Division Environment and Infrastructure
TERNA Wind Energy Programme

# Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

## 23 Country Analyses
## Chapter Pakistan

Eschborn, September 2007

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## New Edition of the TERNA Country Survey

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

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

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

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

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

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

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

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

Eschborn, September 2007

## Legal Information

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

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## The TERNA Wind Energy Programme

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

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

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

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

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

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

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

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

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# 21 Pakistan

## 21.1 Electricity Market

### Generating capacity

In mid-2006, Pakistan's total installed power generating capacity amounted to 19,450 MW, and had therefore more than doubled since 1990/91 (8,776 MW). Thermal power plants contributed 64% of that total, while hydropower accounted for 34%, and Pakistan's two nuclear power plants 2%.[1]

| | Hydropower | | Thermal | | Nuclear | | Total |
|---|---|---|---|---|---|---|---|
| | MW | % | MW | % | MW | % | MW |
| 2001/02 | 5,051 | 28.4 | 12,286 | 69.0 | 462 | 2.6 | 17,799 |
| 2002/03 | 5,051 | 28.4 | 12,285 | 69.0 | 462 | 2.6 | 17,798 |
| 2003/04 | 6,496 | 33.7 | 12,299 | 65.4 | 462 | 2.4 | 19,257 |
| 2004/05 | 6,499 | 33.5 | 12,423 | 64.1 | 462 | 2.4 | 19,384 |
| 2005/06 | 6,499 | 33.4 | 12,489 | 64.2 | 462 | 2.3 | 19,450 |

**Tab. 1: Power generating capacities by energy source; Pakistan; 2001/02-2005/06, MW, %[2]**

### Power generation

The electricity market in Pakistan has been characterised in recent years by marked changes in the primary energy sources used for producing electricity. In the 1990/91 accounting year, hydropower still accounted for nearly 45% of all electricity generated in the country, but by 2005/2006 that share had dropped to only 33%, after falling as low as 26% in 2001/2002. In the same period, the share of thermally generated electricity increased from 54% to 64%. Most of that increase is the result of capacity expansion since the early 1990s in response to power shortages and the resultant frequent power outages.

Pakistan has little commercially exploitable oil of its own. Consequently, as much as 75% of the country's oil needs were met by imports in the fiscal year 2005/06. The imports were used for such purposes as firing thermal power plants. Plants fuelled with natural gas, however, operate almost exclusively on domestic resources. This also applies to Pakistan's few coal-fired power plants.[3]

In 2005/06 the partly state-owned enterprises WAPDA and KESC produced 57% and 10% of the country's electricity respectively. The two state-owned nuclear power plants contributed 3%, while independent producers accounted for a share of 30.5%. In the 2005/2006 accounting period the amount of electricity generated increased by 9.3% compared with the previous year, to approximately 94 TWh.

| | Hydropower | | Thermal | | Nuclear | | Total |
|---|---|---|---|---|---|---|---|
| | GWh | % | GWh | % | GWh | % | GWh |
| 2001/02 | 18,941 | 26.1 | 51,174 | 70.7 | 2,291 | 3.2 | 72,406 |
| 2002/03 | 22,351 | 29.6 | 51,591 | 68.2 | 1,740 | 2.3 | 75,682 |
| 2003/04 | 26,944 | 32.1 | 52,122 | 64.5 | 1,760 | 2.1 | 80,827 |
| 2004/05 | 25,671 | 30.0 | 57,162 | 66.8 | 2,795 | 3.3 | 85,629 |
| 2005/06 | 30,862 | 33.0 | 60,283 | 64.4 | 2,484 | 2.7 | 93,629 |

**Tab. 2: Power generation by energy source; Pakistan; 2001/02–2005/06, GWh, %[4]**

### Transmission network and power losses

The transmission network in Pakistan consists of 500-kV and 220-kV lines.[5] According to a report from the Pakistani grid operator published in January 2007, the transmission system is not capable of meeting the load. In 2006, 77% of the 500-kV power transformers and 69% of those rated at 220 kV were overloaded. In January 2007 the Asian Development Bank (ADB) put up a loan amounting to US$ 226 million for expansion of the network.

1 The nuclear power plant in Karachi has been in service since 1971 and a second in Chashma was commissioned in 2001.
2 Source: HDIP (Pakistan Energy Yearbook). The fiscal year in Pakistan ends on 30 June.
3 Pakistan's commercially exploitable gas reserves were estimated at approximately 32.6 billion cubic feet in 2006. Since some substantial new deposits of brown coal (lignite) have been located in the Thar Desert in the province of Sindh, Pakistan is planning to increase the share of coal used for generating electricity.
4 Source: HDIP.
5 A map showing the existing transmission lines can be found on the homepage of the distribution network operator, NTDC. See: www.ntdc.com.pk/TransmissionLines.asp

The existing national power transmission- and power distribution systems reach so far 55 % of the Pakistani population. The safe and reliable transmission and distribution of electricity remains a major problem in Pakistan. Due to weak grid infrastructure and substantial theft of electricity, losses from the transmission and distribution network totalled 26,5 % in 2005. The government has set the aim of reducing losses to 21.5 % by 2010.

Demand for electricity rose by 6.6 % in the fiscal year 2004/05 compared with the previous period. In 2005/06 the rate of growth was even higher, at over 10 %. Further rises in electricity demand are expected to continue in the years to come. As the growth in demand will exceed the new capacity that is planned to be added in the short term – an increase of more than 4 % per annum is expected for the period 2006 to 2009 – it is possible that there will be shortfalls in electricity supply in the coming years. These deficits are meant to be countered by private investment.

| | Households | | Industry | | Agriculture | | Public institutions | | Trade/commerce | | Street lighting | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TWh | % | TWh | % | TWh | % | TWh | % | TWh | % | TWh | % | TWh |
| 2001/02 | 23.2 | 46.0 | 15.1 | 29.8 | 5.6 | 11.0 | 3.4 | 6.7 | 3.0 | 5.9 | 0.2 | 0.6 | 50.6 |
| 2002/03 | 23.6 | 44.8 | 16.2 | 30.7 | 6.0 | 11.3 | 3.3 | 6.3 | 3.2 | 6.0 | 0.2 | 0.4 | 52.7 |
| 2003/04 | 25.8 | 44.9 | 17.4 | 30.2 | 6.7 | 11.7 | 3.6 | 6.3 | 3.7 | 6.4 | 0.3 | 0.5 | 57.5 |
| 2004/05 | 27.6 | 45.0 | 18.6 | 30.3 | 7.0 | 11.4 | 3.7 | 6.0 | 4.1 | 6.7 | 0.3 | 0.5 | 61.3 |
| 2005/06 | 30.7 | 45.4 | 19.8 | 29.3 | 7.9 | 11.7 | 4.0 | 5.9 | 4.7 | 7.0 | 0.4 | 0.6 | 67.6 |

**Tab. 3: Power consumption by ultimate user; Pakistan; 2001/02-2005/06; TWh, %[6]**

## Power consumption

With the sole exception of fiscal year 1998/99, power consumption in Pakistan has grown steadily in recent years. Between 2001/02 and 2005/06, total consumption increased by more than 33 %, from 50.6 TWh to 67.6 TWh. Again with a single exception – fiscal year 1990/91 – the domestic sector was the consumer group with the largest proportion of consumption, followed by industry and agriculture.

## Electricity tariffs

Electricity tariffs are set individually for each of the eight distribution companies by the regulatory authority NEPRA. The tariffs are differentiated in various ways, for example between households, commerce, agriculture, industry and public lighting. Apart from a fixed monthly standing charge that has to be paid regardless of electricity consumption, the tariff system is progressive. In addition, the electricity tariffs vary according to peak-load and low-load periods.[7] In January 2007 it was announced that the electricity tariffs were to be raised by an average of 20 %.

6 Source: HDIP.

7 Detailed tables can be found on the homepage of the regulatory authority: www.nepra.org.pk

### Expansion of generating capacities

In light of the projected increase in the demand for electricity by some 10,000 MW by the year 2010, the Government of Pakistan launched a large-scale expansion programme for the long term. To minimise future supply deficits, Pakistan has adopted a development plan called 'Vision 2025' that targets a long-term capacity increase of around 35,000 MW by the year 2025. The plans for expanding generating capacity were updated for the period 2005 to 2010 in the government's medium-term development plan. In this plan, the Government Planning Commission sets the objectives for 2030 of continuing to increase the proportion of domestic hydropower (almost 33,000 MW), making more use of domestic coal resources for electricity generation (20,000 MW), expanding the installed capacity of nuclear energy from today's figure of 400 MW to 8,800 MW, and making greater use of renewable energy (9,700 MW, i.e. a share of at least 5 %, not including hydropower). This is intended to increase the security of supply for the country and reduce dependence on imports, in particular crude oil.

## 21.2 Market Actors

### Utility companies WAPDA and KESC

Two utility companies, both still partly in state ownership, currently dominate the electricity market in Pakistan: WAPDA (Water and Power Development Authority) and KESC (Karachi Electric Supply Corporation). The Pakistan Water and Power Development Authority was founded in 1958 to help coordinate work in these two sectors. In addition to the generation, transmission and distribution of electricity, its tasks also included water supply, flood management and inland waterway transport. WAPDA is by far the largest power producer in Pakistan: in June 2006 it owned 58 % of all generating capacity, while KESC held 9 % of the total . WAPDA's transmission and distribution network extends across large parts of the country, whereas KESC is responsible for supplying the trading area of Karachi, capital of the province of Sindh.

In addition to the state operators of the two nuclear power plants, Karachi Nuclear Power Plant (KANUPP) and Chashma Nuclear Power Plant (CHANUPP), since 1994 a series of private operators have set themselves up as independent electricity generating companies.

### Vertical unbundling and privatisation of WAPDA and KESC

The vertical disintegration of WAPDA was begun in the year 2000 as part of the country's new electricity market restructuring and liberalisation programme. WAPDA was broken down into thirteen separate units: four generating companies, eight distribution companies, and the National Transmission and Dispatch Company (NTDC). The Pakistan Electric Power Company (PEPCO) was founded in 1998 to handle the unbundling and privatisation process.

By the end of 2006 only the generating company KAPCO had been privatised. This company, which was listed on the stock exchange in April 2005, is now the country's largest privately owned producer, with an installed capacity of 1,600 MW. The distribution companies FESCO and GESCO and the generating companies Jamshoro Power Co. and National Power Construction Corporation Pvt. Ltd. are the next ones scheduled for privatisation.[8] In December 2005, 73 % of the shares in the regional state-owned utility company KESC were sold to a Pakistani-Saudi Arabian consortium.[9]

8 The companies being readied for privatisation are presented on the homepage of the national Privatisation Commission (www.privatisation.gov.pk).

9 The consortium is made up of Hasan Associates, Al-Jomeih Holding Co. and Premier Mercantile Services.

However, the envisaged privatisation of these independent generating and distributing companies is proving difficult, because they often operate at a loss due to unpaid bills and submarginal electricity tariffs. Despite the repayment of debts, WAPDA and KESC have continued to make losses in recent years. Moreover, the national trade unions are opposed to the privatisation of the electricity companies. For the time being, hydropower will continue to be excluded from the privatisation process as it is a separate field within WAPDA; it will therefore remain in WAPDA's possession.

### Independent power producers

All in all, 19 independent power producers of notable size had been granted licences by the regulatory authority by the end of 2006.[10] The two largest privately owned electricity generating companies are the HUB Power Company (HUBCO) and the Kot Addu Power Company (KAPCO). HUBCO belongs to a consortium formed by National Power (United Kingdom), Xenal (Saudi Arabia) and Mitsui Corporation (Japan), and possesses just under 1,300 MW of generating capacity.

In addition to engaging in competitive bidding, privately owned producers can apply to NEPRA for permission to implement a project without being requested to do so. Instead of negotiating the power purchasing contracts bilaterally with each power purchaser, NEPRA sets the tariffs following consultation with the independent power producer and the power purchaser.

At the end of 2006 the Private Power and Infrastructure Board PPIB, the state-owned consulting institution for private investors which is responsible among other things for conducting negotiations on the implementation of projects, dealt with 50 projects with a total capacity of over 13,000 MW. These are supposed to enter service over time through to January 2016. The additional capacity is shared relatively evenly between hydroelectric and thermal power plants. In 2005 the Ministry of Water and Power decreed that the regulatory authority NEPRA should draw up tariff tables for independent power producers according to technology type, with the aim of achieving greater transparency and simplifying the award of licences. These tables were not yet available by January 2007.

## Other Actors

### Private Power and Infrastructure Board (PPIB)

With a view to improving investment incentives in the Pakistani power sector, a new state-owned consulting institution was established in 1994: the Private Power and Infrastructure Board (PPIB). This institution is intended to serve as a central contact point primarily for private investors in Pakistan's power sector, providing advice and guidance for the implementation of power plant projects. PPIB's main task is to negotiate the implementation agreement and provide support in negotiating fuel supply contracts and power purchase agreements. PPIB also provides guarantees to private investors that government entities will meet their obligations in the power market, monitors litigation and international arbitration for and on behalf of the Government of Pakistan, and assists the regulatory authority in determining and approving tariffs for new private power plant projects. PPIB is staffed by representatives of the four provinces and the semi-autonomous territory of Azad Kashmir.



10 The license for another power producer, New Park Energy Ltd., is currently in the pipeline.

### Regulatory authority NEPRA

The sectoral regulatory authority, the National Electric Power Regulatory Authority (NEPRA), was created by statute in December 1997. In particular NEPRA is intended to ensure fair competition and the protection of consumers. NEPRA's most important powers include the issue of licences for power production, transmission and distribution (including the setting of licensing fees) and the specification of electricity tariffs. As consumers have so far not had the option of purchasing electricity from producers of their choice through bilateral agreements, NEPRA is also responsible for specifying the sale of electricity by the producers to NTDC. In addition, NEPRA is able to impose fines for non-compliance with the relevant regulations.

### Alternative Energy Development Board (AEDB)

The Alternative Energy Development Board (AEDB) was established in May 2003; it answers directly to the Prime Minister. The purpose of the Board is to promote and exploit the country's renewable resources and achieve the objective set by the government of expansion to 10 % by 2015 (not including hydropower). The AEDB is also responsible for developing the national policy for promoting renewable energy sources in the medium and long term, which has been set out in a set of measures known as the Policy for Development of Renewable Energy for Power Generation. In addition, its functions include the coordination of joint ventures with the aim of having foreign technologies in the field of alternative energies fabricated in Pakistan. The AEDB is also responsible for handling projects in the renewable energy sector.

## 21.3 Legal Framework

The ministry responsible for formulating Pakistan's energy policy is the Ministry of Water and Power (MoW&P). Due mainly to the shortage of electricity in the 1980s and early 1990s, a strategy plan geared to restructuring the Pakistani electricity sector was adopted in 1992.

### Private sector power law of 1994

An energy law was adopted in 1994 (Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan). It was meant to encourage private investment in Pakistan's electricity sector and standardise the investment conditions for independent power producers. It covers the following measures in particular:

- Up-front setting of a uniform rate of remuneration amounting to 5.7 US cents/kWh, coupled to the exchange rate between the Pakistan rupee and the US dollar, including allowance for the U.S. inflation rate and potential fluctuations in raw-material prices[11]
- Surrender of decision-making powers to the project's implementing institution with regard to the size, technology, energy source and siting of the power plant
- Guarantee of power-grid connection and purchase of power within the framework of standard contracts
- Guarantee of supply of the required primary energy sources, for as long as a supply contract with a government institution is in place
- Exemption of independent power producers from numerous forms of taxation (corporation tax, income tax and turnover tax) and duty

11 In addition, a bonus of 0.25 US cents/kWh was offered for power plant projects commissioned by the end of 1997.

### Power law of 2002

A new power law was enacted in 2002. Basically, it closely resembles its predecessor dating from 1994, but it has a broader range of application. Entitled 'Policy for Power Generation Projects – Year 2002', the new power law promotes both private investment projects and public-private partnerships (PPP). It also makes it possible for private investors not only to participate in public tendering for projects but also to propose power plant projects on their own.

The respective provincial governments are now responsible for approving plants with ratings below 50 MW. A two-component system of remuneration has been defined for power providers: part of the remuneration depends on the output of the respective plant (capacity purchase price, CPP), and the rest is a function of the sources of energy employed for producing the electricity (energy purchase price, EPP). According to the law of 2004, the latter is supposed to account for at least 34 to 40 % of the total remuneration.

The new provisions from 2002 give preference to projects involving the use of domestic energy resources, i.e. mainly water, coal or natural gas and renewable energy. This manifests itself primarily in the exemption of all such power plant projects from income taxes, turnover taxes and capital gains taxes on imports (with oil-fired power plants constituting an exception). Moreover, import duties on plant components have been reduced to a mere 5 % of the standard rate.

### Wholesale market

Regarding the creation of a wholesale market, as a first step a so-called 'single buyer plus' model was established in July 2002. In that model, the NTDC functions as the sole purchaser of all electricity generated by all producers. Beginning in mid-2009, major consumers are to be allowed to purchase electricity from producers of their own choice by way of bilateral supply agreements. The introduction of a wholesale market is envisaged for mid-2012.

## 21.4 Promotion of Renewable Energy Sources

Pakistan's first promotion measures for renewable energy sources were implemented in the early 1980s. For example, the sixth Pakistani energy plan (1983-1988) devoted approximately EUR 14 million to work on regrowable energy crops and biogas and to a feasibility study into the commercial exploitation of solar energy.

### Pakistan Council for Renewable Energy Technology (PCRET)

In the 1970s and 1980s, initial measures aimed at the promotion of renewable energy were advanced by the Pakistan Council of Appropriate Technology (PCAT, founded in 1975) and the National Institute of Silicon Technology (NIST). In May 2001 these two separate research establishments merged to become the Pakistan Council for Renewable Energy Technology (PCRET). The main purpose of this move was to better coordinate research activities and avoid overlaps.

### Policy for Development of Renewable Energy for Power Generation

In December 2006 the Government of Pakistan published the first national package of measures aimed at promoting renewable sources of energy. The provisions apply to hydropower plants with a capacity of up to 50 MW, solar thermal, photovoltaics and wind energy. Over the short term, i.e. to mid-2008, technologies that are already in commercial use internationally are to be trialled through the mechanism of attractive power purchase contracts and partial risk coverage. In the medium term, i.e. to 2030, it is hoped to have installed at least 9,700 MW of capacity for renewable electricity in this way.

Under these provisions, the grid operator is obliged to purchase the electricity and has to erect connecting lines up to a certain length.[12] In contrast with conventional power producers, generators of renewable electricity have the possibility of selling either some or all of the electricity they produce to end customers within the framework of bilateral contracts. Special incentives are granted for those producers of renewable energy who feed all their generated power into the national grid. These include the risk of varying wind speeds being borne by the power purchaser. If the producer does not attain the previously calculated benchmark level at the project location due to factors beyond his control (for example an unforeseeable lack of wind), remuneration is payable on the basis of the benchmark as originally set. However, remuneration drops if the reduced rate of infeed is attributable to the producer (such as because of a failure to perform maintenance). The benchmark used for this purpose is the average of mean monthly wind velocities at the project location. The average figure is calculated on the basis of data from at least three years. 10 % of the tariff is paid for power produced over and above the benchmark figure. In this way the additional income is shared between the producer and the consumer. The same applies to electricity generated from hydropower.[13]

It is generally a matter for the grid operators to extend and expand the transmission line network. The level of remuneration is set either through public competitive bidding procedures, bilateral negotiations between the independent power producers and NEPRA, or up-front tariff setting (power input remuneration model). NEPRA is currently drawing up precise tariff tables so as to shorten the time needed to set tariffs. The assumptions and methods it uses to do this are to be published.

Operators of renewable energy power plants for self use have the possibility of selling surplus power to the grid operator[14] and of purchasing additionally required electricity at the respective standard tariff. Renewable energy-based power producers are granted further fiscal and financial incentives as part of the package of measures. These include not having to pay customs duty on imported plant components and exemption from income tax.

The conditions for installing off-grid generating plants, especially small hydropower projects, are to be considerably simplified. Relevant arrangements are to be developed by the AEDB and the responsible provincial governments. Small hydropower projects connected to isolated grids of up to 11 kV may then be put into operation by anyone, following consultation with the local authority, without having to obtain approval from the AEDB, the provincial authorities or the Environmental Protection Agency. The tariffs will be negotiated at a bilateral level between the power producers and the consumers. The Government of Pakistan grants a one-time subsidy for the implementation of small hydropower projects of up to 5 MW, based on the plant's installed capacity. Similar arrangements are to be put in place for off-grid wind and solar plants.

For renewable energy-based power generation plants approved after July 2008, competition within the technology categories is to be increased, subsidies reduced and risk cover minimised. In the long term,[15] renewable energy is supposed to become an integrated part of national energy planning and to compete with conventional sources of energy. Further arrangements relating to the use of biomass and other forms of renewable energy are being drawn up by the AEDB and the government.

12 The guarantee applies on condition that the plant is located no further than 70 km from the nearest 220-kV transmission line. At lower voltage levels the maximum distance is reduced (50 km for 132 kV, 5 km for 11 kV and 1 km for 400 V). The producer also has the possibility of installing new power lines to connect to the national electricity grid at its own cost. The electricity purchase tariff is adjusted in accordance with these determinants.

13 A water use charge of 0.15 rupees per kWh is payable in the context of hydropower projects. The charge is adjusted annually according to the rate of inflation.

14 The basis for payment in the case of plants with a capacity greater than 1 MW is the tariffs determined by NEPRA for oil-fired power plants over the applicable quarter of the year, less 10 %. This arrangement applies to all renewable technologies.

15 Long-term projects are classified as those that will be completed from mid-2012 and then begin supplying electricity.

### Clean Development Mechanism

Pakistan signed the Kyoto Protocol in January 2005. The Designated National Authority (DNA) for Pakistan answers to the Ministry of Environment. It is made up of the national CDM Steering Committee, the Technical Committee and the CDM Secretariat, and is advised by the Committee on Climate Change. The latter is composed of several ministers and is chaired by the Prime Minister. The Steering Committee, under the chairmanship of the Ministry of Environment, is responsible for political advice, inter-ministerial coordination and supervision of the implementation of CDM projects. The Technical Committee is divided into three entities: renewable energy/energy efficiency, waste management, and agriculture, forestry and livestock. The CDM Secretariat is the main point of contact for CDM affairs and issues licences for CDM projects on behalf of the government.

The first CDM project was registered with the UNFCCC in November 2006. According to the package of measures for renewable energy of December 2006, all qualified renewable energy projects (in the initial phase these are projects in the fields of windpower and mini-hydropower) are to be encouraged to register as CDM projects to enable them to trade in emission reduction certificates. The receipts from the trade in emissions certificates are supposed to be taken into account when setting tariffs, and must be openly declared to the regulatory authority. The Government of Pakistan aims to promote the implementation of CDM projects in cooperation with international development organisations, and allocated about EUR 500,000 (39 million rupees) for this purpose in 2006.

## 21.5 Status of Renewable Energy Sources

In addition to growing levels of research and other work to determine the actual potential for utilisable renewable energy sources in Pakistan, plans to develop these sources are also multiplying, as indeed are development operations themselves. In particular the expansion of hydropower and wind power is currently being stepped up, for both large- and small-scale plants.

### Hydropower

The total theoretical hydroelectric potential in Pakistan has not yet been fully evaluated. Conservative estimates assume a capacity of roughly 45,000 MW. In view of the expected growth in demand and the fact that not even 20 % of the potential for hydropower is being exploited, the government is planning to expand hydropower in several stages. By the end of 2006 the total installed hydropower capacity was 6,608 MW, mostly in the northern parts of the country. This was made up of 5,928 MW in large hydropower plants (> 250 MW), 437 MW in medium-sized plants (from 50 MW to 250 MW) and 253 MW in small to micro plants (< 50 MW).

One important major project that commenced operation in 2003 is the Ghazi-Barotha run-of-river plant on the upper reaches of the Indus, built for a total output of 1,450 MW. The additional plant has enabled the share of hydropower in total installed capacity to be considerably increased again. The project was financed by the World Bank, the ADB, the Japan Bank for International Cooperation (JBIC), the European Investment Bank, the Islamic Development Bank, and resources from German Financial Cooperation (KfW). WAPDA covered 47 % of the total costs, contributing about US $ one billion.

In addition to this major project, further medium-size hydroelectric plants were installed by GTZ between 2002 and 2005 as part of the national programme to promote hydropower. In 2006 the Government of Pakistan applied for a loan from the ADB for projects in the field of renewable energy. The first tranche of the loan, amounting to US$ 510 million, was pledged by the ADB in December, and among other things is supposed to be used to implement medium-sized and small hydropower projects in the north-west of the country. The projects include eight grid-coupled hydropower plants ranging in capacity between 2.6 MW and 36 MW. In recent years, 570 locations with a total capacity of 2166 MW have been identified in the category of hydropower projects with ratings between 1 MW and 50 MW.

### Micro hydropower

In northern Pakistan alone there is an estimated potential of 300 MW for micro-hydropower plants with installed capacities below 100 kW each. The potential in the canal system of the Punjab amounts to a further 350 MW. Up until 2006, PCRET had installed 300 micro-hydropower systems in the mountainous North-West Frontier Province, with a total capacity of 3 MW. The systems have a rated output of between 5 kW and 50 kW. All of the components come from domestic production.

### Wind energy

There are many regions in Pakistan suited to the commercial exploitation of wind energy, including in particular the south of the province of Sindh and the coastal region of Balochistan. At the beginning of the 1990s initial wind measurements were conducted at locations throughout the country but especially in the province of Balochistan, which were used to produce the first wind maps.[16] In recent years wind measurements were taken in the region around Gharo-Keti Bandar for the specific purpose of planning wind farms.

### UNDP/GEF project 'Commercialisation of Wind Power Potential in Pakistan'

The first official initiative to stimulate the use of wind power in Pakistan was launched in November 2000. With financial support from UNDP and GEF, Pakistan's Ministry of Environment initiated a project entitled 'Commercialisation of Wind Power Potential in Pakistan'. This included a study that identified the existing obstacles to the use of renewable energy in Pakistan and put forward suggestions on how to overcome them. The suggestions were largely taken up within the framework of the package of measures for renewable energy from December 2006.

Under the aegis of the follow-up programme, Sustainable Development of Utility-Scale Wind Power Production: Phase 1, which was launched in January 2004 for a period of five years, wind power is supposed to gain a foothold in Pakistan through the elimination of political, institutional, legal, fiscal and technical barriers. Wind power is also supposed to be integrated into Pakistan's power grid, especially in remote regions.

### Wind energy projects

Planning for commercial wind farms in Pakistan is concentrated on the area around Gharo-Keti Bandar in the province of Sindh in the south-east of the country. The AEDB has identified a wind corridor in this region that because of excellent local conditions promises a potential wind energy capacity of 50,000 MW. Average wind speeds at a height of 65 meters are around 7 to 8 m/s. The AEDB will facilitate use of the land on favourable rental terms at approximately EUR 15 per hectare and year. The NTDC will construct new transmission lines from Mirpur Sakro to Thatta to cater for the additional capacity in the region.

16 See Nasir/Raza/Raja, 1992 and Nasir/Raza/Abidi, 1991.

In 2004 the AEDB authorised the private company New Park Energy to build the first 45 MW of a wind farm in Koti-Kun near Gharo that is ultimately planned to have a capacity of 400 MW. The project is to be implemented in further phases of 45 MW each. General Electric will supply 30 turbines for the first phase, each rated at 1.5 MW. The power generated from wind energy is to be fed into the KESC grid. Before the commencement of physical implementation, in the spring of 2007 the investor had not yet submitted a Performance Guarantee, which the AEDB requires before it issues a final Letter of Support (LOS).

The pre-feasibility study in the region was carried out by the AEDB. By December 2006 the AEDB had entered into 59 agreements on cooperation with national and international enterprises through Letters of Intent (LoI). By this route it is intended that 700 MW of wind power is to be installed by 2010, and by 2030 as much as 9,700 MW in total. At the end of 2006 six companies filed applications with the regulatory authority NEPRA to generate electricity from wind energy; three applications were approved, with 50 MW each. The AEDB has leased land to twelve investors. By the end of 2006, thirteen private investors had given the AEDB firm undertakings to install 50 MW each over the next two years.

The producers are able to choose between accepting a standard tariff set in advance by NEPRA or applying for remuneration from NEPRA. The up-front tariff averages 7.2 euro cents/kWh for a period of 20 years. For the first 10 years the rate is 8.7 euro cents/kWh, while over the subsequent 10 years it drops to only approximately 3.8 euro cents/kWh. So far New Energy Park is the only company to have applied for the tariff to be fixed for its project and to have had this approved.

An international consortium was set up for the local production of individual plant parts in Pakistan. However, it is not expected that the production of individual components for wind turbines will begin until there are clear signs of an appropriate market volume.

### Micro installations

By the end of 2006 there were 140 micro wind turbines (300-500 W) installed in Pakistan for generating electricity and others for pumping water (about 30 systems). As a result, 356 households have been provided with electricity in the province of Sindh and 111 in Balochistan.

### Biomass

According to the last census from 1998, approximately two thirds of the population of Pakistan live in rural areas, and these people in particular rely almost exclusively on biomass in the form of fuelwood or charcoal for cooking and heating. 30 % of the country's energy needs are therefore met by biomass, and its use is continuing to rise, by an average of 5 % per year.

The Government of Pakistan launched a programme promoting the use of biogas in 1974. By 1987 more than 4,100 biogas plants had been installed, in a number of phases. However, as the last phase no longer offered any official financial assistance, no more such systems were installed. Since May 2003 a further 1,200 plants have been installed as part of a new biomass/biogas programme operated by PCRET, with each plant being state-funded to the tune of 50 %.

The potential for generating electricity from bagasse is estimated at 400 MW. Operators of sugar mills have the possibility of feeding any excess electricity they produce into the power grid. This option is available for combined heat and power plants with a capacity of up to 700 MW. The as-yet unutilised potential for electricity generation from waste is estimated at 500 MW per major city.

### Solar energy

Pakistan's potential for the use of solar energy is very good. The average daily insolation rate is approximately 5.3 kWh/m$^2$. Almost half of the area of the country shows potential for the economically viable exploitation of solar energy. The south-western province of Balochistan in particular offers excellent conditions. There, the sun shines approximately 3,000 hours per annum. The potential for the country as a whole is estimated at about 70,000 MW.

Despite these favourable prerequisites, the use of solar energy for generating electricity or for heating is still only in its infancy. At the beginning of 2006 output from photovoltaics amounted to about 0.8 MW, used for rural electrification, garden lighting and telecommunications. As far back as the early 1980s, the Government of Pakistan had 18 PV systems with a composite output of 440 kW installed in various parts of the country. Due to a lack of technical expertise in operation and maintenance, though, no further systems were installed. For the same reason, seven other PV systems with a total output of 234 kW, which were installed in the Pakistani part of the Hindu Kush in the late 1980s, are now no longer in operation.

Within the context of public-sector development programmes, several '100 Solar Homes' programmes were conducted by the AEDB in 2005 and 2006. These enabled a total of 991 households to be supplied with electricity from off-grid solar home systems with modules rated at 88 W each.

The utilisation of solar thermal energy is currently being trialled by the AEDB in the course of pilot projects in the provinces of Sindh and Balochistan. The potential is estimated at 10,000 $MW_{th}$. In future, solar energy is also to be used for drinking-water treatment and desalination. To this end, the AEDB has initiated a project in which PV systems are to be installed for treating drinking water in five villages in the remote district of Tharparkar in the province of Sindh, along with solar thermal systems for desalination. Two solar-powered desalination facilities which can provide a daily supply of 22,710 l of fresh water are in use in the province of Balochistan.

### Geothermal energy

There are numerous hot springs in various parts of Pakistan, for example in the vicinity of Karachi and the Pakistani part of the Himalayas, with temperatures ranging from 30 to 170 °C. Potential areas of use for geothermal plants were identified as long ago as the 1980s.[17] To date, though, no use has been made of geothermal energy in Pakistan for generating power.

17 See Tauquir, 1986.

## 21.6 Rural Electrification

An estimated 40,000 villages still had no access to electricity in 2006. In the province of Balochistan the population density is very low, averaging only 22 inhabitants per $km^2$; 90 % of the villages in this province continue to have no access to grid power. The government has initiated a multiplicity of projects on rural electrification in cooperation with international institutions. Microcredits are made available by the Kushali Bank. The ambitious target set by the government's Kushal Pakistan programme, which envisaged every inhabitant of the country being supplied with water and electricity by the end of 2007, will definitely not be achieved. The rural electrification programme was called into being by the government in 2001, initially for a period of two years, and was then extended for a further five years.

### Roshan Pakistan programme

The Roshan Pakistan programme is a key part of the Government of Pakistan's overall strategy for rural electrification. All in all, 7,874 remote villages that are more than 20 km from the national electricity grid and for which there are no grid expansion plans in the coming 20 years will be provided with an electricity supply. 906 villages are in the province of Sindh and 6,968 in Balochistan. The AEDB is heading the project in cooperation with the provincial governments of Sindh and Balochistan, and is planning for the electrification of 400 villages in the provinces of Sindh (100) and Balochistan (300) in the first phase. This is meant to be completed by 2009. GTZ provided support to the AEDB in planning its electrification strategy.

Five PV systems of various sizes will be made available in order to implement this programme. The Government of Pakistan is subsidising the cost of purchasing the systems, depending on the number of occupants and number of rooms in each house. The users of the systems are supposed to pay only for operating and maintenance costs. German and other European companies took part in the tendering process for the project at the end of 2006. A total of 18,000 solar home systems are supposed to be installed.

Exchange rate (19 February 2007):
100 Pakistan rupees (PKR) = EUR 1.25

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There is great potential for generating electricity from renewable energy sources in many developing and emerging countries. Obstacles to the exploitation of such sources and to the involvement of foreign investors include a lack of knowledge of framework conditions in the energy industry and insufficient transparency with regard to the prior experience and interests of national actors. This fourth, updated and expanded edition is aimed at overcoming barriers such as these.

The electricity markets and their respective actors are investigated for 23 countries in various regions: Latin America, Africa – Middle East and Asia. The country studies analyse the energy-policy framework conditions and closely examine the status of and promotion policy for electricity generation on the basis of hydropower, wind power, solar power, biomass and geothermal energy. The chapters on each country are rounded off by information about rural electrification.

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