Division Environment and Infrastructure
TERNA Wind Energy Programme

Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

21 Country Analyses

Eschborn, June 2004

Part China

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Background to the New Edition

Structural changes in the energy sector, accompanied by liberalisation of the relevant markets, have been continuing in many developing and transition 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 renewable energy in Germany is a subject that is being followed with interest, even outside Europe. Experience here shows that the creation of a conducive political and economic framework and the implementation of appropriate promotion measures can speed up the exploitation of renewable energy.

The German and European market acts as the motor for a wind energy industry and provides an indispensable background of experience. The level of growth in this sector within Germany has slowed down, however. Project developers are therefore increasingly turning their attention to off-shore schemes, other parts of Europe, and the Mediterranean states. The markets for technologies based on other renewable energy sources are also experiencing growing interest. While it is true that the potential for hydropower, wind power, solar power, biomass and geothermal energy in developing and more advanced countries is often considered to be high, obstacles to entry into this field include insufficient knowledge of the framework conditions prevailing in the energy industry in those countries and a lack of transparency with regard to the prior experience and interests of the national actors.

One of the aims of this third, updated and expanded edition of the study – under a new title – is to facilitate entry into the field of renewable energy. It is based on the previous editions from 1999 and 2002, which were published under the title 'Producing Electricity from Renewable Energy Sources: Energy Sector Framework in 15 [or 12] Countries in Asia, Africa and Latin America'. These studies have been much in demand, not only by suppliers and project developers but also by financing and operating companies involved in renewable energy technologies.

The analyses of the individual countries comprise sections on the respective electricity markets and the actors in those markets, along with information on the energy-policy framework. The policy for promoting electricity generation from renewable energy sources is examined, and the status of the various forms of renewable energy is analysed in detail. The chapters on each country are rounded off by information about rural electrification.

In comparison with the 2002 edition, eleven new countries have been added. The information about a further ten countries has been updated:

New since 2002		**Updated**	
Albania	Philippines	Brazil	India
Bosnia - Herzegovina	Senegal	Chile	Mexico
Croatia	Sri Lanka	China	Morocco
Georgia	Vietnam	Colombia	South Africa
Jamaica	Yemen	Dominican Republic	Tunisia
Pakistan			

Information about Argentina, Cuba, Jordan, Kazakhstan and Turkey is given in the 2002 edition. Analyses of Egypt, Indonesia and Thailand were conducted in the 1999 edition. These previous editions are available in electronic form free of charge from www.gtz.de/wind/english/downloads.html.

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

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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 of wind power projects are also impossible without hard information about wind conditions. Such analyses, however, form the basis for the financing and ultimately the successful implementation of a wind farm.

The purpose of the TERNA (Technical Expertise for Renewable Energy Application) Wind Energy Programme, implemented by the GTZ on behalf of the Federal German Ministry for Economic Cooperation and Development (BMZ), is to assist partners in developing and more advanced countries in planning and developing wind power projects. Since 1988 the aim within the TERNA framework has been to lay the foundations for sound investment decisions while at the same time enabling partners to plan and develop further wind power projects in the future.

The TERNA Wind Energy Programme's partners are institutions in developing and more advanced 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 know-how 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.

The prerequisite for promotion by the TERNA wind energy programme is that project development has a realistic prospect of implementation: if the underlying conditions in the electricity sector are sufficiently favourable, and if the proposed wind farm project has a minimum capacity of roughly 20 MW and is situated in a windy area (expected annual average wind speeds of over 6 m/s at a height of 10 m above ground level). Small individual installations or decentralised wind/diesel systems are not normally eligible for promotion, nor are research projects.

Up until 2004, TERNA has been active in over ten countries around the world. In Colombia the first wind farm started operation at the end of 2003 with the help of the TERNA programme. The municipal utility of Medellín built the 19.5MW Jepírachi wind farm on the Guajira peninsula with a total investment volume of some 27 million euros. The 800,000 tons of carbon dioxide saved by the wind farm by 2012 will be documented and sold to the Prototype Carbon Fund (PCF), which will mean additional revenues of around 3.2 million euros for the investor.

The TERNA projects are not financed from the country quotas which the Federal Germany Government agrees with individual partner countries. From the viewpoint of the partner country, therefore, TERNA offers additional funds for wind energy.

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

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Electricity Market

Capacities

In 2003 the installed electricity generating capacity in the PR China was over 380 GW, meaning that it had more than doubled since 1993.

Capacity is currently being expanded at a fast rate. It is expected that the electricity demand trends will continue for a few years, resulting in a need for additional power stations. A secure supply situation is not expected until 2006 when the new power station capacities will be in place.

According to the goals of the current (2001–2005) and forthcoming (2006–2010) five-year plans and expert appraisals, electricity generating capacity will be expanded to about 420 GW in 2005 and 550 GW in 2010.

In the course of the 1990s the size structure in the power station landscape shifted in favour of small plants producing less than 50 MW and large-scale plants with a capacity of over 300 MW. Low-capacity power stations were built primarily by independent electricity producers on the basis of local permits. New large-scale power stations have block capacities of 600 MW.

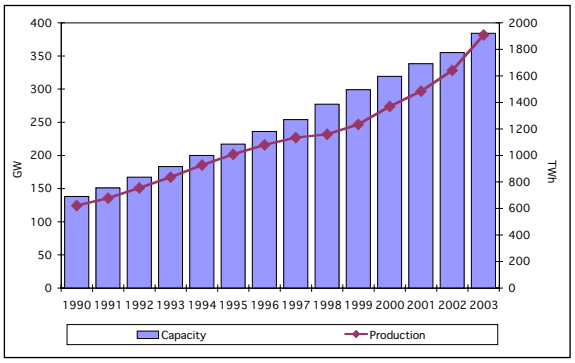

Figure 14: Electricity generation and capacity, China; 1990–2002; GW, TWh

Electricity generation

Electricity generation has almost tripled since 1990, and by 2003 production totalled 1,900 TWh. This makes China the world's second largest electricity producer.

75%–80% of electricity production is based on coal in thermal power stations supplemented by oil-fired systems. Hydroelectric power contributes at least 15% to overall production, even in weak hydropower years. Nuclear energy accounts for a share of about one per cent. Other energy sources such as wind power and natural gas are relatively insignificant so far. Even if the average efficiency of coal-fired power stations has been distinctly improved, environmental pollution caused by SO_2, NO_x and particles remains substantial, since the power stations are only partly equipped with anti-pollution facilities.

The Chinese Government stands by coal as the basis for electricity production. However, thermal electricity production is being relocated primarily to the mining regions in order to reduce emissions in conurbations and replace coal transport by electricity transmission ('Coal by Wire' programme). As a new natural gas pipeline is being installed, the aim is to increase the share of gas used for electricity generation in conurbations.

Electricity transmission and distribution

Massive investments are being made to link the five large regional transmission grids and a large number of smaller transmission networks, as well as to create a single national interconnected grid by the year 2006.[234] The government also plans to improve the efficiency of transmission and distribution networks in coming years. Internal consumption at the production facilities and network losses currently account for about 15% of gross electricity generated.

Isolated networks

Generating capacity in isolated networks has declined steeply in recent years, since these have increasingly been integrated into the regional integrated networks. However, there are still small settlements in remote areas that cannot be reached with overland lines and in which isolated systems powered by diesel generators or hydroelectric power therefore still frequently exist.

Electricity consumption

Lower growth rates in power demand as of the mid 1990s were partly the consequence of the Asian crisis. Increases of 8–15% a year have been registered again since the year 2000. Up to 2020 the average

234 In September 2003 the world's largest electricity grid was formed by joining two regional networks between the provinces of Hebei and Henan.

annual growth in power consumption is expected to be over 5%.

It is often the case that electricity demand cannot be met at peak load times. Supply problems and power cuts have become worse since summer 2003, especially in the growth centres in the east and the south of the country.

By far the most important consumer groups are industry and craft & trades (secondary sector), which together account for 72% of electricity consumption (in 2000), followed by domestic households with 13%, services with 11%, and the primary sector (agriculture and forestry, mining) with 4% of consumption. The effect of the sustained high economic growth is that there is increasing power demand not only for production but also by private households as incomes rise. It is expected that private households and the service sector will account for a growing share of electricity demand.

Electricity prices

In 2001 the regulated average consumer prices for electricity were in a range between about 4 and 7 € cents/kWh. In some cases, foreign-financed BOT/BOO (Build-Own-Transfer, Build-Own-Operate) facilities belonging to independent power producers received secured purchase prices of over 5 € cents/kWh within the framework of electricity purchase contracts. Such purchase prices, often higher than the final consumer tariffs, to which costs of transmission, distribution, sales etc. must be added, can only be explained against the background of the enormous electricity shortages prevailing at the time the contracts were signed. These pro-producer agreements have mostly been cancelled and are being converted to normal, long-term purchase contracts with lower prices. A new, transparent price system that specifies separate tariffs for production, transmission and distribution is being prepared.

Market Actors

Up to the time of the electricity sector reform in 2003, the State Power Corporation of China (SPC), created in 1997, was the dominant company with about half the production capacity, 90% of the transmission lines above 220 kV, and a majority of the distribution networks. The unbundling of SPC led to the creation of 11 state-owned enterprises, including two network operators, five generating companies and four other companies providing supporting services (for example engineering).

New generating companies

The five electricity producers evolving from SPC were each assigned a capacity of 30,000–37,000 MW and hence 45% of total capacity. A large share of the wind power capacity was allotted to one of these five enterprises, the Guodian Group, which in turn concentrated these in its subsidiary Long Yuan. There are some 40 other electricity producers in addition to the companies mentioned. Industrial self-generators own power station capacity totalling roughly 30 GW. Foreign investors have so far been able to build plants with a total capacity of about 33 GW on the basis of BOT/BOO contracts; in future these will participate in competition in the same way as other producers.

New grid companies

The two newly created grid operators are the State Grid Corporation (SGC), which will control five new, combined regional grids with over 20 provinces, and the South China Grid Corporation, which is responsible for five provinces. SGC will take over management of the Lhasa Power Grid in Tibet.

Responsibility for rural electrification

In addition to the large state-owned grid operators, the Ministry of Water Resources (MWR) in particular operates with small hydroelectric power plants, frequently based on isolated networks. In the meantime MWR is also engaged in the field of wind energy.

Legal Framework

During the last two decades China's electricity sector has gone through major changes. Triggered by the economic boom since the 1980s, supply bottlenecks and increasing environmental problems, the production market has been cautiously opened for foreign capital, and monopoly structures and planned economy have gradually been replaced by competition.

Restructuring of the electricity sector

After the political responsibility was separated from operational responsibility in 1998, the reforms of 2003 again paint a completely different picture. Experts expect that the existing system will be transformed further and that in 2005, following successful implementation of the present reforms, the Electricity Act of 1996 will be amended.

The reforms that have been ongoing since 2003 are set out in the Document No. 5 adopted by the State Council in April 2002. The plans essentially encompass the splitting of regulatory and commercial functions, the separation of electricity production and transmission, and new rules for pricing.

Institutional landscape 2003

In 2003 the People's Congress set up a new body, the State Asset Supervision Administration Commission (SASAC), to supervise the assets, performance, finances and senior executive staff of the state-owned enterprises; it is thus responsible for the major enterprises in the electricity sector. Other new bodies were the Ministry of Commerce (MOFCOM) and the National Development and Reform Commission (NDRC), both of which evolved from departments of the former State Development and Planning Commission (SDPC), the State Economic and Trade Commission (SETC) and the Ministry of Foreign Trade and Cooperation (MOFTEC). The new MOFCOM is responsible for foreign trade, including issues of equal treatment of foreign and Chinese enterprises. In addition to responsibility for price supervision and approval of investments, the NDRC was allocated total political responsibility for the energy sector, including renewable energy sources. An Energy Office was set up within the NDRC with the rank of a Division.

New regulation authority

A separate regulatory authority was set up for regulating the electricity sector, namely the China Electric Power Regulatory Commission (CERC). Its functions are yet to be defined in relation to those of the NDRC. The CERC's general tasks are supervision of the reform process and consistent regulation of enterprises in the power sector.[235]

Energy research

The Energy Research Institute (ERI) is formally attached to the NDRC. However, it shows great independence in its research strategy and its role in the debate on energy policy. The Ministry of Science and Technology (MOST) participates actively in formulating and implementing the energy policy with research and demonstration projects. Among the institutions allocated to MOST are the Tsinghua University with several energy institutes. The Academies of Science, Engineering and Social Studies also have a series of research institutes investigating energy matters.

Foreign investment in the energy sector

A range of measures were taken in the past to promote investment of foreign capital in China's energy sector.[236] Since the mid 1990s the Chinese Government has allowed direct investment of foreign capital for electricity generation.

Clean Development Mechanism

The Chinese side places great hopes in the Clean Development Mechanism (CDM) within the framework of the Kyoto Protocol as a further possibility of obtaining finance. As the world's second largest CO_2 emitter, and in view of the rising demand for energy, China presents a broad field for action. The GTZ is cooperating with the World Bank and Switzerland in having a national CDM study drawn up by Chinese experts. The Climate Change Office in the NDRC and the Ministry of Science and Technology are the contact bodies for CDM measures in China.

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235 The regulating authority will also be responsible for licensing enterprises in the electricity sector. The 'Provisions on the Regulation of the Power Industry' are to enter into force in 2003/2004.

236 The 'Regulation for Utilization of Foreign Capital in China's Power Sector' of 1997 is particularly important here. Following China's accession to the WTO in December 2001, further steps to liberalise trade and investments are also expected.

Policy for Promoting Electricity Generation from Renewable Energy Sources

Without government steering, large-scale technical use of renewable energy sources will not be competitive considering the production costs of less than 3.5 € cents/kWh for electricity produced from coal. Exceptions to this are small hydroelectric power plants, electricity production from wind or photovoltaic facilities in remote areas, and the use of agro-industrial wastes in combined heat and power stations (cogeneration plants).

Regulation on infeed of electricity from wind energy

A set of rules for linking wind power plants to the grid was put in place some time ago, in 1994.[237] According to this, grid operators are obligated to buy all electricity generated in such facilities and to pay for it on the basis of uniform pricing principles. The price negotiated from case to case is made up of the gross electricity production costs, the taxes and charges to be paid, and an 'appropriate' profit of about 12-15%. The extra costs resulting from wind-based electricity for the distribution company can be apportioned fully to the connected consumers throughout the province. The high costs of wind power resulting from these tariff rulings have led to the responsible province governments adopting a refusal attitude. In practice, therefore, this incentive mechanism has only produced results in isolated cases.

In 1996 the SDPC launched the Cheng Fengi ('Ride the Wind') programme to promote local production of large wind power plants.[238] The Shuang Jiai ('Double-Increase') programme, also launched in 1996, chiefly promotes the construction of large-scale commercial projects.

In order to support the financing of wind power projects, the government provides low-interest loans provided that the plants originate from domestic production. Furthermore, in 2002 the value-added tax for wind-generated electricity was halved from 17% to 8.5%. Wind energy concessions were put out to tender for the first time in 2003.

Law to promote RE in preparation

The dissemination of renewable energies in China was largely driven by international programmes in the past.[239] Support for renewable energies, which was hitherto only provided in isolated cases, is to be boosted by a comprehensive promotion act. The National People's Congress (NPC) therefore commissioned the draft of a 'Renewable Energy Development and Utilization Promotion Law' in August 2003. The Energy Office of the National Development and Reform Commission (NDRC) was nominated as the responsible body in the executive and has in turn commissioned the Center for Renewable Energy Development (CRED) of the Energy Research Institute (ERI) with technical coordination. The GTZ is supporting CRED, partly within the framework of the TERNA programme, in evaluating experience with internationally implemented promotion instruments. Parallel with this the NPC is obtaining consultancy services from experts at Tsinghua University and others. It is expected that the law will be implemented in 2005.

GEF project: Capacity Building for the Rapid Commercialisation of Renewable Energy (CCRE)

In 1999 the Capacity Building for the Rapid Commercialisation of Renewable Energy (CCRE) project, promoted with GEF funds, was set up by UNDP. It aims to build up commercial industry sectors in the field of renewable energies.[240] With financial support from the Australian and Dutch Governments, the project contributes to institution building and implementing demonstration projects. The Chinese Renewable Energy Industries Association (CREIA) was established within the scope of the project. This body sees itself as an intermediary between industry and public authorities and in this role aims to bring national and international project developers and investors together. Further measures also include training of technical staff, policy consultancy, demonstration plants and product certification.

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237 'Regulation on the Management of Grid-Connected Windfarms'.

238 One result of the programme is the joint venture between the German wind power plant manufacturer Nordex and a Chinese partner.

239 One organisation that has been prominent in this connection is KfW, which has promoted about one third of the wind energy capacity. Other bilateral donors such as Denmark and Spain are also active in this field. The World Bank and ADB have only just started to finance renewable energy installations for electricity generation (apart from hydropower plants). GTZ, UNDP, the World Bank (both with GEF funds) and the American Energy Foundation lead the way in technical cooperation.

240 Consideration is given to PV and wind hybrid systems for municipal networks, biogas from industrial and agricultural residues, solar thermal applications and grid-coupled wind power plants, as well as bagasse-fired CHP schemes.

Cooperation with Germany

Financial and technical assistance from German institutions for the use of renewable energy is largely to be found in China's rural regions. Since the beginning of the 1990s the Federal German Ministry for Economic Cooperation and Development (BMZ) has been focusing more on photovoltaics.

One GTZ project aims to reinstate small village hydroelectric power systems, irrigation methods and vocational training in Tibet. Since the end of 2001 the GTZ has also been conducting a programme entitled Renewable Energies in Rural Areas to disseminate solar power systems and small hydropower plants in the provinces of Qinghai and Yunnan together with the SDPC (now NDRC), and supporting the Township Electrification Program by training teaching staff to coach local operators, by quality assurance methods and other inputs. This project, building on experience gained in Inner Mongolia, will soon be expanded to the provinces of Gansu and Tibet. Within this framework KfW is contributing to the installation of approximately 300 hybrid PV/diesel village electricity units in the provinces of Xinjiang, Qinghai, Yunnan and Gansu with Financial Cooperation funds.

Comprehensive programmes to finance wind farms (in Hainan, Zhejiang, Guangdong, Inner Mongolia and Xinjiang) are currently being implemented. KfW is supporting the implementation of these with government Financial Cooperation funds, as well as with its own market means.

The creation of a national wind energy centre focusing on training, consultancy and applied research is currently being prepared. This centre will be set up by the China Long Yuan Power Group and the China Electric Power Research Institute (CEPRI) together with the GTZ.

Status of Renewable Energy Sources

The development status of the use of renewable energy sources for electricity generation in China is well advanced in some fields, but distinctly lagging in others.

Grid-coupled installations

As far as grid-coupled electricity generation on the basis of renewable energy sources is concerned, small-scale hydropower (installations rated at < 25 MW) is by far the most significant type. Small hydropower plants with a total capacity of 25 GW have been installed. So far wind energy has not achieved any notable share (around 470 MW), nor has grid-coupled electricity generation from biomass, geothermal or solar energy.

Off-grid application and isolated networks

As regards non-grid-coupled applications, there are currently more than half a million plants for providing energy to individual households in China, powered one third each by small wind energy units, photovoltaics and micro hydropower plants.

A relatively large number of users in small settlement centres obtain electricity generated from renewable energy sources in isolated schemes, chiefly small hydropower plants, and to a lesser extent wind hybrid plants and biomass plants, as well as more recently from PV hybrid plants to an increasing extent.

Hydropower

China has the world's largest hydropower potential, chiefly concentrated in the West of the country. The large distances between those areas that are rich in hydropower and the industrial conglomerations in which electricity is needed make it more difficult to utilise these resources and increase the power transmission requirements towards the east and south coasts.

Installed capacity and expansion planning

At the end of 2002 the total installed capacity of all hydropower plants in China was 84 GW. The technically utilisable hydropower potential is quantified at 676 GW. It is planned to increase the installed hydropower capacity to 95 GW and 125 GW by the years 2005 and 2010 respectively. A long-term plan envisages hydropower achieving a share of over 25% of total electricity production by 2015.

The capacity of large hydropower plants is to be expanded in future. In addition to the gigantic Three Gorges Power Station on the Yangtze, that alone will have a capacity of 18.2 GW after it is completed in the year 2009, it is planned to use five further river courses for power stations with a total capacity of 50 GW.

Small and micro hydropower units

In China small hydropower stations are generally operated in isolated networks by the Ministry of Water Resources (MWR). At present there are about 40,000 small and micro hydropower plants with a total capacity of 25 GW in operation. When the isolated networks are connected up, many small hydropower plants will be taken out of service. On the other hand, once again there is now a distinct trend in central and west China towards building new plants that feed electricity into the grid.

China manufactures the largest number of micro hydropower plants in the world, and thanks to their low price these are exported too. However, the product quality, often judged as being in need of improvement, presents an obstacle to wider distribution in foreign markets.

Wind Energy

Topping the world league with an estimated onshore wind potential of 250 GW[241], China shows great promise for the exploitation of wind energy. Windy locations are to be found above all in the steppe and desert areas in the west and north of the country, and in coastal regions. The technical potential for offshore locations has been quantified at as much as 750 GW by the Chinese Wind Power Association.[242]

Wind measurements

Within the framework of a UNDP/GEF project, wind measurements are currently being taken at ten locations in order to survey the local conditions more precisely. These locations are considered as pilot projects within the framework of the National Wind Development Plan and are to receive state promotion as a priority when wind farms are realised. China is also participating in the multi-national Solar and Wind Energy Resources Assessment (SWERA) project, supported by UNEP, with which the general data situation is to be improved at regional level. A wind atlas for South East China was drawn up as part of the SWERA programme.[243] The GTZ supported wind measurements in Hubei province under the TERNA wind programme between 2000 and 2002.

Previous wind energy use

Up to the end of 2002, wind farms and individual plants were erected with a total capacity of 468 MW. However, developments are characterised by a fluctuating annual rate of additional installation.

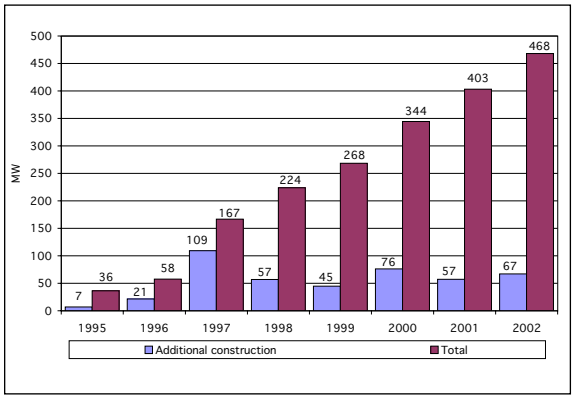

Figure 15: Installed capacities and annual additional construction of grid-coupled wind power installations; China; 1995–2002; MW[244]

The provinces of Liaoning on the east coast with about 110 MW and Xinjiang in the north-west with some 90 MW are ranked highest in terms of installed capacity. These are followed by Inner Mongolia in the north and Guangdong on the south-east coast, each with approximately 80 MW.

Expansion targets

According to the targets set in the 10th five-year plan (2001–2005), 1,200 MW is to be installed by the year 2005, and according to the 11th five-year plan (2006–2010) a total of 3,000 MW of wind power capacity by the year 2010.[245] The concession projects operated by the NRDC provide for 100 MW to be set up at each of selected locations. Altogether 20 development plans in the provinces are to contribute to implementing two projects per province in the next two years.
In the past, announced and certainly realistic planning

241 According to information supplied by the Chinese Wind Power Association, the potential of 250 GW refers to wind resources at a height of 10 m. According to the Association, the potential doubles at a height of 50 m and more.

242 The wind data obtained from over 900 meteorological stations does not always satisfy international standards, however. This applies in particular to the identification of specific locations for wind power projects.

243 For more information on SWERA see http://swera.unep.net. The Wind Resources Atlas for South East China is available under www.rsvp.nrel.gov/wind_resources.html.

244 Data source: Chinese Wind Power Association, 2003.

245 Projections for medium- and long-term expansion of wind power vary substantially. The Chinese Wind Power Association considers a wind power capacity of 4 GW to be realistic for 2010, and a capacity of 20 GW for 2020 (including 4 GW offshore).

targets set by the Chinese Government have not been met and have been revised in the course of time. A large proportion of the installed wind power capacity is based on bilateral or multinational promotion programmes and funding, and less on the country's own commitment.[246]

Obstacles to expanding wind power

Expansion of the wind power sector has been faced with a series of obstacles in the past:

- lack of transparency in permit-issuing procedures
- slow decision-making and approval processes
- sub-optimal legal framework
- high import duties
- the local content requirement stating that wind turbines and their components must largely originate from Chinese production[247]
- major frictional problems between institutions
- frequent, often annual, renegotiations of power purchase agreements

National manufacturers of wind power plants

Relatively large plants with a capacity of 100 kW or more have only been built during the last ten years, either within the framework of joint ventures or under licence. There are presently six national manufacturers of turbines in the 600 to 660 kW class with a high share of local components.[248] Demand for these turbine types was relatively low in the past, however, since imported plants are generally cheaper and have a reputation for better quality.[249] Recent agreements, for instance between the German company REpower and the Tianjin Hi-Tech Group, also provide for production of relatively large plant units.

GTZ wind energy project in Hubei province

In a feasibility study the GTZ determined total investment costs of € 22.2 million for a 19.2 MW wind farm with 600kW turbines. The plants satisfy the local content requirement of Chinese authorities and could be serviced by local specialists. The purchase costs for wind power were calculated at 0.75 to 0.97 RMB/kWh (7.7 to 10 € cents/kWh). This means that it would be more expensive to operate the wind farm than coal-fired power stations, which produce electricity at costs of 0.2 to 0.6 RMB/kWh (2.0 to 6.2 € cents/kWh). The planned wind farm is not being realised at present. The reasons for this lie not only in the electricity production costs, but also in the changing framework conditions in the Chinese electricity market.

REDP

The Renewable Energy Development Programme (REDP) of the World Bank and GEF supports the construction of two wind farms with 20 MW each near Shanghai by providing low-interest loans of US$ 13 million.

Calls for tender for large projects

On the one hand investors are to be guaranteed long-term feed-in tariffs by two government-run calls for tender for large 100MW projects on a concession basis; on the other hand the power generating costs are to be kept low. When the bidding procedure was completed in September 2003, the Huarui Group[250] was awarded the Rudong wind farm in Jiangsu province, and the Yuedian Electric Power Group gained the contract for the Huilai wind farm in Guangdong province. Concessions for 25 years were granted for the wind farms, which are set to join the grid no later than the end of 2005. The feed-in tariff is made up of two phases: for the first 30,000 full-load hours the best price of 0.5 RMB/kWh (5.2 € cents/kWh) determined in the call for tenders will be paid for the Yuedian project and 0.43 RMB/kWh (4.4 € cents/kWh) for the Huarui project. After this, remuneration will be based on a market price which is currently estimated at 0.55 to 0.60 RMB/kWh. Consequently the realisable starting price is about 10% below the wind power prices that have been customary so far. Further calls for tender are planned for 2004.

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246 About one quarter of the total capacity in China was made possible with German support.

247 China intends to build up a competitive wind power industry. In addition it would like to avoid excessive dependence on imports in the provision of energy resources and facilities.

248 Three manufacturers are engaged in mass production, the other three manufacturers have developed prototypes. These also include Nordex, which has a production plant in Xian, and Goldwind, which produces plants designed by the German manufacturer REpower under licence.

249 At the end of 2002, 11% (54 MW) of the total installed capacity originated from domestic production. In 2002, 28 MW of the total of 67 MW of newly installed plants was purchased from local production.

250 The largest private investor in energy projects in China, who so far operates two small wind farms in Helanshan (Ningxia province) and near Beijing.

Small off-grid plants

The total capacity of small, off-grid wind power systems (< 3 kW) is about 42 MW. About 250,000 small wind power plants (0.1–3 kW) were installed in the off-grid sector up to the end of 2002. With 22 producers (end of 2002), China is the world's largest manufacturer of such plants, but these are mainly deployed in the domestic market.

Biomass

The considerable biomass resources for energy purposes, chiefly in the form of harvest residues, firewood, forest timber residues and organic wastes, were estimated at over 5,500 TWh for the year 2001. Only one third of this potential is used, and this chiefly for thermal purposes.

Biomass, which has been used as an energy source in small stoves and furnaces since time immemorial in all rural areas of Asia, can be developed to generate electricity in China. Two processes chiefly enter into consideration for larger-scale applications: the use of organic materials (mainly bagasse) in combined heat and power stations with steam turbines, and the conversion of biogas into electricity in gas motors.

Converting bagasse into electricity

For many years now China's sugar industry has been using bagasse in relatively large factories to produce its own electricity. Over 800 MW of capacity is installed in the sugar provinces of Guangdong and Guangxi alone. However, this branch of industry does not generally feed surplus power into the grid. According to estimates in a World Bank report, a potential of 700 to 900 MW of electrical energy that could be exploited with clear financial profit would be available in the above areas and Yunnan alone.

However, a series of impediments hamper expansion of bagasse-generated electricity for feeding into the grid:

- the currently poor economic situation of the Chinese sugar industry that leaves no scope for investment
- partial lack of insight on the part of sugar mill managers
- the lack so far of low-interest, long-term loans (low-interest loans with a term of 3 years were only provided for on-site electricity supply up to the year 1999)
- the low level of remuneration for electricity fed into the grid
- the lack of a standardised set of rules on electricity supply and remuneration
- the seasonal nature of sugar production (and hence of bagasse availability), which only runs for about 5 months a year

Biogas plants and their promotion

China is the world leader in the application of anaerobic biomass gasification plants. In addition to millions of small and micro plants, which chiefly help to minimise slurry problems on farms, there are some 700 larger plants including about 150 in which the organic component of industrial waste water (from paper, sugar and pharmaceutical industries and from alcohol and food production) is gasified.

Energy production from biogas is supported in China's agriculture by low-interest credits totalling US$ 33 million, committed by the Asian Development Bank (ADB) at the end of 2002.

Within the framework of the current five-year plan (2001–2005) and a promotion programme for high technology[251], the focus is on developing biomass plants for electricity generation. Substantial market potential is seen in this segment.

Use of landfill gas

With support from the UNDP-GEF project Promoting Methane Recovery and Utilisation from Mixed Municipal Refuse, landfill sites in several municipalities are being examined for their suitability for converting landfill gases into electricity. The relevant studies are to be completed by mid-2004. A first pilot plant in Ansham has already been completed and is also scheduled to begin full operation by mid-2004.

Enterprises and research institutes

In the meantime there are 200 enterprises that produce biomass plants and components. The Biomass Development Center (Beijing) is very important in the research sector; it brings together a large number of technical institutes as members. There is a network of political

251 This is the scheme known as the 863 Research Programme.

and scientific institutions and enterprises for developing, demonstrating and disseminating biomass technologies.

Solar Energy

China's potential for solar energy applications is large. The average energy quantity per day is above 4 kWh/m^2. The sun often shines for over 3,000 hours a year, especially in the west of the country.

Although the high plant costs are a constraint limiting rapid dissemination through the market in the near future, conversion of solar energy into electricity can have a long-term future in China in large-scale photovoltaic and solar thermal plants. In the near future, however, medium-size plants (10–100 kW) will first be used for decentralised supplies to villages, and micro plants (solar home systems, SHS) with a capacity of 20–100 W for basic electrification of households in remote regions of China.

Market for photovoltaics

At present the driving force behind this comes above all from government-promoted programmes for improving rural energy supply. An estimated 150,000 solar home systems and 80 photovoltaic school systems were installed in 2001. In 2002 alone some 20 MW of PV capacity was installed, representing almost half the total capacity of 43.5 MW at the end of 2002.

Local production of PV equipment

In 2001 seven companies produced solar cells with a capacity of 4.5 MW_p and thus twice as much as in 1998 (2.1 MW_p). At the end of 2003 there were 11 cell manufacturers, some of whom also produce modules. The largest manufacturer is the Chinese-Australian joint venture Wuxi Suntech Power with an annual production capacity of 25 MW_p. This is followed by the Japanese firm Kyocera that started up a production line for 12 MW_p in Tianjing in October 2003. So far all other manufacturers produce only small volumes.

Other components for PV systems, such as charging regulators and pumps, are also produced in China. Within the scope of the GTZ rural electrification project already described, there are initiatives to bring about a sustainable improvement in the quality of local production through greater cooperation with the German solar industry.[252]

According to NDRC plans and the rural electrification programmes it has initiated, some 80 MW of PV capacity should be installed by the end of 2005. This capacity could increase to over 200 MW by 2010.[253]

Grid-coupled solar systems

Only a few individual larger systems are connected to the electricity grid. In May 2002 there was a call for tenders to install a 1MW system. Further calls for tenders for plants with capacities of 70–300 kW are expected. [254]

Obstacles to further development

However, the following obstacles stand in the way of faster growth in the number of installed systems:

- only state-supported system suppliers enjoy public-sector promotion; generally loans are rare for system suppliers and installers.
- poor maintenance and service provision reduces the service life of the systems.
- there is no institutional basis for granting loans or financing solar home systems.

Geothermal Energy

Despite substantial resources, there has been virtually no development of electricity generation from geothermal sources in China so far. The potential that can be used directly to generate electricity due to high temperatures (> 150°C) is estimated at 5.8 GW. Potentially utilisable resources are located along the eastern coast facing Taiwan (Taiwan Geothermal Zone) and in the Yunnan Geothermal Zone in the Autonomous Region of Tibet.

The installed capacity is only 30 MW, shared between a 25MW geothermal power station in Yangbaijing in Tibet and a number of smaller demonstration projects. 255 locations suitable for geothermal electricity production have been identified in China, and by 2010 ten of these are to be developed with a power generation potential of 300 MW. According to the government's

252 See GTZ: 'Solarenergie: Strom für ländliche Gebiete – Kooperationsmöglichkeiten für die deutsche Solarindustrie im Rahmen der Technischen Zusammenarbeit in den Provinzen Qinghai und Yunnan' [Solar energy: electricity for rural areas – cooperation options for the German solar energy industry within the scope of Technical Cooperation in the provinces of Qinghai and Yunnan] in: Sonne, Wind und Wärme, June 2003.

253 Chinese Renewable Energy Industries Association (CREIA) (2001): New and Renewable Sources of Energy in China – Technologies and Products.

254 According to a report (www.chinaview.cn of 26.09.2003) the largest PV plant with a capacity of 150 kW was installed in Xinjiang province and supplies a farm with 600 households in isolated operation.

long-term development plan, the installed capacity in 2010 should be about 75–100 MW.

Rural Electrification

Degree of electrification

Approximately 98% of the population can now be supplied with electricity thanks to grid expansions and rural electrification programmes. Of the remaining 30 million people without electric power, especially in the provinces in the west and north of the country,[255] about 23 million are to be provided with basic electricity supplies by 2010 within the framework of the highly ambitious Brightness Program.

In the peripheral territories renewable energies represent an economic alternative to grid supply and a more appropriate and environmentally sound option than conventional diesel-fuelled facilities. The energy demand in remote areas correlates particularly well with their potential for solar and wind energy as well as micro hydropower, so that these alternative forms of energy appear predestined to electrify rural areas in China. The high concentration of supply in some regions even makes it possible to harness the potential of renewable energies for grid energy production. This applies especially to wind energy.

Township and Village Electrification Program

At present several national promotion programmes to improve rural electricity supplies are being implemented, some with bilateral and multinational support.[256]

One of the most ambitious programmes on a global scale is the Township Electrification Program (Song Dian Dao Xiang), which is an implementation measure of the National Brightness Program. Based on a financial volume of US$ 240 million, 20 MW of PV systems and hybrid PV/wind systems as well as 200MW micro hydropower plants were installed and connected to mini electricity grids in just 20 months up to June 2003.

While the first programme phase covers over 1,000 communities, about 20,000 further communities are to be included in a second phase during the period 2005–2010 (Village Electrification Program – Song Dian Dao Cun) and receive PV village systems with a total capacity of 100–150 MW. Funding of some US$ 1.2 billion is planned for this. By 2010 it is intended that as many as 23 million people will receive electricity supplies.

The GTZ and KfW are supporting the Township Electrification Program. In the long term the aim is that sustainable and self-supporting electricity supply systems should develop on a commercial basis. The GTZ is transferring expertise to local teaching staff, who in turn are then to train local technicians responsible for operating and maintaining the installations.

Because of the extremely tight time-frame within which the demanding target figures had to be achieved when the generating and grid systems were installed, some of the equipment chosen was of poor quality and inadequately dimensioned. In order to identify technical problems as soon as possible, when the first signs appear, and to determine the influence of electrification on the users' living and working conditions, a comprehensive technical and socio-economic monitoring system is being set up, also with GTZ support.

REDP – PV component

The second most important programme for renewable energies in off-grid areas is the Renewable Energy Development Programme (REDP) with support from the World Bank and GEF. Financial and institutional support for local firms is provided so that they can procure, install and maintain off-grid PV facilities with a total capacity of 10 MW_p. These systems are then to be sold to households in rural regions in six north-west provinces. Altogether a subsidy of US$ 27 million has been agreed. However, up to the end of 2002 it had only been possible to install 2% of the proposed systems.

Exchange rate (28 Oktober 2003): 100 Renminbi (RMB) = € 10.30

255 Tibet is the province in which by far the largest proportion of households (approx. 80%) have no access to electricity.

256 Including a GTZ project to improve general conditions, a KfW promotion scheme worth € 18.2 million for building village electricity systems, and the Silk Road Illumination Project promoted by the Dutch government worth € 13.8 million with the participation of Shell.

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The potential of renewable sources of energy in developing and emerging countries is often considered high. Obstacles to their exploitation and foreign investors' engagement often include a lack of knowledge of framework conditions in the energy industry and insufficient transparency with regard to the prior experience and interests of the national actors. These are barriers which this third, updated and expanded new edition intends to overcome.

The **electricity markets** and their respective **actors** are investigated for **21 countries** in various regions: **Latin America – Caribbean, Africa, Europe – Caucasus** and **Asia – Pacific.** The country reports 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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