each other and ensures that the necessary capacity is made available. Its highest authority is a coordination council, which is headed by a representative of the Superintendencia de Electricidad and is otherwise made up of one representative...
from each of the private utility companies, the state hydroelectric plants and the field of transmission and distribution.

**Wind Energy**

So far no use is made of the considerable wind resources. The National Renewable Energy Laboratory (NREL) in the USA in conjunction with USAID, Winrock and the U.S. National Rural Electric Cooperative Association (NRECA) has performed an initial assessment of the wind potential which can serve as a basis for relatively large wind power projects. The main objective of the study was to register the wind resources in all regions of the Dominican Republic and compile the results in a wind atlas.

The evaluation revealed that the best wind conditions are to be found in the extreme south-west (in the provinces of Pedernales and Barahona) and north-west (in the provinces of Puerto Plata and Monte Cristi) of the country, but also in exposed high-altitude areas of the interior, where sites can be used in particular for off-grid supply (rural electrification). There are also other regions along the coast, though, which have good wind conditions.

All in all some 1500 km² were identified as having good to very good wind potential (equivalent to 3 % of the total area of the country). A potential of more than 10,000 MW could be tapped in this area. 20 provinces have a potential of at least 100 MW, and in 3 provinces this even amounts to more than 1,000 MW. However, further studies would have to be carried out in order to examine the electrical transmission routes and accessibility more closely. If the locations with moderate wind resources are also included, which can be utilised for rural electrification, the potential rises to more than 30,000 MW or 60 TWh/a. In that case 12 provinces have a potential of at least 1,000 MW. USAID is currently conducting a long-term measurement programme at several locations in collaboration with NRECA and Winrock/REGAE in order to improve the data situation further.

Plans to implement wind power projects on a larger scale are still at an early phase of development. As well as this, four wind farm projects each with a capacity of more than 100 MW by US, Canadian and Spanish project developers have advance approval, but in terms of detail they are still at the investigative or negotiation stage.

Because there is no separate set of regulations for wind power projects, until further notice all projects will have to follow the existing provisions applying to the electricity sector.

**Other Renewable Energy Sources**

The Instituto Nacional de Recursos Hidráulicos (INDHRI) is responsible for the management of water resources. This institute also issues licences for hydropower.
the use of water resources for energy generation, and ensures harmonisation with other forms of use, in particular irrigation in agriculture. Recently, with Taiwanese assistance, INDRHI has identified an extensive portfolio of possible small hydropower plants (100 kW to 2 MW) with grid connection potential and has developed them to the stage where they are ready for implementation.

According to a presidial decree of 8.12.2000 (No. 1277-0), the private sector is authorised under licence to use hydropower resources of no more than 1 MW. Conversely, this also means that all larger hydroelectric plants are assigned to the national interest and may only be operated by the responsible state-owned supplier.

GTZ is involved with Dominican partners in appraising a joint project to promote the use of renewable energy. The focal areas that are being pursued in this connection are the provision of advice on the shaping of legal and regulatory framework conditions and on management of the Fund for Renewable Energy, support for decentralised village supply networks with micro hydropower plants, and the promotion of PPP approaches in the field of renewable energy (especially wind power, small hydropower and solar-thermal energy).

Rural Electrification

It is assumed that across the country there are still roughly 250,000 households, most of them in rural regions, which are not supplied with electricity from the national grid\textsuperscript{125}. The great majority of these households has to manage without electricity for lighting, communications and productive purposes.

After the establishment of the special department for rural electrification within the CDEEE\textsuperscript{126} as described above, there is an expectation that the still considerable shortcomings in this sector will gradually be eliminated. The tasks associated with this are to be financed in part from the current earnings of the capitalised distribution companies and generating plants. 20% of the total resources from the relevant fund (Fondo Patrimonial) are earmarked for this.

The NGO NRECA has been active in the Dominican Republic in cooperation with Winrock International since 1996. Several projects in the fields of small wind energy conversion systems and micro hydropower have been identified and implemented in order to demonstrate the feasibility of public-private partnerships.

\textsuperscript{125} Richard Hansen, president of Soluz, Inc., estimates that of the 8 million inhabitants only 75% have a connection to the electricity network. In rural areas, which have a population of 3.2 million, he says that the electricity supply rate is 35%. Hansen therefore puts the number of people without a grid-coupled power supply at 2 million, equivalent to approximately 400,000 households.

\textsuperscript{126} Unidad de Electrificación Rural y Sub-urbana
partnerships.

In August 2001 USAID made funds available to draw up a national electrification plan for the Dominican government (represented by the department for rural electrification at the CDEEE) with the aid of NRECA. As well as expansion of the existing network, the aim here is to consider the opportunities for renewable energy technologies in off-grid regions and the way they can be financed.

At the same time the NGO Renewable Energy Growth Assistance Entity (REGAE) received financial aid from the American government to expand the use of wind energy, solar energy and micro hydropower through appropriate up-front measures.

Over the past few years the non-governmental organisation ADESOL (Asociación para el Desarrollo de Energía Solar)\(^\text{127}\), which originally began in 1984 as a small communal group, has built up a network of independent PV companies which offer systems to end customers in the form of credit sales. ADESOL provides a revolving fund for this purpose. In addition, development organisations at the provincial level and cooperatives have included PV financing in their standard credit programme for small businesses.

Since 1994 Soluz Dominicana, a subsidiary of the US company Soluz Inc., has been offering PV systems on the basis of a fee-for-service arrangement in its role as an energy service provider. The systems for basic electrification are financed either through fixed monthly payments or by means of short-term loans. Soluz installs the systems and takes care of maintenance. By April 2000 Soluz Dominicana had installed more than 3500 solar home systems, some 1700 of them with a fee-for-service contract. By 2003 it is hoped that a total of 5000 systems will have been sold on this contractual basis. In addition to small standalone PV systems, so far a limited number of wind power systems for rural households and small commercial enterprises have also entered service.\(^\text{128}\)

The non-governmental organisations REGAE, NRECA and Fondo Pro Naturaleza (PRONATURA) have implemented a range of schemes in the fields of renewable energy and rural electrification in recent years (solar home systems for basic electrification of rural households and communal facilities, micro hydropower plants for local village electricity supply) and in so doing have cooperated closely with rural regional development programmes (such as “Plan Sierra”) and village cooperatives. The programmes have largely been financed by the GEF (small project fund) and USAID.

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\(^{127}\) ADESOL is closely linked to the US NGO Enersol Associates, Inc. (http://www.enersol.org)

\(^{128}\) More detailed descriptions of the work carried out by ADESOL and Soluz Dominicana are given in National Renewable Energy Laboratory (NREL), Renewable Energy for Microenterprise, November 2000. See also: Eric Martinot (GEF), Making a Difference in Emerging PV Markets; Experience and Lessons from a Workshop in Marrakesh, Morocco, September 2000, Washington November 2000.
Over the past years the energy division of INDOTEC (División Recursos Energéticos) has carried out the installation of PV systems for supplying electricity to remote health stations.

Incentive Systems for Renewable Energy

In order to promote the use of renewable energy, at the end of 2000 the Dominican government passed a law on the taxation of consumption of fossil energy sources and petroleum products\(^{129}\). From the money raised it is intended to build up a special fund for the promotion of alternative forms of energy and energy-saving programmes, starting with 2 % of the revenue initially from the year 2002 (likely to be US$ 8 million)\(^ {130}\). The proportion will be increased by one percentage point every year until it reaches 5 %.

A (revised) draft of an incentive law for the development of renewable and clean energy sources was submitted to the National Congress for debate in October 2001\(^ {131}\). The draft law relates to wind power installations up to a total of 50 MW, electricity-generating solar installations of all sizes, hydroelectric plants up to 10 MW, and biomass power plants with an organic fuel content of at least 70 % and an output of up to 50 MW.

Among other things the provisions include tax exemption for imports of plants and systems for exploiting renewable energy for a period of five years, a five-year exemption from taxes on earnings from electricity generation on the basis of renewable energy, and accelerated depreciation of corresponding generating plant for a limited period.

Preferential arrangements are also envisaged for feeding into the public electricity supply network. In the event of falling oil prices, tradable compensation payments (bonds) are to be introduced in order to maintain the competitiveness of renewable energy sources.

At present it is unclear whether and to what extent this law will be passed, and this also depends on the form taken by relevant statutory instruments enacted within the framework of the new Electricity Act.

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129 Ley que establece un impuesto al consumo de combustibles fósiles y derivados del petróleo (112-00).
130 Fondo de Interes Nacional, for which the Trade and Industry Ministry is responsible.
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INDIA

Electricity Market

Although the situation has improved over the past 5 years, the Indian electricity market is still characterised by considerable shortfalls in its ability to meet peak loads (2000: 12% shortfall) and to cope with the demand for electricity (shortfall: 6%; see Fig. 3).

At the same time power requirements have risen considerably in recent years (see Fig. 3). An additional aggravating factor is that the targets set for expanding generating capacity have been missed by some distance. In the period 1999-2000 only 62% of the planned capacity increase was achieved. As neither the federal government nor the individual federal states have sufficient financial means to make new investment, private power producers have been willingly approved for a number of years now.

Despite this, only little over half of the declared target in the Eighth Economic Plan (1992-97) of a growth in capacity of more than 30,000 MW could

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133 The growth in capacity fell from 8.4%/a in the eighties to around 3%/a in recent years, in contrast to the demand situation, and to date has risen again only slightly.
134 However, the Indian government made it obligatory for independent power producers to enter into competitive bidding on a tender basis. This does not apply to projects on the basis of non-conventional energy sources though. Moreover, in the past a large number of private projects did not get off the ground because of long approval processes and a shortage of financing.
be met. At the same time over the past decade the proportion of hydro-power fell noticeably to Fig. 4).

In the course of the Ninth Economic Plan (1997 - 2002) the installed capacity was supposed to increase by about 40,245 MW, in particular in order to drastically reduce the shortfalls in the required quantity of electricity. In the first three years of the Ninth Economic Plan, however, a growth of only 12,179 MW was achieved, so the figures for the period as a whole have in the meantime been corrected to 28,100 MW. Additional efforts will therefore be required in improvements to the performance of existing power stations, reduction of the high level of transmission losses (currently estimated at 24.5 %) and on the consumer side (demand side management) in order to improve the security of supply.\textsuperscript{135} At the beginning of 2000, 57 projects (52 thermal and 5 hydroelectric plants) by private power suppliers with a total capacity of 29,376 MW had received implementation approval from the Central Electricity Authority (cea). 9 projects (2,624 MW) were still at the appraisal stage.

\begin{table}[h]
\centering
\begin{tabular}{|l|c|}
\hline
Type of plant & Capacity in MW \\
\hline
Conventional hydroelectric plants & 23,527 \\
Thermal power stations & 69,475 \\
Nuclear power stations & 2,240 \\
Non-conventional "renewable" power stations (mainly wind power plants) & 1,603 \\
\hline
Total & 96,845 \\
\hline
\end{tabular}
\caption{Installed electricity generating capacity in India on 31.1.2000}
\end{table}

\textsuperscript{135} Forecasts estimate the capacity requirements for 2010 at more than 200,000 MW.
Within the context of the programme for electrification of rural areas, in October 1997 the Ministry of Power defined the term “electrified settlements” much more narrowly. As a result, the degree of electrification in rural areas “fell” to approximately 71% in 1999. On the set date of 30.9.1999, according to the Ministry of Power’s figures more than half a million villages were electrified. The degree of electrification across the country was approximately 85%. As expansion of the grid makes economic sense in only a limited number of cases, supplies to remote rural areas will increasingly be provided by standalone solutions (diesel generators, small hydropower, PV systems, biogas systems).  

Although most of the growth in capacity will be based on conventional energy media (mainly fossil fuels), there is a highly favourable field of application for non-conventional forms of energy.

Primary responsibility for the electricity sector at the national level is borne by the Ministry of Power (MoP). The Central Electricity Authority reports to it in technical and economic matters. Public electricity generation and distribution is mainly the responsibility of 18 State Electricity Boards (SEB) and 13 Electricity Departments (ED - also at the state level), a municipal public utility company and 57 distribution licensees, 5 of which also operate electricity-generating plants. Alongside the state sector there are also a number of private electricity supply companies which hold licences in separate service areas. At the level above the state and regional system there are 5 central electricity-generating companies, among them the National Hydroelectric Power Corporation (NHPC).

The Indian electricity market has been open to private investors, both domestic and foreign, since 1991. Import duties and taxes were reduced for independent power producers and secured rates of return were offered. Despite this, the lack of other extensive reforms and the existence of numerous legal hurdles relating to approval have meant that endeavours to introduce privatisation have so far often been unsuccessful.

Considerable problems for the development of the energy sector result from the fact that some groups of customers (for example farmers) receive electricity at highly subsidised prices on account of traditional political preferences and that the state power utilities in some cases operate below a level that covers their costs. With the particular intention of introducing the urgently required tariff reform and making the payment of subsidies transparent, in April 1998 the Indian President promulgated a law on the establish-

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136 There are special governmental promotion programmes in place for this, which are partly financed from international funding sources.

137 Projects above 100 MW require technical and economic clearance by the CEA. However, this does not apply to hydroelectric plants up to a capacity of 250 MW.

138 In some cases electricity is even supplied free of charge. In contrast, industrial enterprises have to pay considerably higher tariffs than private households, for example.
The Central Electricity Regulatory Commission (CERC) that was then set up in response to the setting of tariffs by the state power producers, regulates electricity distribution across the country and advises the government on matters of policy relating to tariffs and competition. The State Electricity Regulatory Commissions (SERCs) set up at the level of the federal states regulate the generating and distribution markets in the various states.

One of the first stipulations of the Electricity Regulatory Commissions, according to which all tariffs were to have been raised to at least 50% of the supply costs, was axed again by the Indian parliament as soon as July 1998.

New legislation for the energy sector on the issuing of licences (concessions), on the expansion of competition, on restructuring of the generating and transmission sectors run by the SEBs and on privatisation of distribution tasks has been in force since 1998. Combined heat and power, the utilisation of renewable energy sources and self-generation in the industrial sphere are to be brought more and more to the fore.

As an initial measure, in August 1998 the Indian government approved a levy of 10 paise per kWh (0.23 € cent/kWh) on electricity consumption in order to promote public and private investment in hydropower projects. As well as this, the additional funds are to be used to pay higher prices to hydropower operators for peak load electricity. At the same time, the capacity limit for hydroelectric plants coming within the sphere of responsibility of the Ministry of Non-Conventional Energy Sources was increased from 15 to 25 MW.

Several federal states (including Andhra Pradesh, Gujarat, Haryana, Madhya Pradesh, Orissa and Rajasthan) have been involved for a number of years now in the introduction of reform programmes (and the formulation of corresponding legal provisions) with the aid of the World Bank and the Asian Development Bank.

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139 The Electricity Regulatory Commission Act of 25 April 1998
140 The Electricity Laws (Amendment) Act of 10 August 1998
141 Captive power generation
142 In the state of Orissa the Electricity Reform Law came into force earlier, in April 1996. As a result of this, the SEB was divided into two independent power producers for thermal (OPGC) and hydroelectric plants (OHPC), a grid operating company (GRIDCO) and four distribution companies. As well as that, large parts of the distribution sector were also privatised at that stage. The states of Haryana, Andhra Pradesh, Uttar Pradesh and Karnataka have likewise put the Electricity Reform Law into force in the meantime and have restructured their SEBs, transferring them into separate generating and distribution companies.
Renewable Energy

As far back as 1982, a department for non-conventional energy sources was set up in the Energy Ministry of the time. In 1992 this department was transformed into a separate ministry (Ministry of Non-Conventional Energy Sources - MNES).

The tasks undertaken by this ministry include the following:

- Management of a Commission for Additional Sources of Energy (CASE)
- Implementation of a programme for rural energy supply (IREP)
- Promotion and development of biogas plants and corresponding application programmes
- Small hydroelectric plants with capacity of less than 25 MW and geothermal energy
- Photovoltaics, including development, production and application
- All forms of ocean energy
- Supervision of the Indian Renewable Energy Development Agency (IREDA)

IREDA was set up in 1987 as a separate authority at the national level above all in order to take care of the financial management of the various research and application promotion programmes. By 31.3.2001, IREDA had promoted 1,450 projects and had approved assistance funds on a credit basis from national and international sources from a fund available at favourable interest rates amounting to some € 1 billion. € 485 million had already been paid out to the projects, of which roughly € 170 million had gone into the wind sector. A loan from the World Bank for wind energy projects amounting to US$ 78 million also contributed to this total. At the level of the federal states, bodies known as State Nodal Agencies operate as counterparts to the agency, mainly in the selection and promotion of renewable energy projects and the dissemination of relevant information.

During the Eighth Economic Plan (1992-97) there were ambitious targets to generate 2000 MW from renewable energy sources. Due to deficiencies in planning and financing, however, it was not possible to achieve this target in the scheduled period. In the year 2000 there was only 1.8 GW of installed capacity on the basis of renewable energy in India (see Fig. 5). Nevertheless, high-flown objectives were set once again for the current economic plan (1997-2002), at around 2,900 MW. In the meantime, however, the growth target for wind energy has already been halved to 1000 MW.

\[143\] Its status is a “Public Financial Institution”
Wind Energy

The use of wind energy has proved to be relatively successful, displaying notable rates of growth in particular in the period 94-97 as a result of corresponding promotion measures and the active commitment of the private sector (see Fig. 6). The target of 500 MW set for wind power in the Eighth Economic Plan was already exceeded in 1995.

In mid-2001 the installed wind power capacity totalled 1340 MW, although the availability of a considerable number of installations is likely to be limited because of technical defects. Almost 90 % of the wind energy conversion systems are located in only three federal states (see Tab. 17).

Fig. 5
Electricity generation from renewable energy sources, as at 31.12.2000

Fig. 6
Installed wind power capacity in India up to March 2000

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144 Source: Indian Renewable Energy Development Agency (IREDA)
145 Source: Ministry of Non-Conventional Energy Sources (MNES), Wind Power Programme, New Delhi 2000
The rate of growth has slowed considerably in recent years, and at times even came to a standstill. It was not until the second half of 2001 that a revival in the market could be recorded.

### Hydropower

Although the installed capacity of hydropower has steadily grown up to the present, its share of total capacity has fallen from over 50 % to 24 % in the past 40 years. In order to counter this trend, on 29.11.1999 responsibility for small hydropower projects (between 3 MW and 25 MW) was passed from the Ministry of Power to the MNES. The MNES had already been responsible for mini hydropower (< 3 MW) from 1989 onwards. The Ministry of Power is now only involved in large-scale projects (> 25 MW).

Mini and small hydropower plants are of great interest among private investors in particular, as they are especially well suited to electricity generation in remote and mountainous regions far away from the supraregional supply networks. Thanks to good state promotion, 271 mini hydropower projects (< 3 MW) with an installed capacity of more than 217 MW have been implemented in India to date. As a result, electricity generation from mini hydropower has more than tripled in recent years. At least 130 projects with a total capacity of more than 133 MW are still in the implementation phase.

The potential for mini hydropower plants is put at an estimated 10,000 MW. In order to further exploit this potential, a range of incentive systems were introduced in the current Ninth Economic Plan for plant up to 3 MW:

- Financial support for studies and expert reports
- Financial support for detailed project evaluations and reports
- Investment assistance

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**Tab. 17**

Installed wind power capacity in the federal Indian states (March 2001)

<table>
<thead>
<tr>
<th>State</th>
<th>Capacity in MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tamil Nadu</td>
<td>812.6</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>189.8</td>
</tr>
<tr>
<td>Gujarat</td>
<td>166.9</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>91.9</td>
</tr>
<tr>
<td>Karnataka</td>
<td>44.6</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>22.6</td>
</tr>
<tr>
<td>Kerala</td>
<td>2.0</td>
</tr>
<tr>
<td>Orissa</td>
<td>1.1</td>
</tr>
<tr>
<td>Others</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,339.8</strong></td>
</tr>
</tbody>
</table>

---

146 From 1989 to 1993 there was a governmental promotion programme that allowed up to 50 % assistance with investment costs for mini hydropower projects. By the middle of the 90s advancement concentrated mainly on the involvement of private investors in small hydropower. Small hydropower is also awarded a high priority in the current Ninth Economic Plan.

147 According to today’s definition, micro hydropower plants are plants rated up to 100 kW, mini hydropower plants up to 3 MW and small hydropower plants up to 25 MW.
Assistance with interest payments for commercial projects
Subsidies for the inspection, modernisation, refurbishment and expansion of plants

13 states have adopted regulations to promote small hydropower projects with in some cases considerable benefits and allowances, and in so doing triggered great demand among private investors. 700 locations with a total potential capacity of 1,000 MW have already been offered in these states, and for the most part they have already been allocated.

IREDA, the “financing authority” of the Ministry of Non-Conventional Energy Sources, offers low-interest loans for commercial projects up to 25 MW. 77 projects with a total capacity of 258 MW have already been approved and 24 projects with 53 MW have been applied for.

The MNES is implementing a GEF-assisted project entitled Optimised Development of Small Hydropower Sites in the Himalayas and Sub-Himalayan Area. In the course of this project it is intended to promote 20 demonstration plants and expand 100 existing plants.

India has a well-developed network of manufacturers and dealers which can provide the market with complete systems as well as components and spare parts. There are as many as 8 manufacturers in India even just for turbines for small hydropower plants.

Solar Energy

The conditions for thermal solar power plants on the Indian subcontinent are highly favourable on account of the natural environment. Above all desert-like regions with large unused areas of land are excellently suited to this purpose. In Mathania in the state of Rajasthan preparations are in progress to build a combined solar/gas power plant with a total electrical output of 140 MW. Two-thirds of the cost of the project are being met by funds from the Federal German Ministry for Economic Cooperation and Development (BMZ; € 60 million), market resources from the Kreditanstalt für Wiederaufbau (KfW; € 68.1 million) and a financial contribution from the Global Environment Facility (GEF; US$ 49 million). The remainder of the roughly US$ 242 million of investment costs is being raised by Indian institutions. Construction of the plant was put out to tender by the KfW at the end of 2001, and the plant is scheduled to enter operation in 2005.

In order to develop solar energy, the government in Rajasthan has also set up a solar energy enterprise zone in the districts of Jaisalmer, Barmer and parts of Jodhpur.

At the end of 2000, 15 grid-coupled photovoltaic installations with a total capacity of somewhat more than 1 MW<sub>p</sub> were in operation in 7 states. Nine of these installations have been promoted by the MNES. A further 10 installations with a total of 625 kW<sub>p</sub> had been applied for or were under construction...
at this time.

Standalone PV installations that are not connected to the grid as well as solar lighting systems and solar home systems are promoted by the MNES PV programme. So far 475,000 installations with a total of more than 15 MWp have been installed in India within the framework of this programme.

**Incentive Systems for Electricity from Renewable Energy**

The success of renewable energy technologies in India, primarily the strong rise in the use of wind energy, is attributable to a bundle of promotion measures by the central and federal governments. Research and development, the implementation of demonstration projects and entry into commercial investment projects has been made possible with subsidies, loans and fiscal incentives.

The financial and tax incentives include the following, in particular:

**At the central level:**

- Exemption from the obligation to obtain approval from the Central Electricity Authority (CEA) for power stations with an investment total below DM 45 million
- Up to 100 % foreign equity capital is permitted in electricity generation projects
- Electricity generation projects are supported according to the Build-Own-Operate principle
- Limited exemption from income tax (5 years)
- Accelerated depreciation (100 % in the first year in the case of investments)
- Preferential customs tariffs for the import of certain components
- Investment/interest subsidies

**At the level of the federal states:**

- Permission for the sale of electricity to the state electricity supply companies
- Permission for electricity transmission ("wheeling") to own customers ("captive power generation") or third parties
- Favoured consideration of demand at peak load times (freedom from power disconnections)
- Possibilities of "banking"
- Preferential treatment in relation to sales taxes (for example by deferral)
- Exemption from electricity tax in the case of auto-generators

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148 Permission is required from the Foreign Investment Promotion Board (FIPB)
Capital subsidies

In 1994 the MNES published an action plan for renewable energy. The plan contains guidelines on how the federal states should design their market incentive programmes for renewable energy sources in detail. The recommendations in this connection include the following:

- For electricity transmission: 2 % of the transmitted energy quantity
- Time span for banking: 1 year
- Payment for input to the network: Rs 2.25 /kWh
- Tariff for sale to third parties: on the basis of a negotiated price

The federal states have adhered to these non-binding guidelines as far as possible with the introduction of their regulations. The price for wind-generated electricity is currently between Rs 2.25 and 2.90 /kWh (5 to 6 € cent/kWh), depending on the state, with generally an annual surcharge being granted in order to adjust the price. These rates of remuneration, however, are mostly considered unattractive and are used by private investors to only a limited extent. The state of Rajasthan has launched a promotion programme for wind energy that aims to install 100 MW of wind power by the year 2004. Within the framework of this programme the Rajasthan State Electricity Board (RSEB) intends to purchase wind-generated electricity for Rs 3.03 /kWh (7 € cent/kWh).

It is generally worthwhile to sell the generated electricity to third parties, something that is now permitted in many states, or to consume it in one’s own facilities. As a general rule and depending on the distance involved, a nominal amount of 2 % of the input energy has to be “paid” for the transmission of wind power (in the case of hydropower the rates are in some cases considerably higher). The price for electricity supplied to end users is a matter of negotiation, but in the state of Karnataka is directly based on the rates of remuneration (input remuneration x 1.3).

In some cases a charge of 2 % is also payable for banking. The permitted periods for balancing transfers range between 6 months and a year, depending on the state.

In addition, some states grant subsidies of up to 20 % and a specified level of assistance, and offer favourable conditions for the leasing of state-owned

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149 This involves payment-free electricity trading: surplus electricity is supplied to the local electricity supply company for resale. The supplier is allowed to draw an equal amount of energy from the grid when he needs it, within a certain period of time.

150 “Guidelines for Promotional and Fiscal Incentives by State Governments for Power Generation from Non-Conventional Energy Sources”

151 By way of comparison: electricity costs for industry in the state of Karnataka, for example, are put at Rs 4.8 - 5.2 /kWh (11 – 12 € cent/kWh) with a continuing upward trend.
areas of land.

The table below (Tab. 18) provides an overview of the various state incentive systems, taking wind energy as an example.

<table>
<thead>
<tr>
<th>State incentive systems</th>
<th>Andhra Pradesh</th>
<th>Tamil Nadu</th>
<th>Karnataka</th>
<th>West Bengal</th>
<th>Madhya Pradesh</th>
<th>Maharashtra</th>
<th>Rajasthan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheeling</td>
<td>2 % of generated energy</td>
<td>20 % of generated energy</td>
<td>2 % of generated energy</td>
<td>-</td>
<td>2.25 RS/kWh</td>
<td>2.75 RS/kWh</td>
<td></td>
</tr>
<tr>
<td>Banking</td>
<td>12 months</td>
<td>2 % for 12 months</td>
<td>6 months</td>
<td>-</td>
<td>12 months</td>
<td>12 months</td>
<td></td>
</tr>
<tr>
<td>Electricity selling price</td>
<td>2.25 RS/kWh</td>
<td>specified on a case-by-case basis</td>
<td>2.25 RS/kWh</td>
<td>-</td>
<td>5 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual surcharge</td>
<td>5 %</td>
<td>specified on a case-by-case basis</td>
<td>-</td>
<td>5 %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity sales to third party</td>
<td>not permitted</td>
<td>not permitted</td>
<td>permitted</td>
<td>not permitted</td>
<td>permitted</td>
<td>permitted</td>
<td></td>
</tr>
<tr>
<td>Capital subsidy</td>
<td>max. 20%</td>
<td>-</td>
<td>-</td>
<td>as for other industry</td>
<td>30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other incentive systems</td>
<td>-</td>
<td>no electricity tax</td>
<td>no electricity tax for 5 years</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tab. 18 Incentive systems operated by the federal states for the generation of electricity from wind power (the arrangements for the states of Gujarat and Kerala are currently being revised)

The earlier generous systems of direct subsidies at the national level were discontinued at the end of 1997 and have so far not been replaced by new regulations. One exception to this is the provision of assistance payments of up to 60 % for demonstration wind farms for each state, each with a capacity of 2 MW. As well as this, extension of loans will continue for private projects via the governmental agency IREDA for up to 75 % of the investment costs at 11 - 14 % interest.

In the summer of 2001 the states presented the draft of a joint statement on renewable energy policy. According to this statement, the proportion of electricity generated in India from renewable energy is set to grow considerably (see Fig. 7). In detail the draft sets the following targets for the promotion of renewable energy in the medium term; these are supposed to be met by the year 2012:

- Attainment of a 10 % share (approximately 12 GW of installed capacity) of national power supplies from renewable energy sources
- Installation of solar water boilers in 1 million households

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152 Source: Ministry of Non-Conventional Energy Sources (MNES), Annual Report, 2000 - 2001
153 The Renewable Energy Policy Statement describes measures for ensuring basic energy supplies to rural areas. It addresses both a grid-coupled approach and an alternative off-grid method of supply from renewable energy sources.
Electrification of at least 4,500 rural settlements (25% of the 18,000 non-electrified villages)
Installation of 5 million solar-powered lanterns and 2 million solar home systems for lighting
Supply of optimised wood-burning ovens to 30 million households
Installation of small biogas plants for 3 million families

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Electricity Market

On account of its geographical position, Jordan is relatively poor in indigenous energy resources and consequently largely (97%) dependent on imports, which constitute a considerable economic burden\textsuperscript{154}. In 2000 expenditure on energy imports accounted for almost 9.3% of gross national product\textsuperscript{155}. The total installed electricity generating capacity in the year 2000 was 1,670 MW\textsuperscript{156} (see Fig. 8), and the peak load approximately 1,238 MW. The amount of electricity generated reached 7,375 GWh, representing a decline of 4.2% compared with the previous year. Higher growth rates are forecast for the coming years\textsuperscript{157}. Despite the present satisfactory level of demand coverage, it is therefore intended to build several additional new power station units in the course of this decade.

\textbf{Fig. 8}

Electricity generating capacity in Jordan according to plant type, in 2000

A new power station with an output of 450 MW, which is being built by a private operator, is not expected to be commissioned before 2003. In the meantime a 100 MW gas turbine is being added to the Rehab power station in order to ensure sufficient coverage of demand. As well as this, a power station fuelled with shale oil is to be built near Sultaneh. The deadline for

\textsuperscript{154} With special permission from the UN (Food-for-Oil programme), Jordan imports almost all of its oil requirements from Iraq.

\textsuperscript{155} Source: Ministry of Energy and Mineral Resources

\textsuperscript{156} 1,540 MW is installed in CEGCO plants (13 power stations) and 130 MW in a range of municipal plants belonging to the power distribution company IDECO and in industrial enterprises.

\textsuperscript{157} NEPCO assumes an average growth rate of 5.7% up until 2010, and the Ministry of Planning (MOP) a rate of 5%.
tenders for that project was May 2001.

In Jordan the generation, transmission and distribution of electricity is regulated by the General Electricity Law of 1996, which was amended in 1999\textsuperscript{158}. The law defines the tasks of the Ministry of Energy and Mineral Resources (MEMR) and of the newly founded regulatory authority (National Regulatory Commission - NRC), and in its amended version of 1999 it initiates the vertical disintegration of the state-owned National Electric Power Company (NEPCO), which had already been converted into a joint-stock company in 1996.

The fields of electricity generation and the sale of electricity to the distribution companies were disincorporated and transferred to the new General Electricity Generation Company (GEGCO). Furthermore an Electricity Distribution Company (EDCO)\textsuperscript{159} was created which supplies electricity to end customers outside the areas which the two existing regional distribution companies are licensed to supply. Electricity transmission and the task of load distribution remained with NEPCO itself. All three companies are still state-owned joint-stock companies.

The two regional distribution companies are the Jordan Electric Power Company (JEPCO), which is responsible for electricity distribution in Amman and central Jordan, and the Irbid District Electricity Company (IDECO), whose service area lies in the north of the country (see Fig. 9). The majority of JEPCO is in private ownership. NEPCO owns a holding of somewhat more than 50 % in IDECO, about 30 % belongs to the local authorities in the area covered by the licence, and the remainder is in private hands. Large-scale energy consumers such as industrial complexes, water companies etc. can also obtain their electricity directly from GEGCO or independent power producers. Conversely, power stations in industrial complexes also supply electricity to the distribution companies for supply to the public.

CEGCO and JEPCO are earmarked for privatisation, whereas NEPCO, with its central role as an electricity carrier, is set to remain in government ownership. The restructuring and privatisation activities are being accompanied by a study into reform of the electricity sector, which the U.S. Agency for International Development (USAID) was commissioned to conduct in 2000.

According to Article 4 of the Electricity Law, the regulatory commission is authorised to issue permits for the construction and operation of electricity generating plants, for transmission through the NEPCO grid and for distribution. In this connection, it is the intention of the government that independent private producers should increasingly come into play in the generating sector. The NRC examines sales tariffs and transit tariffs to ensure that they are justifiable, and lays down economic and financial ground rules for

\textsuperscript{158} General Electricity Law No. 10 of 1996 and Law No. 13 of 1999

\textsuperscript{159} The state holds 75% of the shares in GEGCO and EDCO, and NEPCO holds 25 %
awarding licences. The regulatory commission is therefore mainly responsible for granting licences for electricity generation, for regulating transit and for monitoring tariffs for end consumers. Payments for input at the high-voltage level and tariffs for large-scale consumers (wholesale prices) are freely negotiable and do not require the approval of the commission, provided they do not affect the prices for end customers.

All technical, financial and statistical data relating to the construction and operation of a plant has to be submitted to the NRC and to the MEMR. The MEMR checks that the requirements expounded in the Electricity Law and the associated statutory instruments are met by the power producing companies. Permits for electricity generation above 5 MW can only be obtained through a tendering procedure. There are no special conditions or exceptions from requirements for generating electricity from renewable energy sources.
The first plant that is being built by an independent power producer (IPP) according to the new regulations is the 450 MW CCGT power station at Kherbet al-Samra mentioned at the start of this section\textsuperscript{160}.

Jordan is involved in a project with Egypt, Syria, Turkey and Lebanon to join up their national grids. The Syrian and Jordanian grids have already been connected. The system interconnection between Egypt and Jordan was established in October 1998 through a 400 kV submarine cable across the Gulf of Aqaba; a second connection is planned.

The long-term marginal costs for electricity supply are listed in Table 19. The electricity tariffs are set at energy prices of 47 fils/kWh (7.5 € cent/kWh) and demand prices of JD 2.4/kW (€ 3.9/kW) and month for large industrial consumers in normal-rate consumption. On average (in a step tariff depending on consumption) 60 fils/kWh (9.6 € cent/kWh) is paid for domestic electricity. Agricultural consumers, in particular, receive electricity at a price below the cost recovery level.

Jordan has been almost completely\textsuperscript{161} electrified since the end of the eighties. There are now only a few individual cases of remote villages or isolated buildings without a connection to the power grid.

<table>
<thead>
<tr>
<th>Energy [JD/MWh]</th>
<th>Capacity [JD/kW/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak load</td>
<td>Cycling duty</td>
</tr>
<tr>
<td>Generation</td>
<td>29.0</td>
</tr>
<tr>
<td>High voltage</td>
<td>30.2</td>
</tr>
<tr>
<td>Medium voltage</td>
<td>31.6</td>
</tr>
<tr>
<td>Low voltage</td>
<td>34.7</td>
</tr>
</tbody>
</table>

**Tab. 19**: Long-term marginal costs for electricity supply in Jordan (Table from: TERNA - Wind Energy Project Jordan, Status Report 12/00; DECON-NERC)

**Renewable Energy**

At present, it is only in the field of the provision of heat that renewable energy sources have a relatively significant role. The available resources have barely been tapped at all yet for the generation of electricity. It is planned to increase the share of renewable energy in energy consumption to 5 % by the year 2010. According to the MEMR this is to be achieved mainly through power stations from private investors, thermal use of solar energy and solar water pumps.

In the past it has primarily been projects aimed at improving the infrastructure of rural regions that have attracted the attention of foreign financiers.

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\textsuperscript{160} The licence was granted to the Belgian company Tractebel for a Build-Operate-Own (BOO) model. The World Bank is furnishing an investment guarantee to the level of US$ 50 million.

\textsuperscript{161} According to information from the MEMR, the figure is 99.1%
For example, the UN Development Programme (UNDP) provided US$ 750,000 for a project to install wind and solar power plants for 200 remote villages in southern Jordan.

**Biomass**

A major project on the utilisation of landfill gas for electricity generation was completed in 2000. The UNDP-assisted project, with a total expenditure of US$ 5.32 million, was implemented by the Ministry of Planning, NEPCO and the municipal authority of Greater Amman. The operating company founded jointly by NEPCO and the municipal authority intends to generate 1.2 MW of electricity from gas recovered from organic wastes. Funding to the tune of US$ 2.5 million was made available from the Global Environment Facility to put the scheme into practice.

Another considerably smaller biogas plant, which is currently under construction, uses residues from olives for generating electricity. The project was set up within the framework of the PPP programme by the BMZ and is being implemented jointly with the German Investment and Development Society (Deutsche Investitions- und Entwicklungsgesellschaft - DEG). The investment volume amounts to € 655,000.

**Hydropower**

The hydropower resources available in Jordan are very limited, in view of the small number and yield of flowing surface water. Currently there are only two small hydroelectric plants, one with a capacity of 3 MW at the Aqaba steam power plant to make use of a downgradient in the cooling water outfall, and one with a capacity of 4 MW on the Zarqa river near Jerash.

In May 1998 Jordan and Syria signed a contract relating to a joint dam project with the exploitation of hydropower. The dam will be built on the upper Yarmuk river with assistance from the World Bank amounting to US$ 115 million. About 30 % of the generated electricity will be fed into the Jordanian grid.

**Wind Energy**

Jordan has considerable wind potential. In some regions of the country the wind velocities exceed 7 m/s. A revised version of the wind atlas for Jordan that first appeared in 1989 was published at the beginning of 1999. Particularly good conditions are found at two windy locations in the south near Shawbak and near Aqaba, where initial wind measurements were made.

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162 Source: Ziad J Sabra, MEMR; Wind Energy in Jordan – Use and Perspectives. DEWI Magazin No.15, August 1999

163 The wind atlas was compiled by the MEMR, the Jordan Meteorological Department (JMD), local institutions and the Risø National Laboratory in Denmark. The revision was carried out by the MEMR and the Royal Scientific Society (RSS).
taken in the nineties. The estimated potential output for these two sites, which have a good connection to the national power grid, amounts in total to about 50 MW.

Early experience with the use of wind energy was gained from 1988 onwards with a grid-coupled pilot project in Al-Ibrahemiya (totalling 320 kW). Since 1997 the installations of an Eldorado-financed scheme near Hofa with an output of 5 x 225 kW have been connected to the grid.

A hybrid system that was built in 1987 and supplies electricity to a remote community near Jurf El-Darawish in the south of the country consists of two 20 kW wind turbines, a 10 kWp PV system and a diesel generator rated at 65 kW.

As part of the TERNA wind programme, the regions around Aqaba and Shawbak are currently being investigated more closely to determine their suitability for wind farms. This includes comprehensive evaluation of the sets of measurements available from Aqaba and additional wind measurements in Shawbak. The results of a feasibility study are obtainable from GTZ and the MEMR as of early 2002.

In the meantime the MEMR has already requested tenders for three wind farms with a capacity of 25-30 MW each for the two above-mentioned sites and another one near Hofa. 40 companies were invited to submit an offer, of which about 10 expressed their interest.

In the course of this tendering process the MEMR drew up a sample contract for the supply of electricity (Draft Power Purchase Agreement) from wind energy conversion systems and agreed on its wording with NEPCO. The draft agreement is seen as being highly favourable for companies generating electricity from wind power and was sent to companies as part of the tender documents. As well as this, the MEMR offers wide-ranging financial securities and guarantees for project developers who want to invest in the advertised wind farms. As there was little response from the supplier side, however, it is to be anticipated that a search for potential investors and operators for the projects will have to be conducted again at a later date.

Solar Energy

The potential for solar energy in Jordan is very high. As long ago as 1983 a research centre for renewable energy sources (RERC) was founded by the Royal Scientific Society, mainly for the purposes of research into this form of energy and for testing technologies to exploit it. Establishment of the centre was given crucial support by the GTZ.

Photovoltaic systems separate from the grid are used in remote areas for

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164 These financial guarantees are fixed in the Draft Implementation Agreement. This document and the Draft PPA are public and are available on request from the MEMR.
pumping water, for radio and telephone stations and for supplying health centres, schools and a few small villages.

Jordan is participating in the multinational SolarPACES (Solar Thermal Power and Solar Chemical Energy Systems) project run by the International Energy Agency. A preliminary study on the fundamental feasibility of a solar-thermal power station was conducted in this connection. At present, however, there are no specific prospects of such a plant being built in Jordan.

**Incentive Systems for Electricity from Renewable Energy**

Under pressure from the World Bank and the International Monetary Fund, Jordan has made great efforts to reduce the presence of the state in trade and industry. A series of laws and other statutory instruments have noticeably improved the investment climate for private-sector enterprises over the past years. The most important instrument in this regard was the Investment Promotion Law No. 16 of 1995, the implementation of which is backed up and monitored by the Investment Promotion Corporation (IPC). This law provides for the following incentives for investment in electricity generating plants:

- 100 % exemption from taxes and customs duties for fixed assets and spare parts
- 25 % - 75 % exemption from income taxes and social security contributions for a period of 10 years
- Free repatriation/transfer of capital, profits and earnings from the sale of assets and winding-up of companies in foreign currencies
- State support in the settlement of disputes
- Protection against expropriation
- Accelerated depreciation applies, depending on the type of fixed asset

As explained earlier, according to current legislation private electricity producers can both supply the public electricity sector and take over direct supply to their own or other companies’ consumers. In either case, the regulatory authority has to issue an appropriate permit.

The same standards and principles apply to users of renewable energy sources as to all other power producers. At present there is no separate le-

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165 Other relevant provisions are contained in the Non-Jordanian Investment Promotion Regulation (Regulation No.30 of 1997) and the Regulation of the Investment Areas and Sectors (Regulation No.2 of 1996)

166 According to the law these plants come under the heading “Industrial Projects”. So far there are no special incentives in place. The introduction of a CO₂ bonus for electricity generated from renewable energy is under discussion.

167 In the southern parts of the country (economic zone C) the allowance is 75 %; the usual rate of income tax for companies is 15 %.
gal arrangement or preferential treatment for electricity generation on the basis of renewable energy resources. Environmental impact assessments are initiated and conducted by the General Corporation for Environment Protection (GCEP). The MEMR is not responsible in these matters.

Payment for the electricity that is fed into the public grid is also subject to the stipulations laid down by the regulatory authority. As no special assistance or concessions are provided for electricity generation from renewable energy sources, the projects have to submit themselves to a direct economic comparison with plants using conventional forms of energy. The long-term marginal costs listed in the table above and the results of future projects by independent electricity producers can be used as a starting point in that connection.

Exchange rate (20.11.01):

\[
JD 1 = 1000 \text{ fils} = € 1.61379 = US$ 1.41884
\]

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The World Bank Group, Jordan Country Unit; Hashemite Kingdom of Jordan; October 2001

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Regulation No. 30/1997: Non-Jordanian Investment Promotion Regulation


Information from the following Internet sites:

GTZ; http://www.gtz.de/wind/deutsch/projekte/jordan.htm

Ministry of Energy and Mineral Resources (MEMR); http://www.memr.gov.jo/

Ministry of Planning (MOP); http://www.mop.gov.jo/

Ministry of Industry and Trade (MIT); http://www.mit.gov.jo/

National Information System; http://www.nic.gov.jo

Royal Scientific Society (RSS); http://mars.rss.gov.jo

Sustainable Development Networking Programme; http://www.sdnp.jo/

National Electric Power Company (NEPCO); http://www.nepco.com.jo/

Central Electricity Generating Company (CEGC); http://www.cegco.com.jo/


UNDP Jordan; http://www.undp-jordan.org

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KAZAKHSTAN

Electricity Market

Since Kazakhstan gained its independence in 1991, the country’s electricity sector has been in the hands of the state-owned supply company Kazakhstanelnergo. Extremely poor paying habits among the country’s electricity customers made investment in the outdated, unreliable transmission and distribution network and in the obsolete power stations impossible, and together with a lack of spare parts and poor maintenance this has resulted in numerous power outages and in a general deterioration in the state of electricity supplies in the country (see Fig. 10). Entire regions were without power supplies during the recent winter periods. Even the industrial areas in the north of the country, which consume about 70 % of the electricity, have only been able to expect sparse supplies over recent years, despite the fact that their consumption has fallen by more than half since the collapse of the Soviet Union.

Fig. 10
Trend in electricity generation from 1992 to 1999

In the year 2000 Kazakhstan had 54 thermal power stations, primarily situated in the north of the country, 5 hydroelectric plants and one nuclear power station in Aktau. The total installed electrical capacity amounted to 17.5 GW in 1999, and was therefore 10 % lower than in 1995 (see Fig. 11).

168 94 % of the gas turbines, 57 % of the steam turbines and 33 % of the steam boilers have already been in service for 20 years or more. According to figures from the bfa Country Report for Kazakhstan of 5.3.2001 for 1998 and 1999, the losses in generation, transmission and distribution amount to more than 8 TWh per year (17 %–18 %).

Plans drawn up by the government envisage the construction of five new power stations using combined heat and power technology with a total capacity of 2,680 MWel in the coming years. It is also planned to build a 1,920 MW nuclear power station near to Lake Balkash, but in view of the high costs involved realisation of this project is doubtful.

Kazakhstan was one of the first of the Caspian states to open its electricity market in 1997, and it privatised almost all of its generating units. The state-owned power utility retained the poorly maintained and in some cases obsolete networks and the associated installations, and was transferred into the joint-stock company Kazakhstan Electricity Grid Operating Company (KEGOC).

In 1999 51% of the last power station still held in state ownership, Ekibastuz State Regional Power Station 2, was transferred to the Russian electricity supply company UES as payment for electricity supplies valued at US$ 249 million. Another important actor in the Kazakh electricity sector is the US company Access Industries. This company operates a 350 MW power station in the north of Kazakhstan and also two of the three coal mines in Ekibastuz, and thus supplies 70% of the coal to power stations in Kazakhstan.

KEGOC estimates the amount of investment needed to bring the transmission and distribution systems up to present-day requirements at US$ 258 million. The Electricity Transmission Rehabilitation Project was approved at the end of 1999, which envisages credit financing by the World Bank and the EBRD. The project covers the upgrading and modernisation of the Ka-s

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Kazakh networks, improvement of management and the establishment of an electricity spot market. It is scheduled to be completed in 2005.

Because of its geographical situation and its history as part of the former Soviet Union, the Kazakh transmission system is connected to those in its neighbouring countries. The northern network, in which 70% of the country’s electricity is generated and consumed, is connected to the Russian grid, while the southern network is connected to the Central Asian transmission system and to the northern Kazakh network via a 500 kV line. The western network has no connection to the two other national networks, but is linked only to the Russian grid, from which it also imports electricity.

In the north and west KEGOC cooperates with the Russian company RAO ES, and in the south with the national power utility companies in Kyrgyzstan, Turkmenistan, Tajikistan and Uzbekistan.

The privatisation of the distribution networks that was begun in 1997 has not yet progressed very far. Of the total of 18 regional distribution companies, the first two to be privatised were Almatyenergo and Karagandaenergo. In July 1999 management of the two distribution companies UST-Kamenogork and Semipalatinsk was transferred to the American AES Corporation, the largest foreign investor in the energy sector in Kazakhstan. In November 2000 the East Kazakhstan Region Electric Company, a subsidiary of AES, signed a fifteen-year contract with the Kazakh government for operation of the electricity grid in East Kazakhstan.

The electricity sector is subject to the control of the Authority for Natural Monopolies and the Protection of Competition, which reports directly to the Prime Minister. It approves the electricity transmission tariffs, the framework for which was laid down in a resolution passed on 19 August 1998. KEGOC is granted the right to apply for higher tariffs for transmission every quarter, if its costs have demonstrably risen. The regulatory authority also sets maximum prices for bilateral electricity sales contracts. Otherwise the contracts the electricity generating companies enter into with the distribution companies and large industrial customers are not subject to any governmental stipulations and are freely negotiable.

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171 With an area of 2.7 million km², Kazakhstan is the ninth-largest country in the world and is as large as Western Europe. With just 16.8 million inhabitants, though, it is only thinly populated.

172 The operator was Almaty Power Consolidated, a Belgian start-up, which has been sold back to the Kazakh government in the meantime.

173 The operator is National Power (U.K.) and Ormand.

174 AES holds licences with a duration of 20 years for two hydroelectric plants and four CHP plants with a total capacity of 1,300 MW. Since 1996 the company has owned the largest coal-fired power station in the country with an installed electrical capacity totalling 4,000 MW, i.e. almost 25% of the total national power station capacity. AES supplies 10% of the electricity customers in Kazakhstan.
Renewable Energy

The potential for renewable energy sources in Kazakhstan is very high, but it was never developed under the government of the former Soviet Union. It is only in recent years that the interest of the Kazakh energy industry in exploiting renewable energy has grown. The Kazakh government at all levels is highly interested in promoting renewable energy for the electrification of rural areas in particular. Wind power and small hydropower projects have especially large potential. Currently there are no specific plans for exploiting other renewable energy sources, such as solar energy, geothermal energy or biomass, and because of the relatively high investment requirements nor will any be developed for the time being.

Hydropower

The hydropower potential in Kazakhstan is concentrated in the eastern, southern and south-eastern parts of the country (95 % of the total potential) and is estimated at an annual figure of 170 TWh, of which 23.5 TWh is achievable from a technical and economic standpoint. To date, only 30 % (7.1 TWh) of this is being utilised.

The small hydropower sector (< 10 MW) is of particular importance for the electrification of the country. More than 450 locations in this output range with a total capacity of almost 1.4 GW and potentially 6.3 TWh of generating capacity have been identified so far. Table 20 shows the extent of the technically and economically feasible small hydropower potential.

<table>
<thead>
<tr>
<th>Capacity range</th>
<th>Number of projects</th>
<th>Capacity (in MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2 MW</td>
<td>227</td>
<td>250</td>
</tr>
<tr>
<td>&gt; 2 MW / ≤ 10 MW</td>
<td>226</td>
<td>1,131</td>
</tr>
<tr>
<td>&gt; 10 MW / ≤ 30 MW</td>
<td>54</td>
<td>973</td>
</tr>
<tr>
<td>Total / &lt; 30 MW</td>
<td>507</td>
<td>2,354</td>
</tr>
</tbody>
</table>

Tab. 20
Small hydropower development projects in Kazakhstan

Solar Energy

Although Kazakhstan counts among the northerly countries, it has relatively high levels of solar irradiation because of its dry climate. According to a report by the UNDP/World Bank there are some 5,100 remote villages without electricity which it would be uneconomic to connect to a supply network.

Source: Kazakhstan and Kyrgyzstan – Opportunities for Renewable Energy Development ; Report No. 16855 KAZ of the UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP), November 1997

2,200 – 3,000 hours of sunshine and irradiation of 1,300 – 1,800 kWh/m² per year
by the Japanese New Energy and Industrial Technology Development Organization (NEDO) revealed that the highly reflective surface of the ground in the desert and semidesert areas, which make up large parts of Kazakhstan, additionally increases the intensity of solar irradiation for photovoltaic applications.

There is a general requirement for solar energy applications for the electrification of remote rural areas, specifically through the use of portable solar home systems for supplying nomadic families.

**Wind Energy**

Thanks to its geographical and meteorological situation, Kazakhstan is one of the countries that is best suited to the utilisation of wind energy. In the past years, though, use of this energy source has not developed beyond the very early stages. The most significant barriers to its use have proved to be large, easily developable coal deposits and their use for electricity generation in central units, low-cost electricity imports from neighbouring countries, enormous gas and oil fields in the western parts of the country and a constant decline in demand for electricity in the nineties.

In the view of the state economic planning authority, the demand for electricity will begin to rise again in this decade. Against this background, from the economic standpoint there are good opportunities in the long term for using wind energy for electricity generation. Especially in areas that are far from the large coal-fired power stations in the north and north-east of the country, and which can only be supplied by incurring large losses because of the great distances involved, it can be expected that electricity generation from wind power will be economic in future.

A project for developing the wind energy market in Kazakhstan (Wind Power Market Development Initiative) assisted by the Global Environment Facility (GEF) was launched in 1995. So far two feasibility studies have been completed in this connection.

Meteorological data from the Kazakh authorities and data from independent organisations such as the US National Renewable Energy Laboratory (NREL) identify excellent conditions for large-scale generation of electricity from wind energy for two regions of the country, as described below.

The “Djungar Gate”, situated in the district of Alakolskij, is an outstanding site for wind turbines, with a forecast availability of 50%. The long, shallow mountain pass, which links two large plains to each other, lies on the border to China and has always been well known for its strong and persistent wind.

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178 According to the bfi Country Study “Kazakhstan Energy Industry” of 19.10.2000 the producer prices for wind energy in the year 2000 were US$ 0.05 – 0.06 /kWh and for electricity from coal US$ 0.01 – 0.02 /kWh.
The wind power potential of the region is estimated at 1 GW. A range of other favourable parameters make this area a promising site for wind turbines:

- The proximity of the area to a high-voltage transmission route
- Wind potential matching the load curve (considerably higher wind velocities in winter than in summer)
- Well developed transport routes
- A regional electricity sales market
- The possibility of exporting electricity to the neighbouring Chinese province of Xinjiang

The second outstanding location is the Chilik corridor, which lies between the towns of Chilik and Charyn, roughly 150 km north-east of Almaty. A technical availability of 35% has been calculated for this region. Data from the local meteorological station in Nurly and records from a 30-meter-high measuring tower revealed average wind velocities of 9 m/s in winter and 5 m/s in summer. The infrastructural parameters for wind farms are not as good in this region as in the Djungar Gate and would have to be developed first.

In 1999 the UNDP together with the Kazakh government initiated a demonstration scheme within the framework of the above-mentioned GEF project to construct a 500 kW wind turbine. Technical implementation has so far failed due to a lack of additional funding.

Other Renewable Energy Sources

Kazakhstan has a range of geothermal sites, although the temperatures of these are not high enough for electricity generation.

Interest in the use of biomass for electricity generation is very low. The reasons for this are as follows:

- Low, subsidised electricity prices
- Residues from agriculture are used for other purposes (composting, manufacture of fertiliser, direct combustion for cooking and heating)
- An uncertain future for animal production, which hampers investment in this field
- A lack of national experience with biomass technologies

Incentive Systems for Electricity from Renewable Energy

The Kazakh government is highly interested in expanding the utilisation of renewable energy sources for the southern parts of the country in particular.

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179 Average wind velocity: 7 – 9 m/s (peak velocities of up to 60 m/s), calculated from measurements at three local meteorological stations and a 25 m-high wind measuring tower.
Wind power and small hydropower projects are supported by the authorities at all levels by the best means available to them. In many cases, though, there is a lack of a coordinated approach. Responsibility for the development of renewable energy sources is spread between a range of institutions and organisations. There is as yet no multisectoral strategy to promote renewable energy. Consequently there are also no corresponding incentive systems or legal provisions.

In general terms there is a wide range of opportunities for foreign investors in the energy sector. The tax laws do not differentiate between domestic companies and those with foreign involvement.

Exchange rate (6.12.2001):
1000 tenge = € 7.88

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**MEXICO**

**Electricity Market**

Since nationalisation in the year 1960 nearly all of Mexico’s electricity sector has been dominated by the state suppliers, Comisión Federal de Electridiad (CFE) and Luz y Fuerza del Centro (LFC), who either own the power stations themselves or commit private plant operators to sell electricity. CFE produces about 92 % of the total electricity demand, while LFC with customers chiefly in the capital city contributes about 2 %\(^{180}\), and the state mineral oil company Petróleos Mexicanos (Pemex) about 4 %. The remaining 2 % is accounted for by private producers.

<table>
<thead>
<tr>
<th>Suppliers CFE and LFC</th>
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<table>
<thead>
<tr>
<th>Tab. 21</th>
<th>Generating capacities of CFE (end of June 2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MW</strong></td>
<td><strong>%</strong></td>
</tr>
<tr>
<td>Thermal power stations (on the basis of mineral oil or natural gas)</td>
<td>21,970.2</td>
</tr>
<tr>
<td>Coal-fired power stations Kohlekraftwerke</td>
<td>2,600</td>
</tr>
<tr>
<td>Nuclear power stations</td>
<td>1,364.9</td>
</tr>
<tr>
<td>Hydropower</td>
<td>9,389.8</td>
</tr>
<tr>
<td>Geothermal power plants</td>
<td>827.9</td>
</tr>
<tr>
<td>Wind energy conversion systems</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36,155.0</strong></td>
</tr>
</tbody>
</table>

At the end of June 2001 CFE, together with its external producers, had a total capacity of 36,155 MW at its disposal, distributed between altogether 154 power stations, including 64 hydroelectric plants, 79 thermal power stations, six geothermal power stations, two coal-fired power stations, one nuclear power station and two wind power sites (see Tab. 21). Autonomous supply units include some 390 MW at sugar refineries generated with bagasse, as well as 15 MW photovoltaic units\(^{181}\), which are mainly operated by private rural users and in isolated plants.

In the year 2000 CFE generated 191.2 TWh (incl. private supplies to the public grid), of which about 68 % was accounted for by diesel, heavy fuel oil and natural gas, and 10 % was coal-based\(^{182}\). Hydropower contributed

\(^{180}\) At the end of June 2001 LFC had a generating capacity of only 827 MW, but supplies nearly a quarter of all the country’s electricity customers, in Mexico City and the neighbouring regions. The electricity required for this is bought in from CFE. The company employs roughly half as many staff as CFE and is thus highly unprofitable.

\(^{181}\) Information about installed PV systems is to be treated cautiously, since it says nothing about the number of plants actually functioning.

\(^{182}\) Altogether 216 TWh of electricity were produced at the national level in 2000, including 28 TWh by private producers.
some 14.5 % to total electricity supplies. CFE and LFC sold approx. 155 TWh of electricity in 2000. While private households consumed less than one quarter of the electricity demand, about 60 % of the electricity was used by the industrial sector. Transmission and distribution losses are high. For the distribution sector alone they are quantified at about 10 %.

The re-enactment with amendments of the Law of 1992 governing public electricity supplies and the associated regulation confirmed the exclusive right of state organisations to provide public power supplies. The right to distribute electricity and sell to the general public is reserved exclusively for the two state suppliers.

However, the re-enactment also allowed investments in electricity generation by the private sector for the first time, after public investments in the electricity sector had declined substantially at the end of the eighties. Private enterprises can operate in the case of autonomous supply, in combined heat and power, as small-scale generators (≤ 30 MW), as independent electricity producers, as importers for their own purposes, and in connection with electricity exports.

For autonomous supply a number of firms can set up a separate firm. Moreover local authorities or state governments in conjunction with local private enterprises can also participate in this ruling. The sole buyer of surplus electricity, as in the case of electricity supplies by independent producers, is CFE, which fixes its terms for this. Conversely, if privately operated plants break down, the autonomous suppliers have to purchase their electricity from CFE. In view of the substantial price differential between buying and selling electricity, however, autonomous production is not a commercially viable solution for most private companies.

According to a new ruling of May 2001, autonomous suppliers with plants producing more than 40 MW are entitled to supply up to 50 % of their capacity to the public grid. Operators with less than 40 MW can make up to 20 MW available to the public electricity grid.

All plans to expand CFE's supply capacities must be approved by the Ministry of Energy. This Ministry can order public bidding to integrate independent electricity producers with a minimum capacity of 30 MW. Electricity purchase contracts are concluded for periods of 20 to 25 years. The electric-

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184 In view of current developments, future electricity export to California can be of particular interest, especially since the electricity tariffs there are much higher than those in Mexico.


186 The CFE's invitation to bid for the first independent electricity generation contracts ended in 1997 and thus much later than originally planned. Up to February 2001 twelve approvals were issued for independent electricity producers who plan to produce 6000 MW by 2004. However, the reorientation of US energy policy might strike at these plans, since various projects depend on natural gas imported from the USA. Foreign companies dominate the suppliers, headed by the French state utility EdF.
ity supply prices for the first contracts lay at 2.5 to 3.0 US cents/kWh, and thus partly below CFE’s average generating costs of 3.0 US cents/kWh (1997).

Small-scale producers sell their electricity exclusively to CFE or LFC and receive no remuneration for firm capacities. Small-scale producers up to 1 MW can also supply electricity to isolated grids.  

All electricity generating plants of autonomous suppliers and independent producers have to be approved by the regulatory authority for energy (Comisión Reguladora de Energía – CRE), which reports to the Ministry of Industry and Energy and is responsible for the gas sector too. From 1994 to April 2001 approvals were issued for autonomous suppliers covering 4,718 MW, for combined heat and power covering 2,130 MW, for export covering 556 MW, for import covering 122 MW, and for independent electricity producers covering 7,619 MW.

Mexico’s energy policy provides for converting many power stations from oil firing to natural gas firing. Natural gas is to be preferred for new capacities too. Despite additional construction, it is generally expected that capacities cannot be expanded in line with demand and that the next decade will therefore see supply bottlenecks accompanied by partial interruptions.

Forecasts by the Ministry of Energy estimate the mean growth rate in electricity demand between 2000 and 2009 to be about 6 % per year. To keep pace with this development the electricity generating capacity for public supplies would have to increase by 26,000 MW in the same period, including 23,000 MW in CCGT power stations on a natural-gas basis and 2500 MW hydropower. At the beginning of 2001, however, only 16 projects with altogether 6,959 MW were under construction (13) or about to start (3).

It is generally agreed that the capital required to expand the electricity sector can only be raised with the aid of the private sector. That is why a legal reform to open up private electricity generation further is in preparation. In this connection the tasks of the regulatory authority are to be restructured too.

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187 Small-scale producers were accepted separately, especially to stimulate the use of renewable energies. However, due to the otherwise unfavourable framework conditions this expectation proved erroneous.

188 The tasks are defined in the Ley de la Comisión Reguladora de Energía of 31.10.1995.

189 About 120 individual approvals.

190 In 2000 electricity was virtually only imported, while exports remained marginal.

191 The installed capacities of CFE have hardly changed from 1994 to 2000. In some cases they even declined due to power station shut-downs.

192 Equivalent to electricity sales by the state suppliers of 257 TWh in 2009.

193 To which about 4,300 MW growth among autonomous suppliers and in combined heat and power must be added.

194 Of the 26,000 MW, about 14,000 MW are to be generated by private electricity producers.
However, privatisation of the two state supply companies is ruled out at present, although CFE will probably be converted to a holding company and be responsible essentially for the transmission network and the remaining power stations, while the issue of private licenses at the distribution level too is being seriously considered.

Energy tariffs for final customers are fixed by the Ministry of Economics. In 1999 they were below the real prices of 1993 in all consumption categories and at the beginning of 2001 the average price was 6 US cents/kWh (see Tab. 22). Tariffs were particularly high for trade and for public facilities. However, state subsidies of 9 and 6 % are still granted for industry and households 195.

### Electricity tariffs

<table>
<thead>
<tr>
<th>Consumption sector</th>
<th>Pesos/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>0.641</td>
</tr>
<tr>
<td>Trade/Light industry</td>
<td>1.314</td>
</tr>
<tr>
<td>Services</td>
<td>1.128</td>
</tr>
<tr>
<td>Public facilities</td>
<td>1.141</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.31</td>
</tr>
<tr>
<td>Medium-sized industries</td>
<td>0.595</td>
</tr>
<tr>
<td>Large-scale industries</td>
<td>0.415</td>
</tr>
<tr>
<td>Average</td>
<td>0.592</td>
</tr>
</tbody>
</table>

Tab. 22  
Electricity tariffs February 2001

**Renewable Energy**

To support government policy an advisory council on the use of renewable energy sources (Consejo Consultivo para el Fomento de las Energías Renovables - COFER) was set up in 1997, to which all major government and non-governmental institutions belong. The advisory council is supervised and coordinated by the national commission for energy saving (Comisión Nacional para el Ahorro de Energía - CONAE) set up in 1989, in conjunction with the national association for solar energy (ANES). In addition to holding regular working meetings, the advisory council has established various technical work groups on individual thematic areas.

In 2000 the Ministry of Energy and the State Institute for Electricity Research entered into an agreement to implement a pilot plan for renewable energy sources. The plan provides for further development of commercial projects (rural electrification, biogas from landfills and sewage treatment plants, wind farms), as well as pilot and research projects (grid-coupled PV, parabolic reflectors etc.). Within this framework existing barriers are to be be

195 According to the information supplied by the Ministry of Energy in April 2001, the household tariffs only cover 40 % of the costs of supply. In the agricultural sector this figure drops as low as 30 %. Altogether the government paid subsidies of 54 billion pesos in 2000.
identified and eliminated, projects advanced, and the establishment of domestic technology promoted. A GEF application for support of the objectives in the wind sector is currently passing through the approval process at the UN development programme (UNDP).

At the beginning of 2000 altogether 46 approvals for electricity generation with renewable energy sources as primary or (in some cases) secondary energy sources were registered at CRE. Of these approved plants, 28 were in operation, four were about to start, five were being completed, and nine were inactive.

For the year 2001 investments of 129 million pesos were expected in the field of renewable energy sources, including 117 million for projects in the field of hydropower and 12 million for geothermal plants.

**Wind Energy**

Mexico has a number of regions with good to very good wind conditions. Notable resources are found in particular in the federal states of Oaxaca in the south, Zacatecas in the uplands, Tamaulipas and Veracruz on the coast of the Gulf of Mexico, along the Pacific coast of the peninsula of Baja California, along the coastline of Quintana Roo in the Caribbean, and in the state of Hidalgo north of Mexico City. A useful potential of 2000 MW is cited for the region La Ventosa in the state of Oaxaca alone, that has mean wind velocities of 7 to 10 m/s, and the capacity for the entire country – if only the best locations are exploited – is quantified at 5000 MW as a minimum.

Practical experience with small-scale installations was first gathered by the Institute for Electricity Research (Instituto de Investigaciones Eléctricas – IIE) in the years from 1977 onwards at the wind test station El Gavilero in the environs of Huichapan in the state of Hidalgo. Plans to develop larger plants were not translated into practice.

In mid-1984 CFE started up the demonstration project La Venta, with 7 wind turbines from the firm Vestas and a total capacity of 1,575 MW, in the south of the Isthmus of Tehuantepec, some 30 km north-east of the municipality of Juchitán in the state of Oaxaca. IIE has been carrying out wind measurements at this location already since 1984.

CFE started up a further individual plant with an output of 600 kW from the Spanish firm Gamesa Eólica near Guerrero Negro, in the state of Baja California.
fornia Sur, at the end of 1998. This installation is operated in an isolated grid system that is otherwise supplied by diesel generators.

Wide experience with hybrid (wind/PV) or multivalent (wind/PV/diesel) systems installed during the last decade is also available. For instance a multivalent wind-PV-diesel system consisting of several wind generators with a total output capacity of 60 kW, a PV installation of 11.2 kW and a diesel generator of 125 kW, was commissioned at Othón P. Blanco in the state of Quintana Roo in 1992. A similar combination comprising 10 wind generators with 7 kW each, one PV installation of 17 kW and a diesel generator of 80 kW, was started in San Juanico in the state of Baja California Sur in 1999.199

Further major projects are at the preparation stage. However, their implementation depends essentially on the creation of suitable framework conditions to improve competitiveness for wind energy. The state of Oaxaca in the south of the country is particularly interested in greater use of wind power. CFE has already announced an invitation to tender for a 50 MW wind farm near the aforementioned La Venta project. In addition further projects of 20 MW each are planned at the same location and on the island of Cozumel, as well as near La Rumorosa in the state of Baja California.200

The relatively low significance attached to exploitation of wind energy by the government is also reflected in government planning, which envisages an installed wind capacity of only 177 MW for 2009.

199 The project was realised as a joint implementation project with support from the USA.

200 According to other information, four projects with altogether 147 MW are at the preliminary assessment and pre-negotiation stage. Approval by CRE is already available for these projects.
Geothermal Energy

Geothermal energy sources with a temperature level sufficient for electricity generation can be found at various places in the country, above all in the state of Baja California. Firm reserves with a capacity of 700 MW are available in Cerro Prieto there. A further 380 MW have been identified in Los Azufres in the state of Michoacán, and in Los Humeros in the state of Puebla. Power stations are generally operated already in these fields and are to be expanded. Additional sources with an estimated 1000 MW could be exploited in the current decade, but so far only construction covering 225 MW has been agreed in the medium-term planning up to 2009\(^2\).

Other Renewable Energy Sources

There is potential for other renewable energy sources, but a lack of reliable information regarding regional distribution and feasibility.

Solar energy could be particularly important in future, since Mexico has very high mean solar radiation, suggesting applications extending beyond rural electrification (see below). During recent years IIE has installed isolated grid-coupled photovoltaic systems with capacities of up to 2 kW as pilot projects. Furthermore, solar energy is used to a considerable extent in the telecommunications sector. According to information supplied by the IIE, PV modules with a total capacity of nearly 1 MW\(p\) were installed above all in the field of rural electrification in the year 2000 alone (see below). Medium-term planning envisages an installed capacity of 23 MW for 2009.

Unexploited water resources are quantified at 11,500 MW, including an estimated 3,250 MW with less than 10 MW. These small hydropower plants used to be widespread, but were given up gradually due to permit-specific or other reasons. CFE has not been operating in this sector for 30 years now. At the end of 2000 only seven small hydropower plants with altogether 84 MW were installed. The first of four mixed state-private projects was started up in August 2001.

Biomass too could be put to much greater use than exploitation of residual agricultural products. In 2000 CRE registered approvals for electricity generation with biogas in two plants with altogether 11 MW. Furthermore, approvals for 19 plants with altogether 171 MW for bivalent combustion of fuel oil and bagasse were issued.

Rural Electrification

About 95% of the total population of some 100 million are connected to the general electricity grid. The remaining 5 million are spread among roughly 201 out of 230 MW intended altogether for this planning horizon.
79,000 small settlements with fewer than 500 inhabitants in remote or poorly accessible regions. Electrification is particularly inadequate in communities with fewer than 100 inhabitants and a high proportion of scattered dwellings.

Mexico has extensive experience in the use of photovoltaic systems for basic electrification. During the last decade especially, this type of electrification in remote areas has caught up by comparison with the traditional use of diesel generators. So far up to 20,000 solar home systems have been sold to private users without any government subsidies.

Furthermore, at the beginning of the nineties the government set up a programme to improve the infrastructure in poor rural communities (Programa Nacional de Solidaridad – PRONASOL) that includes electrification measures too. Within the context of this programme, local authority buildings and households without electricity connections and without prospects of grid connection in various parts of the country are equipped with PV installations for basic supplies (lighting/communications). Altogether some 40,000 systems have been installed to date within the scope of this scheme.

The programme strongly involves the local decision-makers in its implementation and leaves the technical selection and monitoring of the installations to CFE. Government authorities look after project planning and development, as well as the management. The local government units (communities) agree to provide technical support during and after installation and have to bear the costs of maintenance and any expansion themselves. Financial contributions to the installation costs by the users are fixed in accordance with individual conditions.

Electrification by the use of renewable energy sources in agriculture is also supported by the federal government's programme Alianza para el Campo. Subsidies are granted for purchasing water pumps and powering agricultural implements. A GEF-supported project (Renewable Energy for Agriculture Project) recently started to tackle the relatively high barriers encountered in implementing this programme, that intends in particular to improve the productivity of the roughly 600,000 farms without electrification.

Incentive Systems and Legal Provisions

The fact that non-conventional renewable energy sources are not prioritised and the lack of a separate set of rules and regulations currently render large-scale exploitation difficult. The monopoly enjoyed by the state utilities and the political constraint that electricity must be purchased or generated at

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202 More precise statistical data are not available.

203 The percentage of such households is particularly high in the rurally structured states of Oaxaca, Chiapas, Tabasco and Zacatecas.

204 Depending on the source, data regarding the number of installed SHS vary considerably. In some cases IIE quotes 60,000 systems installed within the framework of PRONASOL alone.
the lowest possible costs and ideally only from "safe" production sources represent an almost insurmountable obstacle. Moreover, unclear or lacking provisions in construction and planning law, as well as a lack of experience among public authorities and developers, doom large-scale projects to failure at the outset. The remuneration offered generally does not allow commercially viable operation, especially since deductions have to be accepted for non-firm capacity.

However, projects for autonomous supply could be of economic interest, provided that electricity purchase prices are sufficiently high, and generation at the point of consumption holds out the prospect of lower electricity costs, for example on the grounds of excellent wind conditions.

Foreign companies can own up to 100 % in sectors of the energy industry that do not belong directly to the public power supply. However, the consent of the Comisión Nacional de Inversiones Extranjeras (national commission for foreign investments) is necessary for shares of more than 49 %.

CRE recently adopted rules concerning the setting of transmission tariffs and other specific issues connected with supply and carriage of intermittent electricity from renewable energy supplies (hydropower, solar and wind energy)\textsuperscript{205}. According to these, operators of installations with more than 0.5 MW only have to pay 30 to 50 % of the costs normally incurred for connections and electricity transmission. It remains to be seen whether the clarification provided by this is sufficient to advance further projects, particularly in the field of wind energy.

Exchange rate (11.12.2001):

10 Mexican pesos = € 1.22

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Electricity Market

The shortage of natural resources in the county compels Morocco to meet most of its energy requirements from imports.\textsuperscript{206} Electricity supplies are based largely on the combustion of imported coal, which is mainly obtained from South Africa, and imported crude oil from Saudi Arabia, Iran, Iraq and Nigeria, together with electricity imports from Spain\textsuperscript{207} and Algeria\textsuperscript{208}. Hydropower accounts for 5\% of electricity supplies and wind power 0.5\%.

Altogether 11,540 GWh of electricity was fed into the supply system in the year 2000. In addition, 2,268 GWh was purchased from Spain and 95 GWh from Algeria (Fig. 13). In September 2000 Spain and Morocco agreed to examine the building of further connections between the two countries.

\textbf{Fig. 13}

\textit{Breakdown of electricity sources in 2000}

Despite considerable improvements in electrification in recent years, on a national average the level of coverage of electricity supplies in the mid-nineties was only 45\%, and in rural areas well below that figure.\textsuperscript{209}

Since the mid-1980s the Moroccan electricity sector has recorded rapidly growing demand (Fig. 14). Annual growth in peak load demand averaged

\textsuperscript{206} The import ratio was 92.7\% in 1999 (source: bfai Länderreport, Marokko – Energiewirtschaft 1998/1999, April 2000).
\textsuperscript{207} In May 1998 the power link between Morocco and Spain was established by a 350 MW high-voltage transmission route, via which up to 2.5 TWh can be transmitted every year.
\textsuperscript{208} An agreement is in place with Algeria to meet peak loads via two high-voltage links.
\textsuperscript{209} The programme for national electrification of 1980 envisaged a degree of electrification of only 25\% for rural regions by the year 2000.
6 %/a between 1986 and 1996. The shortfall in meeting electricity requirements that still existed in the first half of the nineties, and which led to frequent power cuts, was virtually eliminated as a result of the electricity imports described above, despite a slight fall in national electricity generation. On the whole there were then no notable power failures.

The installed capacity of Moroccan power stations was broken down as shown in Fig. 15 at the end of 2000.

Since 1994 the electricity market in Morocco has been successively opened to private power producers and suppliers. Law 2-94-503 of 23 September 1994 gave the state supplier Office National de l’Electricité (ONE) the possibility of inviting tenders from private investors and operators for projects with a generating capacity of more than 10 MW. Primarily this was intended to overcome financial shortages in the state-owned company. In practice the projects are set up according to the BOT model, which are transferred to the

Source: Internet pages of the Office National de l’Electricité (ONE)
ownership of ONE after 30 years.

The coal-fired power station Jorf Lasfar, which is soon to be commissioned, is of particular importance for the future of electricity supplies in the country. It is owned by a Swiss-American consortium, and with an installed capacity of 1,320 MW it is said to be the largest private power station in Africa.

The national transmission network is still fully owned by ONE. The consumer prices for electricity are set by the Ministry of Energy and Mines in consultation with the Ministry of Finance.

**Rural Electrification**

Rural electrification has made great progress over the past few years. Whereas only 15% of rural areas were connected to an electricity supply at the start of 1996, the degree of electrification in these regions had risen to about 40% by the year 2000. More than 4,500 villages had been additionally connected to the supply network by the end of 1999. According to information from the Ministry of Energy and Mines this figure was 5,290 villages by the end of 2000, in which more than 50,000 households were provided with electricity. By 2006 it is planned to connect 80% of all rural settlements to the electricity supply.

ONE is responsible for rural electrification, in cooperation with the relevant local authorities. Until 1995 rural electrification was carried out within the framework of the national electrification programme “Programme National pour l’Electrification Rural” (PNER), and always through connection to the grid. In August 1995 ONE presented a revised national electrification pro-

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gramme “Programme pour l’Electrification Rurale Général” (PERG) to the government council, and launched it in 1996. In order to achieve the objective of almost complete electrification of rural areas (95 %) by 2006 it is planned to inject an annual input of funds amounting to € 147.7 million.\textsuperscript{212}

In a critical assessment,\textsuperscript{213} however, ONE itself admits that the targets for connection to the grid can probably not be attained in some provinces (see Fig. 17):

- 8 provinces will not reach an electrification rate of 50%.
- 9 further provinces will not exceed 56%.
- 37 provinces will exceed 60%, and some of them will even reach 100%.

![Development of the electrification rate according to region between 1998 and 2004](image)

In the long term therefore PERG is to supply electricity to the majority of rural households in Morocco, and at the same time also integrate decentralised generating technologies. Local authorities, ONE and the users are financing the electrification measures jointly:

\textsuperscript{212} According to the original plans, an electrification rate of 80% was envisaged by 2006 and achievement of the target of 95 % not until the year 2010.

\textsuperscript{213} Source: information from ONE on its Internet pages, www.one.org.ma/html/m4_02_03_.html

\textsuperscript{214} Source: information from ONE on its Internet pages, www.one.org.ma/html/m4_02_03_.html
The local authorities contribute 35% of the costs and bill each applicant household for a one-off payment of DH 2,085 (€ 205) or five annual payments of DH 500 (€ 49).

The households, which have a 20% share of the costs, commit themselves when registering with the scheme to pay DH 2,500 (€ 246) or they contribute DH 40/month (€ 4) for a period of 7 years.

ONE bears the remaining costs to the tune of 45%.

In contrast with its predecessor programme, PERG also includes the off-grid electrification of communities and villages away from the distribution networks. This part of the programme for decentralised electrification started in 2000 and mainly promotes the use of solar home systems (SHS). Some 200,000 households in about 6,000 villages (equivalent to 7% to 8% of rural households) are to benefit from this technology.

The action plan developed by ONE envisages three models:

- In what it refers to as direct action, ONE provides the complete service, from provision of the equipment through installation to maintenance of the systems. The state organisation Centre de Développement des Energies Renouvelables (CDER) provides technical support. The money to be paid by the user is paid directly to ONE. In the province of Essaouira so far 130 SHSs have been installed according to this model, which is only being used in regions which are of no interest to the private sector.

- In the service model, ONE provides the complete equipment to the households (customers of ONE) and leaves installation, maintenance and customer service to a private company, which also collects the charges on ONE’s behalf. 1,500 SHSs have been installed in the province of Khouribga according to this model.

- In the partnership model, ONE provides only the modules and the batteries, leaving the supply of the remaining equipment, installation, maintenance and customer service to a private company. The households are direct customers of the private company.

Rural electrification through SHSs within the framework of PERG is supported by a KfW loan.

The Photovoltaic Market Transformation Initiative (PVMTI), a scheme for PV-based electricity supply in rural areas in India, Kenya and Morocco set up in 1998 by the Global Environment Facility (GEF) and the International Finance Corporation (IFC), supports the installation of 50,000 SHSs in the next 5 to 7 years in each of these countries. The programme earmarks an investment volume of US$ 5 million for Morocco. This is intended to

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215 Some of these costs will be met by a power levy on every kilowatt hour sold, amounting to 2.25% of the respective tariff.

216 Source: Abderrahim Jamrani, The Moroccan General Rural Electrification Programme,

217 Source: Abderrahim Jamrani, The Moroccan General Rural Electrification Programme,

make investment resources available to private companies which offer energy services on the basis of PV systems. These funds can be used for loans to end consumers, as working capital for business expansion or for guarantee funds.

Renewable Energy

Among the Maghreb states, Morocco is now the country in which the tapping of renewable energy for electricity generation has advanced furthest. The development of renewable energy sources is the responsibility of CDER and – if it relates to rural electrification – of ONE.

Since the beginning of the eighties the Moroccan government has been trying to reduce dependence on imported energy sources and to promote renewable energy. This was the purpose behind the founding of CDER as a specialist and advisory institution, whose task is strategic development for the exploitation of renewable energy. The Centre has received support in its tasks from GTZ for more than 10 years.

Wind Power

Morocco has good to very good wind conditions, with average wind velocities of more than 11 m/s in places, and has considerable useable wind potential in relation to its area and the demand for electricity.

Between 1991 and 1994 the wind potential on the Atlantic coast and in the north east was measured by CDER within the framework of a wind energy evaluation programme with financial assistance from GTZ.\(^{219}\) In a second phase (1997 to 2000) the potential at selected locations on the Atlantic coast was investigated. Results of measurements from this phase are shown in Table 23.

<table>
<thead>
<tr>
<th>Location</th>
<th>Measurement period</th>
<th>Average wind velocity at height of 40 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essaouira</td>
<td>VII / 1998 – V / 1999</td>
<td>8.92 m/s</td>
</tr>
<tr>
<td>Tarafaya</td>
<td>VII / 1998 – VI / 1999</td>
<td>7.69 m/s</td>
</tr>
</tbody>
</table>

\(^{219}\) Results were published in March 1995 by CDER in the report “Le Gisement Eolien du Maroc”.

\(^{220}\) Source: information from the GTZ-TERNA Wind Energy Programme, Internet page: www.gtz.de/wind/files/terna_morocco_en.pdf
At the end of 2000 a 3.5 MW wind farm was constructed at the Al Koudia Al Baida site (Tlat Taghrmat in the province of Tétouan, 40 km east of Tangier), the cost of which amounted to approximately € 6 million. The Kreditanstalt für Wiederaufbau (KfW) provided a low-interest loan of € 4.35 million for this scheme with German turbine technology. The operator is ONE.

Another wind farm with a capacity of 50 MW at the same location, for which the European Investment Bank provided a loan of € 24.4 million, went online in the second quarter of 2000. The generation price was calculated at DH 0.40 to 0.60 /kWh (3.9 to 5.9 € cent/kWh), therefore placing it in the range of the average electricity production costs of conventional plants (see below). 84 wind generators from Vestas each with an installed capacity of 600 kW were erected by the Compagnie Eolienne de Détroit (49 % EDF, 35.5 % PARIBAS Merchant Bank, 15.5 % GERMA Consulting) for approximately € 45.7 million. This scheme is an entirely private project on the basis of a BOT contract with ONE, to which the wind farm will be transferred completely after 19 years.

Other wind farms with a total of 200 MW are to exploit the potentials in the region of Tangier in the north of Morocco and a region in the south (near to the town of Tarfaya). The planned Tangier wind farm has two sites: Sendifou (65 MW) and Dhar Saadane (75 MW). The Tarfaya wind farm is to have an installed capacity of 60 MW. The electricity production costs are put at between DH 0.38 and 0.4 /kWh (3.7 to 3.9 € cent/kWh) for these schemes, and are therefore on the same scale as the costs of conventionally generated electricity. In a limited tendering procedure, at the end of 1999 nine groups of companies were invited to submit offers. Seven consortia then put in bids. The award of the contract, originally planned for October 2000, has so far not taken place.

By the year 2010, 4% of Morocco’s electricity needs are to be met by wind power.

**Solar Energy**

Despite excellent solar irradiation conditions, the use of solar energy for grid-coupled electricity generation in Morocco is still in the early stages of development. There is only a 1 kWp photovoltaic system connected to the grid as a pilot plant and model installation.

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221 Source: KfW project overview of the Tangier wind farm. The project was originally to have been completed by the end of 1996. Apart from the erection of 7 Enercon wind turbines of 500 kW each, the investment volume also includes the costs of connecting to the public grid as well as training courses and consultancy services.

222 Source: information from ONE on its Internet pages, http://www.one.org.ma/html/m2_01_04_.html
Windpower Monthly 4/2000, p.8; Short List; April 2000
Windpower Monthly 4/2001, p.19; Results Delayed, April 2001

According to statements by the Director General of CDER at a press conference on 25.10.2001, it is planned to increase the installed wind capacity to 1,000 MW by the year 2010.
The electrification campaign with solar home systems described under Rural Electrification is making good progress. In the year 2000 about 35,000 solar energy systems were installed.

National production of PV solar technology is supported by the IFC/GEF project PVMTI described above. According to information from the Moroccan Solar Energy Association AMISOL (Association Marocaine des Industries Solaires), about 20 companies assemble simple PV systems from imported components.

A thermal solar power installation in combination with a gas turbine is to be built in the east of Morocco near Aït Beni Mathar, about 90 km south of the city of Oujda, with a GEF loan; it has a designed total capacity of 180 MW.\(^{224}\) The fuel for the gas turbine is to be obtained from the pipeline running from Algeria to Europe. A feasibility study completed in 1998 and financed by the European Investment Bank (EIB) estimated the cost at US$ 200 million. The plant was put out to tender in July 1999; no contract has yet been awarded.\(^{225}\)

**Hydropower**

The hydropower potential in Morocco that is technically usable for electricity generation is estimated at 2,500 MW, of which only approximately 37 % has been developed so far.

Morocco has excellent potential especially in the field of small hydropower. Utilisation of this potential is limited however because of seasonally varying rainfall.

Two small-capacity hydroelectric plants in Agadir Aït Mehamed (300 kW) and in Askaw (200 kW) are to provide electricity for 63 villages in the Assif Tifnout valley (Souss river). The requests for tenders for building the two plants have already been issued.\(^{226}\)

A 450 MW pumped storage power station for peak load supply is planned near Beni Mellal. The project is to be implemented with a loan from the EIB.

**Incentive Systems for Electricity from Renewable Energy**

There are no obligations as to the purchasing of and payment for electricity from renewable energy sources. Instead, bilateral contractual relationships between the operator and ONE determine the price conditions for the electricity. As mentioned at the beginning, a public invitation to tender is also

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\(^{224}\) The proportion of solar-generated electricity is intended to be 7 %.

\(^{225}\) Source: information from ONE on its Internet pages, [http://www.one.org.ma/html/m2_01_03_.html](http://www.one.org.ma/html/m2_01_03_.html)

\(^{226}\) Source: Abderrahim Jamrani, The Moroccan General Rural Electrification Programme
possible for projects of more than 10 MW.

Pointers to the remuneration that can be expected are given by the electricity production costs of conventional power stations. In 1996 they averaged DH 0.523 /kWh (approx. 5.2 € cent/kWh) for thermal power stations, and DH 0.113 /kWh (approx. 1.2 € cent/kWh) for hydroelectric plants. DH 0.360 /kWh (3.5 € cent/kWh) had to be paid for imported electricity from Algeria, resulting overall in a weighted average generation price of DH 0.451 /kWh (approx. 4.4 € cent/kWh). Taking account of transmission and distribution losses, this figure can be rounded up to roughly DH 0.5 /kWh (approx. 4.9 € cent/kWh). The tariffs for end customers are on average more than twice this amount, and are set on a progressive scale for consumption by private households, for example. In recent years ONE has reduced the tariffs for the medium-voltage range (industry): by 5 % in October 1997, 6 % in July 1998 and 17 % in October 2000.227

There are no specific promotion programmes for renewable energy apart from the programmes on rural electrification described above, and in view of the general financial situation in Morocco none are to be expected. All hopes therefore rest on international donor aid from the World Bank/GEF, other international financing institutions or national development banks.

The import duties for importing certain components to utilise renewable energy sources have been significantly reduced (2.5 %). There are currently no other provisions for tax incentives or reliefs.

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SOUTH AFRICA

Electricity Market

The South African electricity market is dominated almost completely by the government-run enterprise Eskom that satisfies about 95% of the national electricity demand. With an installed net capacity of 39,870 MW (1999) and grid capacity supplies of 178,561 GWh, Eskom is the seventh largest electricity supply company. Eskom generates its electricity chiefly in coal-fired power stations (see Fig. 18). In addition to this, in 1999 a further 6,657 GWh electricity were imported and 3,128 GWh were exported.

South Africa is an important member of the Southern African Power Pool (SAPP) and thus has access to low-cost and safe sources of supply in neighbouring countries.

In July 2000 peak demand in Eskom’s integrated network was 29,188 MW (in 1999 it was 27,813 MW). Additional generating capacity is managed by private electricity producers (private industry has approx. 836 MW at its disposal) and local authority utilities (2,436 MW). In 1999 total available generating capacity amounted to 34,472 MW (Eskom: 32,704 MW, private sector: 831 MW, local authority utilities: 937 MW).

376 distribution companies, chiefly owned by local authorities, and Eskom itself supply the electricity to end customers. At this level too, Eskom is the largest direct distributor as regards electricity sales and number of customers.

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228 Source: Data Monitor, UK; 1999
229 Eskom sells 56% of the electricity produced directly to final customers.
The heterogeneous structure of the distribution sector represents a considerable obstacle to further development of the South African electricity market. More than 120 local authority units have fewer than 1000 customers, and over 90 local authority units achieve sales of less than one million Rand per year. On the other hand, four municipal authorities earn 50 % of all profits. One quarter of the local authority distributors even lose money on their electricity sales due to excessively high distribution costs or tariffs that are too low, and which moreover vary strongly from company to company. A growing number of local authorities is unable to pay Eskom for the electricity purchased and thus has no potential for enlarging its market from its own resources by further electrification. In November 2000 the South African government announced the introduction of a special tariff for financially disadvantaged areas (Electricity Poverty Tariff).

Even if it is true that electricity costs in South Africa are among the lowest in the world thanks to the low-cost domestic coal resources available, the substantial differences in tariffs between the distribution companies and the consumer groups must also be taken into account.

Eskom customers paid the following average net prices in 1999:

<table>
<thead>
<tr>
<th></th>
<th>cent/kWh</th>
<th>€-Cent/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural supply</td>
<td>22.87</td>
<td>2.72</td>
</tr>
<tr>
<td>Business customers</td>
<td>23.47</td>
<td>2.79</td>
</tr>
<tr>
<td>Households</td>
<td>24.59</td>
<td>2.92</td>
</tr>
<tr>
<td>Industry</td>
<td>12.83</td>
<td>1.52</td>
</tr>
<tr>
<td>Mining companies</td>
<td>12.32</td>
<td>1.46</td>
</tr>
<tr>
<td>Transport</td>
<td>14.49</td>
<td>1.72</td>
</tr>
<tr>
<td>Average</td>
<td>16.29</td>
<td>1.94</td>
</tr>
</tbody>
</table>

Roughly 6.8 million of the approx. 9.6 million households in South Africa are supplied with electricity. Two million of these are located in rural areas. Approx. two million rural households as well as tens of thousands of schools and hospitals are not connected to the public grid.

An electrification campaign was launched already in 1991, in other words shortly after the end of apartheid. A National Electrification Forum (NELF) set up by the new government in 1993 formulated a national goal of creating 2.5 million new household connections between 1994 and 1999 and electrifying all schools and hospitals as quickly as possible. Densely populated areas were to be electrified via grid connections, while decentral solutions were planned on a broad scale for rural regions especially (see below).

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230 In 1997 the average electricity costs at distribution level (incl. electricity purchases) ranged from 23.9 c/kWh (2.8 €-Cent/kWh) for distributors selling less than 1 GWh per year up to 13.4 c/kWh (1.6 €-Cent/kWh) for distributors selling over 1000 GWh per year.
Eskom has declared that its contribution to this major input for the general Reconstruction and Development Program (RDP) of the government elected in 1994 is a target of 1.75 million household connections (equivalent to 300,000 per year). The local authorities were to create 150,000 connections a year. These figures were in fact achieved, and in some cases exceeded, with approximately 3.1 million new electricity connections being produced from 1991 to the end of 2000, resulting in an electrification degree of 70%. According to information supplied by the International Energy Agency, however, even under relatively optimistic assumptions (quasi undiminished continuation of electrification beyond the year 2000) just under ten million people will still be without electricity connections in the year 2010.

The government would therefore like to take legislative and other measures to achieve general access to electricity. Grid-coupled and non-grid-coupled solutions are to be taken into account, depending on their economic feasibility. These include solar home systems, generators, hybrid systems, battery systems, and other potential supply solutions. Promotion activities within the scope of the annual connection targets should also benefit areas remote from grid supplies. It is planned to create a National Electrification Fund fuelling by utility charges, taxes, grants, and other suitable sources to raise the assistance funds.

Reorganisation of the South African electricity market has only progressed hesitantly so far. It is true that establishing the National Electricity Regulator (NER) in 1995 created an independent regulatory authority which monitors all energy utilities and an – admittedly limited – number of industrial plants with their own electricity generation and distribution. However, the authority’s functions and powers will only be defined more closely in the near future by clear, statutory mandates. A corresponding bill has already been drafted (Electricity Supply Industry Regulation Bill) and was to be tabled in Parliament in 1999. A law to convert Eskom into a joint stock company (Eskom Conversion Bill) was passed in October 2000. It did not specify any date for privatisation.

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231 Connection of 25,900 rural schools was also promised, including 16,400 with solar systems remote from the grid.
On the basis of a White Paper on South African energy policy adopted by the government in December 1998 following extensive discussions with various actors, further arrangements are now being made to open up and reorganise the electricity market. The aspects under consideration include free choice of the electricity supply company by customers, the introduction of competition – especially in the generation sector, open and non-discriminatory access to the transmission system, encouragement of private participation in the supply industry, and merging of the distribution sector in a few regional enterprises.

In August 2000 the Ministry of Public Enterprises presented a policy framework (An Accelerated Agenda towards the Restructuring of State Owned Enterprises) for dividing the Eskom sectors of generation, carriage and transmission into separate companies and for dividing the power stations between several independent companies.

**Renewable Energy**

At present renewable energy sources account for approx. 10 % of primary energy supplies in South Africa. They include in particular biomass in the form of fuelwood, timber wastes, dung, charcoal and bagasse, the latter also being used for electricity generation in sugar refineries. In fact these energy sources account for 60 % of the energy consumption by households. Hydropower contributes less than 1 % to electricity generation and is, moreover, used chiefly by pumped storage power stations. Other renewable energy sources account for a small but fast-growing share of the energy supply. These include biogas and landfill gas.

In 1998 Eskom launched a programme to investigate the potential use of renewable energy sources for grid-coupled electricity generation on a large scale and to test these in demonstration projects. This South African Bulk Renewable Energy Generation (SABRE-Gen) Program has four components:

- Biomass use (SABRE-Gen – BioEnergy)
- Solar thermal electricity generation (SABRE-Gen – Solar Thermal Electric)
- Use of wave energy off the coasts (SABRE-Gen – Wave)
- Use of wind energy (SABRE-Gen – Wind)

The programme components wind energy use and solar thermal electricity generation are most advanced. Appropriate demonstration plants are to be set up shortly.
Solar Energy

The provision of small PV systems for isolated supply situations in areas which cannot expediently be connected to the grid for economic reasons is a major element of the aforementioned electrification of rural regions.\textsuperscript{232} The RDP includes non-grid-coupled electrification of 16,400 schools by Eskom and of approx. 2,000 hospitals by 2005. Schools are to be equipped with an average PV output of 500 W, while larger systems are planned for rural hospitals.\textsuperscript{233} So far PV modules have been installed for about 1,700 rural schools and 300 rural hospitals with funds from the RDP and international donors.

Several villages in rural areas have received solar home systems to cover elementary demand needs of rural households. For further development Eskom and Shell International Renewables have jointly started an initiative worth 150 million Rand (€ 17.8 million) to electrify 50,000 rural households with PV systems. The first phase at the beginning of 1999 tackled the electrification of 6,000 households in Eastern Cape Province.\textsuperscript{234} Problems in establishing the distribution and service organisation delayed the installation of the systems until December 1999. "Powerhouse" systems are made available to the households for a single payment of 150 Rand (€ 17.7). The users have to buy a magnetic card for 47 Rand (€ 5.6) to activate the system. The credit balance on the card is used up after 30 days and a new card has to be purchased. These fees also cover complete maintenance of the system, including battery changes.

The Bavarian state government is co-financing an electrification project in a local authority unit in the Folovhodwe region in Northern Province. With a budget of 2.3 million Rand (€ 273.000), three schools are to be electrified, 582 solar home systems (SHS) are to be set up, and two solar-powered water pumps are to be supported.

The total installed PV capacity in 1999 was approx. 11 MW\textsubscript{p},\textsuperscript{235} with about 7 MW\textsubscript{p} being accounted for by telecommunication applications, 1.64 MW\textsubscript{p} by SHS (approx. 40,000 systems) and the rest by schools, hospitals and water pumps.

The state-owned Telkom ordered 8,000 PV systems in 1994 alone to expand the telephone system. However, this market segment appears to be largely saturated today. Furthermore, by 1999 more than 3000 PV-based water pump projects with a capacity of altogether 800 kW\textsubscript{p} had been started up.

\textsuperscript{232} Two factors are often combined here: the line costs are too high and the electricity demand is too low due to low available incomes.

\textsuperscript{233} The electrification programme with renewable energy sources for rural hospitals is headed by the Independent Development Trust (IDT).

\textsuperscript{234} In this province more than 64 % of the rural households (839.000) were without electricity at the end of 2000.

\textsuperscript{235} Source: Renewable Energy Technologies in SADC, A Guide for Investors; EC DGXVII, DBSA, ISES.
In the year 1996 the total sold capacity of PV systems was estimated at 1250 to 1850 kWp. The demand for the market segments water pumps and SHS is estimated at more than 150 MWp within the next 15 years. One obstacle to the dissemination of PV technology is the fact that local producers of PV systems have to pay import duties on some imported components, while importers of finished systems are exempt from such duties.

**Wind Energy**

The wind potential is good, especially in the long coastal strip area. The average wind velocities there are above 4 m/s and in some places even higher than 6 m/s. Traditionally wind energy is used in windmills for pumping water. At present some 250,000 to 280,000 such plants are still in operation. So far only small wind generators with a scope of altogether about 400 kW are being used for electricity generation.

Further developments include considerations regarding combining wind turbines with the existing pumped storage power stations.

Following feasibility and viability studies, a first major pilot wind power project for electricity generation has now reached the advanced planning stage. The firm Darling Independent Power Producer proposes to set up the wind farm covering 5 MW and costing 30 million Rand at Darling on the west coast. The plant is to be started up at the beginning of 2002\(^{236}\). The supply remuneration for the electricity from the wind energy conversion system has yet to be negotiated with the municipal administration of Darling\(^ {237}\).

The parastatal Centre for Scientific and Industrial Research (CSIR) is reviewing the possibilities of using wind turbines in isolated operation to supply small economic units in the province of Eastern Cape with electricity.

**Hydropower**

South Africa’s hydropower potential is regionally limited. Eskom itself possesses only two relatively large hydroelectric plants with altogether 600 MW and has a further four small plants with together 61 MW under contract. However, hydropower electricity is imported from Mozambique on a large scale. Moreover three local authorities operate plants with altogether 4 MW, and there is one privately operated hydroelectric plant with 3 MW. Expansion is possible above all with small and micro-plants.

\(^{236}\) Source: information on the Internet pages of the South African wind energy association; www.icon.co.za

\(^{237}\) Further information is obtainable from the investor and operator Mr. Hermann Oelsner (e-mail: oelsnergrp@mbury.new.co.za)
Incentive Systems for Electricity from Renewable Energy

According to the decisions taken in the aforementioned White Paper on energy policy, the South African government plans concentrated promotion for the development, demonstration and implementation of renewable energy sources for small-scale and large-scale applications. The key areas include uses of biomass, photovoltaics, electricity generation systems on the basis of small hydropower units and wind energy. A first draft of an implementation strategy for this objective, which had otherwise only been outlined boldly, was presented in February 2000.

For reasons unknown, the state-owned company Renewable Energy for South Africa (REFSA) set up at the beginning of 1996 was shut down again in 1998. REFSA reported that it was to implement a series of pilot projects in 1997 and 1998 with technical and financial assistance from South Africa, USA, Denmark and institutions from other countries.

At present there is a lack of special rules for supplying electricity from renewable energy sources and of any fixed terms of remuneration. However, new generation facilities and electricity distributors always require approval by the NER, unless for example local authorities are already entitled to secure their own electricity supplies.

As long as no relevant framework conditions and regulations are set, the procedure to be followed for independent electricity producers from case to case can only be clarified by concrete applications.

Exchange rate (19.11.2001):

1 Rand = 100 cents = 0.118 €

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TUNISIA

Electricity Market

In the year 2000 electricity consumption in Tunisia totalled 9,040 GWh. Altogether 97 % of this power was produced in thermal, oil-fired or gas-fired power stations, 2.6 % in hydroelectric plants and 0.4 % in wind turbines. The installed capacity is currently 2.3 GW. As a result of economic growth and continuous improvement of the population's living conditions, electricity demand has risen steadily during the past years. Between 1999 and 2000 energy consumption increased by 7 %.\(^{240}\) The Ministry of Industry estimated a growth rate of 7.5 % for 2001.

According to the 10th development plan, in which infrastructure measures for the next five years (2002–2006) are determined, forecast consumption will rise from 9,720 GWh in 2001 to 14,140 GWh in 2006.\(^{241}\) This over 45 % increase in consumption is to be covered by installing more than 1,600 MW additional power station output capacity by 2006.

The government has recognised that this development can only be mastered in conjunction with the private sector and therefore cautiously paved the way for a change in energy policy already in the mid-nineties. The law of 1996 de-monopolising the state-owned utility company Société Tunisienne d’Electricité et du Gaz (STEG) opened the door to involvement of the private sector in the electricity market. Private companies are now basically allowed to produce electricity and sell it to STEG. The selling prices can be negotiated freely with STEG. However, the electricity tariffs for end customers are state-controlled (Table 26). In the low voltage sector the tariff structure has a distinctly progressive component.

Since 1999 gas-producing enterprises have been allowed to operate gas-fired power stations and to sell the electricity generated to STEG.\(^{242}\) The corresponding tariffs have not yet been fixed. The precise framework conditions are to be regulated by an ordinance that is currently being debated. It is expected that production plants of up to 40 MW will be covered by these rules.

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\(^{240}\) Source: US-Department of Energy (Energy Information Administration), Country Analysis Briefs Tunisia, September 2001

\(^{241}\) Direction Générale de l’Energie, Ministère de l’Industrie; Prévision de la demande d’électricité en Tunisie; May 2001

\(^{242}\) Law No. 99-93 of 17.08.1999 : portant promulgation du code des hydrocarbures
The construction and operation of a natural gas-fired power station (Rades II with a capacity of 471 MW) was put out to tender internationally for the first time in 1997. The contract was awarded to a consortium made up of the US firm Public Service Enterprise Group (PSEG) with a 35 % share, the firm Sithe Energies (the US branch of the French enterprise Generale des Eaux - GDE) with a 32.5% share, and the Japanese firm Marubeni, also with a 32.5 % share. At the end of March 1999 the licensing agreements for a 20-year BOT model in which STEG agreed to purchase all the electricity generated during the contract period were signed. At the end of 1999 the financing of the 250 million US$ project was secured and construction work started. The plant is expected to go into operation at the beginning of 2002.

Tunisia has a well-developed electricity grid spanning the entire country, especially the north and the centre. There is an interconnected network with Algeria and Libya at the 400 kV level.

Renewable Energy

In the year 1977 the Tunisian government launched a national research programme (Programme National de Recherche - PNR) to bring together all relevant actors in the energy sector. One segment of the programme covers renewable energy sources - especially solar energy - and their use for electricity generation.

The Tunisian agency for renewable energy sources (Agence Nationale des Energies Renouvelables - ANER) was set up in 1985\textsuperscript{244} and has been reporting to the Ministry of the Environment and Urban Development (Ministère de l’Environnement et de l’Aménagement du Territoire - MEAT) since 1998. It has two fundamental scopes of tasks:

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Sector & Day-time tariff & Night-time tariff \\
\hline
High voltage sector & 3.10 & 2.09 \\
Medium voltage sector & 4.65 & 4.65 \\
Low voltage sector & & \\
& 0 - 50 kWh / month & 4.73 & 4.73 \\
& > 50 kWh / month & 6.44 & 6.44 \\
\hline
\end{tabular}
\caption{Electricity tariffs in €-Cent/kWh \textsuperscript{243}}
\end{table}

\textsuperscript{243} Source: Agence National des Énergies Renouvelables ; Energy Statistics 1999. According to the information supplied by STEG the price for end customers in the low voltage range in the higher consumption zone has in the meantime risen to 6.75 €-Cent/kWh

\textsuperscript{244} formerly Agence de maîtrise de l’énergie (AME)
- to improve energy efficiency, and
- to promote renewable energies.

In the field of renewable energies the function of ANER lies chiefly in back-stopping and managing projects in this sector. ANER is also responsible for training issues, awareness-raising and information measures, as well as for research and development. ANER plans to build up a division for wind energy, which is to be responsible for implementing an appropriate programme. The construction of a grid-coupled 80 MW wind farm is also planned within this context. MEAT has contacted the World Bank via ANER to secure financial support for the wind programme.

In 1996 the Centre International de Technologies de l'Environnement de Tunis (CITET) was established to disseminate and promote environmental technologies. CITET also reports to MEAT. One of CITET's fields of activities is to develop and promote renewable energies. The Centre runs a series of training packages.

Apart from the Sidi Daoud wind farm commissioned at the end of 2000, renewable energy sources have so far played hardly any role in Tunisia's electricity supply. According to the plans of the Tunisian government, this situation is to change considerably in the coming years as a result of the joint work of the aforementioned institutions, at any rate in the wind energy sector.

By the year 2010 about 25% of the country's energy demand is to be covered by renewable energies. Grid-coupled wind farms and decentral electricity generation by solar energy in particular are to be given preference. The government aims to connect wind farms with a total capacity of 2,000 MW to the supply grid by the year 2010.

There are no special incentive systems for electricity generation from renewable energies in Tunisia.

Wind Energy

Although Tunisia has regionally good wind potential with average wind velocities of up to more than 7 m/s, the exploitation of wind power has only progressed modestly in the country in recent years. Wind energy is chiefly used decentrally, for instance for pumping purposes to irrigate fields in remote regions, and for desalination of brackish water.

So far only one wind farm has been set up in Sidi Daoud (Gouvernement Nabeul) at Cap Bon. With 32 turbines, each having a capacity of 330 kW, the farm has a generating capacity of altogether 10.56 MW. The project

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245 Source: bfai, Länder und Märkte/Tunesien; Tunis setzt neue Energiepolitik um; April 1999
was put out to tender in 1996 on the basis of a feasibility study\textsuperscript{246} prepared between 1990 and 1992. The contract for turnkey construction of the plant worth €11.4 million was awarded to the Spanish manufacturer MADE in 1998. The wind farm is operated by STEG.

The average annual wind velocity at the Sidi Daoud location is 7.2 m/s. STEG plans to expand the wind farm at the end of 2001 / beginning of 2002.

STEG is conducting wind measurements at five locations together with a US firm to investigate further possible sites for wind farms in Tunisia. GTZ proposes to examine three further locations more precisely together with ANER in 2002 to review their suitability as wind farm sites. These comprise El Haouaria on the Cap Bon peninsula, a highland plain south of Thala in the centre of the country, and a location near Raf Raf in the Bizerte region.

**Solar Energy**

Tunisia enjoys solar radiation for 2,800 to 3,200 hours/year. The average energy radiation is approx. 2,000 kWh/m\(^2\). Despite these excellent conditions, exploitation of solar energy for electricity generation is amazingly underdeveloped. PV systems are only used occasionally for decentral power supply for border stations, lighthouses, water pumps, water desalination plants and telecommunication facilities.

A programme for decentral rural electrification started in 1995 with national and international promotion provides households in rural areas with Solar-Home systems (SHS) with a capacity of 100 W\textsubscript{p}. In order to retain the operability of the installations and the supply infrastructure in the long term, training measures covering the themes of service, maintenance and plant surveillance were conducted in parallel.\textsuperscript{247}

In a demonstration project the community of Ksar Ghilène in a desert area in southern Tunisia was electrified with a central PV system. Solar energy is used here to pump water, for telephones, and for lighting.

Tunisia aims to supply all rural areas with electricity by the year 2010. Solar electricity generation should make a contribution of 3% towards achieving this goal.

**Other Renewable Energy Sources**

Tunisia has no plants for direct conversion of biomass to electricity. Nothing is known about plans to use biomass to produce electricity. According to in-

\textsuperscript{246} The feasibility study was drawn up jointly by STEG, AME, INM (Institut National de la Météorologie) in cooperation with the American firm US Windpower.

\textsuperscript{247} Source: http://www.citet.nat.tn/english/energies/sources.html
formation supplied by CITET there is simply a demonstration project that produces biogas on an industrial scale from poultry rearing wastes.

The geothermal energy sources in the south of the country have relatively low temperatures between 30°C and 80°C and are not suitable for electricity generation. They are therefore chiefly used as therapeutic thermal spas.

Some 235 GWh electrical energy was produced by hydropower in Tunisia in the year 2000. The Sidi Salem dam has been in operation since 1982 and is the most important hydroelectric plant in Tunisia. With an installed capacity of 36 MW it produces 40 GWh a year.

The government is pursuing the goal of increasing the share of hydropower to approx. 330 GWh a year by 2010 by building new installations. It is planned that small hydropower plants especially should be used.

Exchange rate (11.12.2001):
1 Tunisian Dinar = 0.76 €

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Electricity Market

During the past 20 years the electricity market in Turkey was one of the fastest growing in the world. The International Energy Agency estimated growth in consumption between 1973 and 1995 at on average 9 % - 10 % per year. Despite the major economic crisis under which the country has been suffering since the end of 2000, a barely inhibited growth in demand is expected for the coming decade too. Forecasts by the Turkish electricity generating and transmission company TEAŞ, which produces 91 % of the electricity in Turkey in 15 thermal and 30 hydroelectric plants, still assume a rise in consumption of on average 9 % a year up to the year 2015.

Power supply interruptions are increasing, since power station construction cannot keep pace with the growth in demand and production and distribution losses amount to 20 %. Attempts are being made to alleviate the problem by purchasing electricity from neighbouring countries. For instance Turkey imports electricity from Turkmenistan, Bulgaria, Russia (via Georgia) and Iran. Alongside these direct purchases of electricity, Turkey has also boosted its natural gas imports and uses these chiefly to increase electricity generation in newly erected LNG power stations of independent electricity producers.

Electricity generation is currently based essentially on the use of hydropower resources, as well as on firing brown coal and hard coal. Natural gas is also being used to a greater extent. At the end of 1999 the installed generating capacity was 26 GW. More than 14 GW of this was accounted for by thermal plants and nearly 11 GW by hydroelectric plants (Fig. 19).

248 According to reports the hitherto electricity trading agreement of 1999 with Bulgaria for 3 TWh is to be extended to 5 TWh by 2005. An increase in the volume of electricity imported was agreed with Russia in October 2000.
According to the long-term plan 2000 – 2020 of the Turkish Ministry of Energy (Ministry of Energy and Natural Resources – MENR), energy demand will more than triple during this period. If the forecasts are correct and no action is taken to counter demand, Turkey will need generating capacity of about 64 GW at the end of this decade.\(^{249}\)

One factor alongside the economic slump that could reduce the rapid growth in electricity demand, at least in the short term, is the steep rise in consumer prices for electricity. Basic electricity prices for industry and private customers have risen by 120 % within one year (from October 2000 to October 2001) (see Fig. 20).\(^{250}\)

\(^{249}\) According to other data a peak load demand of 46.2 GW is forecast for the year 2010.

\(^{250}\) Source: Turkish Electricity Distribution Corporation (TEDAŞ), but in connection with substantial general inflation.
A first step towards allowing private companies in this sector was taken already in 1984 with Law 3096 on the “Award of licences to institutions other than the (then) Turkish utility company TEK for generation, transmission, distribution of and trade with electricity”.\textsuperscript{251} The background to this was formed by high financial requirements in the electricity sector and a condition imposed by the IMF limiting the burden of external debt. According to this, activities by private investors had to be certified. The licences issued by the state were always for a limited term (max. 99 years).

The former central state-owned utility TEK was divided up in 1993 into two separate enterprises, TEAŞ (electricity generation and transmission) and TEDAŞ (electricity distribution) (ordinance of 15.9.1993). TEAŞ is responsible not only for building and operating power stations, but also for the transmission network above 66 kV. TEDAŞ with seven regional enterprises, formed in 1995 above all for the purpose of privatisation, is responsible for distributing electricity at the lower voltage levels. The electricity for this is purchased almost exclusively from TEAŞ. In addition there are further distribution companies at local level without any electricity generation of their own.

In March 2001 the Turkish government passed the long awaited electricity market law (Law 4628\textsuperscript{252}), which paves the way for liberalising electricity generation and distribution in the country. Its signature by the Turkish President in July 2001 essentially heralded the following modifications in the electricity sector:

- TEAŞ is to be divided into three independent enterprises for electricity generation (Turkish Electricity Production Corporation), electricity transmission (Turkish Electricity Transmission Corporation) and electricity trading (Turkish Electricity Trading and Contracting Corporation).

- Türkiye Elektrik Üretim Anonim Şirketi (Turkish Electricity Production Corporation) will take over all generating plant from TEAŞ and can operate, expand or reduce these installations within the framework of capacity planning by the regulatory authority for the electricity market. The requirements of private electricity producers must be taken into account here. The share of total capacity held by a private electricity producer may not exceed 20 % of the installed capacity in Turkey the year before. The regulatory authority prescribes the volume of electricity that autonomous producers can sell externally. Generally this may not exceed 20 % of the total volume produced in a calendar year. Furthermore special rules apply for autonomous generators.

- Türkiye Elektrik Iletim Anonim Şirketi (Turkish Electricity Transmission Corporation) is responsible for the operation, maintenance and servic-

\textsuperscript{251} Published in the Official Gazette of 19.12.1984; amended by Law 3613, published in the Official Gazette of 15.3.1990

\textsuperscript{252} Published in the Official Gazette of 3.3.2001
Electricity trading rests in the hands of Turkish Electricity Trading and Contracting Corp., which assumes all rights and obligations from the contracts of TEAŞ and TEDAŞ, as well as in the hands of private electricity trading enterprises. The share of a private enterprise in electricity trading in any year may not exceed 10% of the total energy consumed the preceding year.

The corporations for electricity generation and electricity trading will be privatised, while transmission remains in the hands of the Turkish state.

A regulatory authority will be set up to supervise the Turkish electricity market. It will also be responsible for examining and approving tariffs for carriage, distribution and electricity sales to large-scale consumers, retailers and end consumers, the award of licences and for monitoring competition. A further important task of the regulatory authority is to adapt existing contracts to the provisions of the new electricity market act. The authority works together with the MENR.

Each activity in the electricity market, such as generation, transmission and distribution of electricity, trade and autonomous production, must be licensed by the regulatory authority. The award of licences is regulated and supplemented by rules and regulations. Licenses are awarded for a maximum of 49 years. The statutory minimum duration for production, carriage and distribution licences is 10 years. Within the framework of a production licence generating companies are allowed to hold shares in distribution companies too.

The regulatory authority issues electricity distribution licences for a specific territory in each case. In addition to their distribution and sales activities, holders of distribution licences are permitted to set up and operate electricity generating plants in licensed territory. However they must procure a generating licence for this and the annual electricity generation in these installations may not exceed 20% of the previous year's electricity supplies in the relevant territory. Distribution companies may only purchase additional electricity up to a volume of 20% of the volume of electricity distributed in the preceding year.

After discussion and agreement with the electricity transmission corporation, the regulatory authority can allow an electricity trading company to import and export electricity additionally within the framework of an electricity wholesale licence. This extension of the licence will only be granted for a certain volume of electricity and for a certain period, which may differ from the period of validity of the actual electricity trading li-
Unlike the licence for selling electricity to large-scale consumers and retailers (electricity wholesale licence), the licence for selling electricity to end consumers is not subject to territorial restrictions. It applies without limitation for the entire Turkish electricity market. Electricity distribution companies holding an electricity trading licence can also sell electricity to end customers in the territory of another distribution company if this is noted in the licence.

Import of electricity at the medium voltage level (<36 kV) is also allowed under the same framework conditions as for the electricity wholesale licence.

Grid-independent electricity generation for autonomous consumption need not be licensed. However, autonomous generators and autonomous generator groups in grid-coupled operation need a licence authorising them to produce electricity for their own consumption and consumption by their partners and to sell surplus electricity to third parties. The volume of electricity which may be sold to third parties is fixed by the regulatory authority and adjusted regularly.

A transitional period of 18 months after the date of proclamation is planned for implementing the electricity market act. The cabinet can extend this period by up to six months.

In the opinion of experts the position of BOT and TOR projects (Transfer of Operation Rights) in the electricity sector that have already been realised or are in the process of implementation has become very uncertain as a result of the adoption of the electricity market act. There has not yet been any clarification by the Turkish government. This situation must be rectified as soon as possible.

Renewable Energy

At present exploitation of renewable is based above all on the use of medium capacity hydroelectric plants. In 1999 the installed capacity for electricity produced from renewable energy sources (without large-scale hydroelectric plants) totalled 25 MW. For the year 2010 about 600 MW are forecast.

The coastal regions and Southeast Anatolia especially offer favourable conditions.
ditions for wind turbines. The southeast and Mediterranean region provide good solar conditions. The Marmara and Aegean region show potential for exploiting geothermal energy, while the Black Sea region has potential for the use of small and micro hydropower plants. Agglomeration areas offer good conditions for using the biomass produced for electricity generation.

Hydropower

The share of hydropower in the total electricity generating capacity increased from 32% in the year 1979 to 47% in 1995 and is now 44%. In 1999 hydropower accounted for 31% of the total volume of electricity generated.

About 30% of the assumed economically useful potential of 125 TWh/a is currently being used already, while a further 4% is at the development stage. In 1999 a capacity of 10.2 GW was installed at 104 locations. A further 38 hydroelectric plants are being constructed. The erection of 339 hydroelectric plants presently being planned will double electricity generation from hydropower by the year 2010. However, this planned headlong expansion of hydropower has led to strong protests from neighbouring countries in the Middle East that suffer from water shortage. The countries of Syria and Iraq especially have declared themselves against damming the Euphrates and the Tigris.

Several hydroelectric plants are only used to cover peak loads. Further expansion of hydropower use in future is to take place above all on the basis of international invitations to tender involving private investors.

Wind Energy

Wind power potential in Turkey amounts to approx. 83 GW, and according to other estimates it is as high as 116 GW (EGETEK - Aegean Technology Foundation). Approx. 10% of this potential can be feasibly used, especially in the country's extended coastal regions.

Wind energy is not very highly developed in Turkey so far when measured against the potential, and it has a relatively brief history. At the end of 2000 a total of 19.2 MW was installed in Turkey, distributed between three locations: Germiyan/Izmir with 1.6 MW, Bozcaada/Canakkale with 10.2 MW and Alaçatı/Izmir with 7.4 MW.

The main reason for the low level of wind power dissemination is considered to be the pronounced attitude of reserve of the Turkish government, and thus also of TEAŞ, regarding New Energies. The most recent planning provides for an increase in installed wind power to just 1.6 GW by the year 2025. In fact wind energy is not even expressly taken into account in the current projections of the Ministry of Energy (MENR). However Turkey's top
industrial association, TÜSİAD, assesses the development of wind power in the country positively. The association considers that the following increases are possible:

- by 2010 to 3 GW
- by 2020 to 8 GW
- by 2023 to 10 GW

In 1998 the first two wind farms were started up in Turkey with 1.6 MW and 7.4 MW. Both wind farms are in the town of Alaçati, located near the Mediterranean. The larger wind farm, inaugurated at the end of 1998, was constructed as a BOT project by the private-sector firm ARES (Alaçatı Rüzgar Enerjisi Santrali) with components from the Danish company Vestas. The plant is operated by a joint venture consisting of the companies Interwind (Switzerland), Lockheed Martin, Güçbirliği Holding, Atamer Dış Tic., Ergun Özakat and the municipal administration of Alaçati.

In June 2000 a third wind farm was started up on the Aegean island of Bozcaada. This 10.2 MW BOT project is operated by the firm BORES A.Ş. (Bozcaada Rüzgar Enerji Sentralı), a joint venture between Demirer Holding and the German plant manufacturer Enercon.

By mid-2000 altogether 71 applications had been submitted for wind turbines with a total capacity of 2.4 GW. By the end of 2000 the Turkish government had approved 17 of these with a total of 494 MW, that were to be set up by the end of 2002.

This development shows that despite the government’s reserved attitude to renewable energies, and a new electricity market law that does not grant any preferences to renewable energies, the wind power market is expanding and in view of the available potential is becoming increasingly attractive.

There is not yet any local production of wind turbines. Only a German-Turkish joint venture for producing components is planned near Düzce.

### Biomass

The Turkish energy sector is becoming increasingly interested in the use of biomass for electricity generation, even though applications are only marginal at present.

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255 Source: German-Turkish Chamber of Industry and Commerce / Ing. Lale Çapalov (RödlPartner Consulting Türkei GmbH), Potenzial für erneuerbare Energien in der Türkei, March 2001

256 Autonomous supply plant of Demirel Holding; equipment from the German firm Enercon GmbH

257 Source: Potenzial für erneuerbare Energien in der Türkei, German-Turkish Chamber of Industry and Commerce / Ing. Lale Çapalov, RödlPartner Consulting Türkei GmbH, March 2001, on behalf of Landesinitiative Zukunftsenergien NRW
So far there are only three small plants for autonomous production of electricity: a landfill gas plant in Bursa with 1.4 MW, a biogas plant in Ankara with 3.2 MW, and a biogas plant in Izmit with 5.4 MW installed capacity.\(^{258}\)

Four further plants for electricity generation from landfill gas in Adana (45 MW), in Ankara (10 MW), in Mersin and in Tarsus (together 30 MW), as well as a plant for energy production from wood wastes in Kastamonu (8 MW\(_{el}\) / 23 MW\(_{th}\)) and an autonomous production plant of the firm Selcuk Gida for using residues from food production (16 MW) are in the planning phase.

**Solar Energy**

Thanks to its geographical location Turkey possesses considerable potential for solar energy. Only a fraction of this potential is used to date, almost exclusively for hot water heating.

In the PV sector, apart from a series of private small and micro plants, there is only a small number of pilot projects of the state research centre for electricity (Elektrik İşleri Etüd İdaresi – EIEI) for powering remote loads, such as watch-towers of the Ministry of Forestry (175 kW\(_{p}\)), meteorological data survey stations (50 kW\(_{p}\)) and emergency telephones along the motorway/freeway Ankara-Bolu (25 kW\(_{p}\)). A grid-coupled experimental plant with 4.7 kW\(_{p}\) was started up in Didim in 1998.

**Geothermal Energy**

With a geothermal potential of 31.5 GW\(_{th}\) and 4.5 GW\(_{el}\) Turkey ranks seventh in the world. According to a study by the top Turkish industrial association TÜSİAD, of this potential 2.4 GW\(_{th}\) and 350 MW\(_{el}\) can be used economically.

Alongside a series of projects for thermal use, partly dating back to the early sixties, the only plant for electricity generation is operated in Denizli-Kizildere. Originally designed for 20.4 MW\(_{el}\), the now outdated power station only runs with a capacity of 12 MW\(_{el}\).

According to the information supplied by the German-Turkish Chamber of Industry and Commerce, one power station \(^{259}\) and five heat stations (altogether 73.6 MW\(_{th}\)) are currently being constructed. Feasibility studies have been completed for nine further heat stations (altogether 655 MW\(_{th}\)).

**Incentive Systems for Electricity from Renewable Energy**

On the basis of the general statutory regulations for the Turkish electricity

\(^{258}\) Source: ibid

\(^{259}\) BOT project near Afyon-Germencik with an installed capacity of 25 MW\(_{el}\)
industry, the use of renewable energies has been facilitated by a series of ordinances and cabinet decisions during the last three years.

The licence-related requirements made of autonomous electricity production from renewable energies have been reduced substantially. For example, the minimum conditions otherwise applying for autonomous electricity production (e.g. settlements of 1,000 households and more, hotels of the four-star category and above) do not apply for wind and solar energy. The transmission costs for electricity produced from solar and wind power are reduced to 50% of the normal tariff for the first five years of operation.

Up to the introduction of the new electricity market law, projects could largely only be set up under the BOT model, or in some cases under the BOO model. Now that this law has entered into force the BOT model will no longer play a role. There is a lack of any adapted regulation on remuneration for private electricity generating plants on the basis of renewable energy.

There is a state investment promotion programme for Turkey that can also be used by companies with foreign capital participation. The programme measures are graded by sectors of the economy and regions of the country (underdeveloped, normal and developed regions). The criteria are reviewed annually and adjusted to the economic development. In addition to sectoral and regional priorities, project-related criteria such as e.g. volumes of investment and self-financing levels are also taken into account in decisions regarding applications for promotion assistance.

The following promotion measures enter into consideration:

- exemption from customs duties and incidental import charges (since the customs union with the EU this is largely only significant for German companies in the case of imports from third countries),
- special depreciation allowances for certain investment expenditures,
- exemption from turnover tax,
- exemption from certain incidental charges, especially export charges,
- low-interest loans.

The energy sector is classed as a priority sector with regard to investment promotion, i.e.
projects are eligible for promotion irrespective of their regional allocation (normally projects in developed regions cannot be promoted);

one hundred percent depreciation is admissible (generally only depreciation up to 60% of the investment is admissible in normal regions and only depreciation up to 40% in developed regions). \(^{260}\)

Exchange rate (11.12.2001):
1 million Turkish Lira = 0.76 €

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TEAŞ will be divided up into three independent enterprises in accordance with the recently passed electricity market law. The locations of the future company head offices are not yet known.

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