Division Environment and Infrastructure
TERNA Wind Energy Programme

Energy Policy Framework for Electricity Markets and Renewable Energies in the PR China

Updated version, Eschborn / Beijing, September 2005

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Preface

The present study on the PR China is based on the GTZ study, "Energy-policy Framework Conditions for Electricity Markets and Renewable Energies – 21 Country Analyses".[1] It was published under the TERNA Wind Energy Programme in June 2004. Besides chapters on the respective electricity markets and their players, the analyses of the individual countries contain information on the energy policy framework. Promotion policy for electricity generation from renewable energies is examined and a detailed analysis made of the status of the individual renewable energy sources. The country chapters conclude with information on rural electrification.

Since the editorial deadline for the third edition of the country study, developments on the Chinese electricity market have been rapid. In response to the production capacity growth of about 51,000 MW in 2004, the adoption of a law to promote renewable energies and the keen demand for information about the Chinese electricity sector we have issued an update under the TERNA programme with information on selected regional projects.

Eschborn / Beijing, September 2005

1 The study is the third, updated and enlarged edition of the country study on electricity markets and renewable energies in developing and emerging economies published every two to three years. It is published under the TERNA Wind Energy Programme. The current and previous electronic editions from 2002 and 1999 are available free of charge at www.gtz.de/wind.

TERNA Wind Energy Programme

As of 1988 on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ), GTZ has been implementing the Wind Energy Programme of the Technical Expertise for Renewable Energy Application (TERNA). The objective of the current phase is to assist partners in developing and emerging economies in planning and developing specific windpower projects and enable them to plan and develop other windpower projects in future. On the other hand, it is developing/upgrading a framework for windpower and other renewable sources of energy with the partners.

TERNA provides its partners with know-how and experience gained over more than 15 years. Adjusted to meet specific needs, TERNA's range of services include, location reconnaissance, wind measurements, studies on wind and energy potentials, feasibility studies, CDM baseline studies and also financial advice. When the findings are promising, TERNA thus initiates windpark projects ready for investment. TERNA does not participate in finance. To qualify for TERNA assistance, the proposed project must have a realistic chance of realisation. Besides these activities targeting specific sites, TERNA also advises partners on setting up a suitable framework for promoting renewable energies. Training measures are a focus in all services.

You can find further information about the TERNA programme at www.gtz.de/wind or directly obtain from:

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Energy Projects in PR China

Within the framework of its economic cooperation the German government is working with the PR China also in the energy and environment sector. The subjects covered comprise energy efficiency, renewable energies, new energy technologies, air pollution control, and resource conservation.

Germany occupies a prominent position in international cooperation with China. Especially in the field of energy policy, it is embedded in the international network consisting of multilateral organisations such as the World Bank, UNDP with UNDESA and ADB as well as non-governmental organisations, such as the Energy Foundation and WWF. Besides projects of financial cooperation, which lie in the responsibility of the German Kreditanstalt für Wiederaufbau (KfW), GTZ on behalf of BMZ is engaged in technical cooperation in the PR China. Selected projects are jointly undertaken by GTZ/KfW.

Successful projects were and are still being implemented, e. g., in the field of increasing energy efficiency of coal-fired power plants or the extinction of fires in coal deposits. Based on experiences from earlier GTZ-projects in the field of renewable energies, the PR China developed and realised large investment programmes for rural electrification. The recently started programme "Research- and Training Wind Energy Centre" aims at supporting the PR China in reaching the ambitious goals for wind energy. A new energy efficiency project targets energy saving measures in existing buildings. In the framework of energy policy consultancy, GTZ is assisting the Chinese government in the development of the Renewable Energy Law and the subordinated directives. On behalf of BMU and BMZ GTZ supports the Chinese organisors of the Beijing International Renewable Energy Conference 2005.

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Electricity market

Capacity

Installed generation capacity in the PR China increased by about 51 GW in the course of 2004, amounting at the end to roughly 440 GW, equivalent to approximately four times the installed capacity in Germany. Capacity is being extended at full speed, with estimates for 2005 alone totalling an additional volume in the order about 68 GW. A variety of power producers are investing in anticipation of rising demand and adequate prices. The pace of expansion is fuelling fears of overcapacity in a few years.

The expansion of capacity in thermal and other power stations is proceeding at the same pace. The share of thermal plants has remained unchanged at 74% for years. Despite the addition of large units, hydropower remains constant at approximately 24% of installed capacity. The remaining 2% is spread over nuclear power and windpower.

Block sizes in the new large-scale thermal power plants amount to between 200 MW and 600 MW; there are now also supercritical stations with a block size of 900 MW.

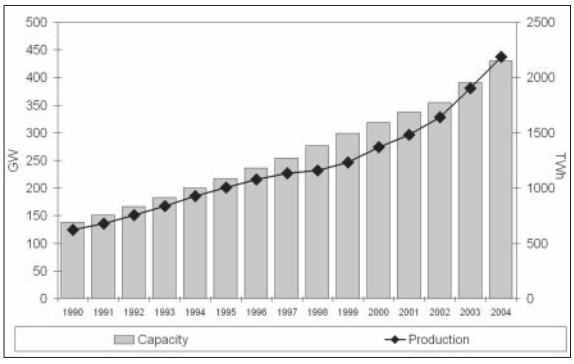

Fig. 1: Electricity generation and capacity; China; 1990 – 2004; GW, TWh

Electricity generation

Gross power generation has more than tripled since 1990, amounting to 2,100 TWh in 2004. This makes China the second-largest electricity producer worldwide.

Eighty to eighty-three per cent of electricity is generated in thermal power stations, largely coal-fired, increasingly based on natural gas and supplemented by oil. Depending on hydraulic availability, hydropower contributes 15% to 18%. Nuclear energy makes up approximately one per cent, windpower still considerably less than 1%.

Even though average efficiency in coal-fired public power stations has improved substantially to about 35%, environmental pollution through SO_2, NO_x and particles is still considerable due to the installation of too few air purification plants. Since 2004, however, stricter thresholds apply, requiring desulphurisation for new facilities. The thresholds for old plants have been lowered in periurban areas, necessitating retrofitting.

The Chinese government is abiding by coal as the basis for electricity generation. Thermal electricity generation has, however, shifted as a matter of priority to coalmining regions to reduce emissions in conurbations and replace coal with electricity transport (Coal by Wire Programme). Another aim is to raise the share of gas in power generation in the conurbations by means of new pipelines. A number of new gas pipelines have been laid or are under construction.

Power transmission and distribution

The existing isolated grids have been integrated more into the regional integrated systems in recent years. Massive investments are underway to link the five large regional and a variety of smaller transmission grids. The aim is to create a single national integrated grid by 2006.

In the next few years, the government is planning to improve efficiency in the transmission and distribution grids. Own consumption by production plants and pipeline losses currently total 15% of gross electricity generation.

In a special programme for rural electrification in the past, small settlements have been electrified in remote areas with new village systems, many with windpower, small hydropower and PV hybrid stations. Currently, 30 million inhabitants (2% of the population) have no access to power supply. A very ambitious development

programme aims to provide basic supply to 23 million people by 2010.

Electricity demand

Net power consumption in 2004 came to more than 1,850 TWh. This represents an annual per capita consumption of about 1,450 kWh.[2] The rates of increase in demand in 2003 and in 2004 exceeded 15% a year, 25% a year in the industrial areas of the Yangtse Delta. Growth will slow down in 2005. For the long run, average rates of about 5% are proposed.

Often, power demand cannot be met at peak load times. Supply problems and power failures have worsened since 2002. About 30 MW peak load could not be met in the summer of 2004.

By far the most important consumer group is industry, accounting for 66% of electricity demand. Household consumption amounts to 15% of the total, the service sector (including transport) accounts for 13%, and the primary sector (agriculture and forestry, mining) 6%. Due to continuous high economic growth, power demand is rising for production but private households are also demanding more due to higher incomes. The share of households and the service sector is expected to rise.

Electricity prices

The average purchase price for electricity nationwide across all consumer groups in 2003 came to the equivalent of 4.2 €-ct/kWh. Purchase prices vary considerably amongst provinces: The average price in Shanghai as a load centre amounted to 5.7 €-ct/kWh and in the sparsely populated Western provinces it came to 2.5 €-ct/kWh. On a scale of different user groups, commercial clients pay the highest prices and the prices for interruptible supply to agricultural clients are the lowest. Household electricity prices are in the medium range as do prices for heavy industry. As supply costs for these groups vary greatly, this is evidently not geared to costs. The pricing policy favours households. To manage loads, a day/night differential is being progressively introduced, also for households.

Rising coal prices in 2003 and 2004 prompted the price authorities to adjust the prices of electricity and assure producers of automatic adjustments. A new, transparent pricing system is being tested in a pilot area with separate cost-based rates each for production, transmission and distribution.[3]

As a prerequisite for progressive unbundling of functions, this system will also make for clearer power generation costs, if it is implemented. At present, the prime costs cited for coal-generated electricity are 3.5 €-ct/kWh, which implies a narrow margin for transport and distribution. However, the most electricity is still used by large customers.

Market players

Before the power sector reform in 2003, the State Power Corporation of China (SPC) founded in 1997 was the dominant enterprise with approximately half of production capacity, 90% of the transmission lines over 220 kV and a large part of the grids. The disaggregation of the SPC resulted in eleven enterprises in government hands, five generating companies, two grid operators (integrated grid operator and a holding of distributors) and four other companies with support services (e. g. engineering).

Production companies

The five power producers emerging from SPC were each allotted 30,000-37,000 MW of capacity, 45% of total capacity in 2003. One of these five enterprises, the Guodian Group, was assigned a large part of windpower capacity, which it then concentrated in the subsidiary Long Yuan.

The remaining 55% was handed to about 40 other power producers, which are, however, now undergoing a process of concentration. Self-generating industry owns generation capacity of about 30 GW in total.

Regulations envisage a higher degree of competition between producers and that no producer company in any balancing area may hold more than 20% of generating capacity.

2 Annual per capita electricity consumption in Germany amounts to about 6,400 kWh.

3 See also the section on the legal framework.

Grid operators

At the moment, the two new grid companies still operate as single buyers. They buy electricity from the producers, manage transmission and distribution and supply the end users.

The South China Grid Corporation (SCGC) operates in the five southern provinces with Guangzhou as the centre. With associated companies, the State Grid Corporation (SGC) is responsible for the remaining 20 provinces. The transmission grids are integrated into five regional grids. The SGC also manages the Lhasa Power Grid in Tibet.

Responsibility for rural electrification

Besides the large state grid operators, the National Development and Reform Commission (NDRC) and the Ministry of Water Resources (MWR) in particular are engaged in off-grid rural power supply with small hydropower stations. In many cases, institutional competency for village power stations in newly electrified villages has still not been definitively assigned.

Legal framework

In the last two decades the electricity sector in China has undergone considerable changes.

Power sector reforms

After political and operative responsibility were separated as early as 1998, the reforms in 2003 completely transformed the institutional landscape. The reforms are set out in Document No. 5 adopted by the State Council in April 2002 and are now in implementation (e. g. the unbundling of production and grid functions). Another large reform step, the disaggregation of transport and distribution and other functions, is expected in a few years.

The directives for setting up a national regulatory authority for the power sector (China Electric Energy Regulatory Commission) were implemented quickly.[4]

From 2004 through 2005 the planned measures for improving the political framework have been and are being implemented, particularly in environmental protection and promotion of renewable energies. Approval procedures have been speeded up. The price reforms already mentioned have also begun, after a certain delay. NDRC issued provisional regulations in April 2005. As a further reform step, it was announced in 2005 that individual regional markets can operate in organised competition and large buyers can purchase electricity directly from producers. In the long run, the conditions for self-generation will be improved.

The individual reform steps will culminate in a comprehensive amendment of the Electric Power Law, which is currently in the planning phase.

Energy policy institutions

In 2003, state competencies were reorganised. The State Asset Supervision Administration Commission (SASAC) was established by the People's Congress. It is responsible for the supervision of assets, performance, finances and executive personnel in state-owned enterprises and thus for the major companies in the electricity sector. The Ministry of Commerce (MOFCOM) and the National Development and Reform Commission (NDRC) arose from the merger of three ministries. The new MOFCOM is in charge of domestic and foreign trade, among other things also for equal treatment of foreign and Chinese enterprises. Besides price supervision and investment approval, NDRC has been entrusted with complete political responsibility for the energy sector, including renewable energies. The Energy Bureau has been established in the NDRC with the rank of a department. Its central tasks relate to energy supply security, energy efficiency and pollution. Responsibility for energy efficiency has been delegated to the environment department in the NDRC. In addition, a 13-member Energy Leading Group under the chairmanship of the Prime Minister was appointed as a macro coordinating body for all relevant ministries in the summer of 2005. This has been accorded an executive office headed by the NDRC President, avoiding competition with the Energy Bureau, which is also located in the NDRC.

4 See also the section on energy policy institutions.

Environmental protection and resource conservation

Responsibility for drafting and supervising environmental regulations is held by the State Environment Protection Administration (SEPA). This environmental administration is represented at all levels (national to local). Besides this, the Ministry of Land Resources, the Ministry of Water Resources and the State Forestry Administration (SFA) are responsible for resource issues. The Ministry of Agriculture also claims responsibility for rural energy supply and bioenergies. It runs offices down to district level.

Besides the executive power, the Environmental Committee of the National People's Congress, that is the legislative, is showing increasing interest in energy and environmental issues.

New regulatory authority for electricity

A separate authority has been set up to regulate the power sector, the China State Electric Power Regulatory Commission (SERC). The main task of SERC is to supervise reform and standardise regulations for enterprises in the power sector. Some functions overlap with the price authorities in the NDRC.

Energy research

The Ministry of Science and Technology (MOST) takes active part in drafting and implementing energy policy with research and demonstration projects. Among others, Tsinghua University with several energy institutes come under its purview. The academies for science, engineering and social affairs also have a number of energy research institutes at their disposal. A strategic role is also played by the Development Research Centre (DRC), which is reporting to the State Council.

The Energy Research Institute (ERI) is formally attached to the NDRC. ERI is an energy sector institute with considerable sway in energy policy discussion and implementation.

Foreign investments in the energy sector

To force investments of foreign capital in the energy sector in China, a number of measures have been taken in the past. As of the mid-nineties, the Chinese government permits direct investment of foreign capital in electricity generation. In 2004, greater access was introduced for domestic and foreign private capital to invest in and operate infrastructure (except for the grid sector).

Aside from general foreign trade regulations that are being increasingly closely defined in the course of WTO entry, plant shipments from foreign countries to Chinese markets are also subject to special access restrictions. China is evidently pursuing a policy of localised production for all technologies that reach a certain level of significance for the Chinese markets: This applies to high-efficiency coal power stations, gas turbines, desulphurisation plants, wind power plants and photovoltaic systems. The government's steering instruments for localisation vary, but the local content requirement aims at establishing capacity for national production and development. This is often effected by requiring a joint venture arrangement with a Chinese enterprise in production. Licences are also frequently purchased from foreign manufacturers. Entire plants are purchased for testing or in emergencies.

Market access for service providers has improved generally but is still regarded as difficult on the whole, irrespective of the fact that independent consultancy services are hardly ever paid for in China (apart from feasibility studies, which are always required). The institutional environment for foreign developers is fraught with large risks.

Clean Development Mechanism

China already ratified the Kyoto Protocol in 2002. The Chinese side pins great hopes on the Clean Development Mechanism (CDM) under the Kyoto Protocol as an additional source of finance.

As the world's second-largest emitter of CO_2 and with its growing energy needs, China affords broad scope for CDM measures. The designated national authority

in China is the Climate Change Office in the NDRC, the Ministry of Science and Technology and Tsinghua University.

Policy for promoting electricity generation from renewable energies

The large-scale use of renewable energies for electricity supply in general is not yet competitive without state intervention. The situation is different for decentralised electricity generation from small hydropower, wind or photovoltaic systems in remote areas and the use of agro-industrial waste in power-heat cogenerators.

Promotion of windpower electricity to date

Since the mid-nineties, a number of measures and regulations have been implemented to promote grid-connected windpower. To support the finance of windpower projects, the government granted soft loans for facilities from local production. Value added tax was also halved for electricity generation from windpower in 2002, i. e. reduced from 17% to 8.5%.

For most of the existing parks, however, individual pricing and feed-in regulations apply, taking into account individual costs and conditions.

Tendering large-scale projects

For the first time, calls to tender for two windpower concessions were issued by the government in 2003 (Rudong Wind Park and Huilai Wind Park.) On the one hand, the invitations to tender for large-scale projects of 100 MW each provide for a long-term feed-in tariff guarantee for investors and on the other hand aim at keeping the costs of electricity generation low.

The winning bidders at the end of tendering procedure in September 2003 were the Huarui Group[5] for the Rudong Wind Park in Jiangsu Province and the Yuedian Electric Energy Group for the Huilai Wind Park in Guangdong Province. Concessions of more than 25 years were issued for the windparks due to go online at the latest at the end of 2005. The feed-in tariff is divided into two phases: For the first 30,000 full-load hours the best price determined during the call for tender of about 0.5 RMB/kWh (5.2 €-ct/kWh) will be paid to Yuedian and 0.43 RMB/kWh (4.4 €-ct/kWh) to Huarui. Payment is then aligned with a market price for electricity delivery.

The actual initial price in the concession schemes currently falls short of the usual windpower prices to date, although these vary widely.

Law on promoting renewable energies

On February 28, 2005, the Renewable Energy Law was adopted by the National People's Congress. This provides a new basis for promoting renewable energies. The major provisions of the law, which is due to enter force on January 1, 2006, are as follows:

- Renewable energies are defined as non-fossil energies such as wind, solar, hydropower, biomass, geothermal energy, oceanic energy, etc.
- Targets and quantitative specifications will be set for RE and (resource) development plans.
- Responsibilities for implementing the law comprises all levels (government, province, municipalities) with chief responsibility at central, state level.
- Permission is required to erect RE power generators, if there is more than 1 applicant for a project licence an invitation to tender is carried out.
- Grid operators are obliged to
  - sign a feed-in contract,
  - provide a grid connection service,
  - buy the RE electricity in their grid area.
- The feed-in price is determined by the pricing authority.
- A financial balancing mechanism is planned amongst grid operators.
- If grid connection incurs costs for the grid operator, these can be passed on in charges for grid use.
- A RE development fund will be set up to promote off-grid renewable energies amongst other things.
- Other development measures include low-interest loans and tax relief.

5 The largest private investor in energy projects in China, which so far operates two small windparks in Helanshan (Ningxia Province) and near Beijing.

The law codifies basic provisions. The necessary, decisive details will be specified in implementation regulations without which the law cannot take effect in the way intended. Altogether, twelve implementing regulations must be drafted, particularly for specifying goals for renewable energies, feed-in tariffs, regulation of a national balancing mechanism, development of the RE fund and specification of technical standards.

Initial steps in implementing the law have already been taken. A national development plan for windpower (see Annex) up to 2020 was agreed in May 2005. This national allocation plan is part of Chinese policy methods. It is evidently not enough to rely on incentives such as the scheduled feed-in regulations. There is apparently no concern at present about the inevitable conflict between price signals and planned capacity as understood in a free market.

Status of renewable energies

The use of renewable energies for power supply in China is very advanced in some sectors and is lagging far behind in others.

On-grid facilities

The most important source of energy for on-grid electricity generation from renewable energies is small-scale hydropower (so far defined as capacity < 25 MW). Altogether, about 30 GW small hydropower stations have been installed. Installed capacity based on windpower rose from 570 MW in 2003 to 770 MW in 2004. On-grid electricity generation based on biomass, geothermal energy (30 MW) and solar energy has not played a notable role so far. For some years now, however, some tidal power plants have been in operation along the coast of Zhejiang and Jiangsu.

Off-grid applications and isolated grids

In off-grid applications, more than half a million systems are currently installed for power supply in single households in China, small windpower, photovoltaic and micro hydropower stations each making up a third.

Over a million residents in small settlement centres are supplied with electricity in stand-alone systems based on renewable energies (small hydropower, PV systems and hybrid PV-wind stations).

Hydropower

China has the greatest potential for hydropower in the world, largely concentrated in the West of the country. The large distance of these hydropower rich areas from the industrial centres that need the electrical energy hampers the use of these resources and places heavier demands on power transmission to the east and south coast.

Installed capacity and expansion plans

Total installed capacity of all hydropower stations in China at the end of 2004 amounted to 108 GW. Technical hydropower potential is estimated at 676 GW. For 2010 and 2020 installed hydropower capacity is planned to rise to 135 and 220 GW respectively. A long-term forecast for 2020 predicts a hydropower share of about 20% in total power production.

Large-scale hydropower station capacity will be enlarged in future. Apart from the gigantic Three Gorges power station at the Yangtze, which will provide 18.2 GW after completion in 2009, five other stretches of river are planned for power station use totalling 50 GW.

Small and micro hydropower

Small hydropower stations are largely operated in separate grids by the Ministry of Water Resources (MWR). About 42,000 small and mini hydropower stations are currently in operation with a total capacity of 34 GW. When the isolated grids are connected, many small hydropower stations will be taken out of service. On the other hand, there is also a pronounced recent trend towards building new on-grid facilities in Central and West China. Currently about 2 GW additional capacity is installed every year.

China manufactures the most micro hydropower stations in the world, which are also exported due to their low price. Their broader dissemination on foreign markets is largely hampered by their unsatisfactory quality, however.

Windpower

With an estimated onshore potential of 250 GW[6], windpower use is very promising in China. Windblown sites are primarily located in the steppes and desert regions in the West and North of the country and in the coastal regions. The technical potential for offshore sites is estimated by the China Wind Energy Association at 750 GW[7].

Wind data

As part of a UNDP/GEF project, wind measurements were taken at ten sites between 2002 and 2005. These sites have been selected as pilot projects in the national wind development plan and will receive priority national assistance to build windparks.

China also takes part in the multinational UNEP-supported Solar and Wind Energy Resources Assessment (SWERA) project to improve the wind database at regional level. Under the SWERA programme a wind atlas has already been drawn up for Southeast China, which will be extended to include other regions.[8] In the TERNA Wind Energy Programme, GTZ supported wind measurements in Hubei Province between 2000 and 2002.

Wind use to date

As at the end of 2004 windparks and individual turbines had been erected with a total capacity of approximately 770 MW. Annual additional capacity fluctuates, however. The threshold of 1 GW will be crossed by the end of 2005.

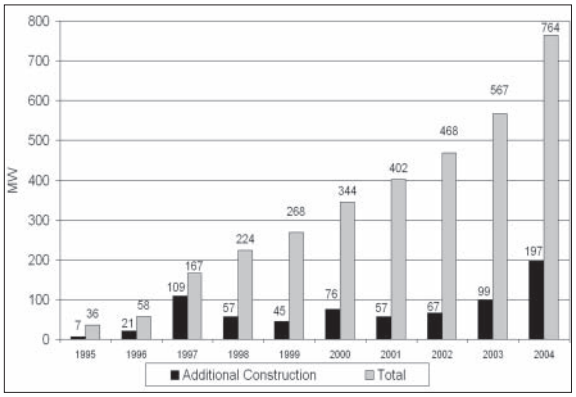

Fig. 2: Installed capacity and annual addition of on-grid windpower stations; China; 1995 – 2004; MW[9]

The provinces Inner Mongolia (135 MW), Liaoning (126 MW) and Xinjian (113 MW) are leaders in installed capacity.[10]

Expansion goals

The 10th five-year plan (2001-2005) foresees an installed windpower capacity of 1,200 MW by 2005 and the 11th five-year plan (2006-2010), 10,000 MW by 2010.[11] The concession schemes operated by NDRC aim at installing 100 MW each at certain sites. Altogether, windpower capacity will be extended to 20 GW by 2020. Considering the ambitious expansion plans of power production corporations, the targets planned for 2020 would appear to be the lower limit. A capacity of 20 GW may be reached much earlier.

Constraints on windpower development

Until the beginning of the decade, the bulk of installed windpower capacity was the result of bilateral or multinational development programmes and funds and less of national commitment.

The development of wind power has in the past been hampered by a number of constraints:

- Intransparent approval procedures
- Slow decision and approval procedures

6 According to the China Wind Energy Association, the potential of 250 GW pertains to wind resources at a height of 10 m. At a height of 50 m, potential would double, estimates the Association.

7 The wind data obtained in over 900 meteorological stations does not always meet international standards, however. This applies in particular to the specific site appraisals for windpower projects.

8 For more details on SWERA, see http://swera.unep.net. The Wind Energy Resource Atlas for Southeast China is available at www.rsvp.nrel.gov/wind_resources.html.

9 Data source: China Wind Energy Association, 2003.

10 Cf. also table in Annex.

11 Forecasts for the medium-term and long-term development of windpower differ considerably. The China Wind Energy Association gauges a windpower capacity of 4 GW to be realistic for 2010 and 20 GW for 2020 (incl. 4 GW offshore). Long-term development plans by NDRC foresee 10 GW by 2010 and 20 GW by 2020.

- Inadequate legal framework
- High import duties
- Local content specification requiring that 70% of the wind turbines or components must stem from Chinese production[12]
- Lack of coordination between institutions
- Annual renegotiation of power purchase agreements as a rule with a downward price trend
- Lack of protection for intellectual property in the case of local production

Some of these barriers will be removed by the renewable energy law and the relevant implementation directives. At the moment, however, a final judgement cannot be made on the basis of present provisions.

National windpower plant manufacturers

Larger stations upwards of 100 kW have only been manufactured for about ten years either in joint ventures or under licence. At present, more than five national manufacturers produce 600-660 kW class turbines with a high share of local components.[13] In mid-2004, the local content share for 600 kW stations amounted to about 96% and only 64% for 750 kW models.

Demand for these turbine models has been rather small in the past, though, as imported turbines are generally cheaper and have a better reputation for quality.[14] Recent agreements with the German enterprises REpower and Fuhrländer, for example, also provide for the manufacture of larger units (1-1.5 MW).

Small off-grid stations

Total capacity of small off-grid windpower stations (< 3 kW) amounts to about 42 MW. About 250,000 small windpower stations (0.1-3 kW) were installed in the off-grid sector at the end of 2002. With 22 producers (end of 2002), China is the world's largest manufacturer of these stations, which are, however, largely used inside the country.

Biomass

The considerable amount of biomass for energy purposes, predominantly in the form of harvest residues, fuelwood, forest wood residue and organic waste was estimated at over 5,500 TWh for 2001. A third only of this potential is actually used, largely for heating.

Biomass has always been used in small combustion facilities in all rural areas of Asia and can be expanded for electricity generation in China. Two main methods can be used for larger applications: organic substances (mainly bagasse) for power-heat cogeneration with steam turbines and power generation from biogas in gas engines.

Power generation from bagasse

It has been common practice for a number of years for larger sugar factories in China to use bagasse for their own power supply. More than 800 MW alone has been installed in the sugar provinces Guangdong and Guangxi. Feeding surplus electricity into the grid, however, is not common in this economic sector. A World Bank report estimates an available potential of 700-900 MW in electrical energy in these areas and in Yunnan alone which could be used at substantial financial gain.

The development of power generation from bagasse, also for grid feed-in, is, however, hampered by a number of constraints:

- Current poor economic situation in the Chinese sugar industry which leaves no scope for investments
- Lack of interest on the part of some sugar mill managers
- Current lack of low-interest long-term loans (soft loans with a term of 3 years were granted up to 1999 only for self-generation)
- Low level of remuneration for electricity fed into the grid
- No standardised set of rules for electricity supply and payment
- The seasonal nature of sugar production (and hence bagasse supply), which only takes place for approximately five months in the year.

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12 China intends to build up a competitive windpower industry. The aim is also to avoid overdependence on imports in the supply of energy resources and systems.

13 Three manufacturers produce in series, the other three have developed prototypes. These include the company Nordex with a manufacturing plant in Xian and the company Goldwind, which manufactures systems of the German producer REpower under licence.

14 At the end of 2002, 11% (54 MW) of total installed capacity stemmed from local production. In 2002, 28 MW of altogether 67 MW new installed turbines came from local production.

Biogas facilities and their promotion

China is the world leader in the application of anaerobic biomass gasification plants. Besides millions of small and micro facilities that are mainly used to minimise liquid manure in farming enterprises, there are about 700 larger plants, including approximately 150 which gasify the organic part of industrial wastewater (from the paper, sugar and pharmaceutical industry, alcohol and food production).

Biogas energy generation in Chinese agriculture is supported by the Asian Development Bank (ADB), which pledged a total of US$ 33 million at the end of 2002 for low-interest loans.

Under the current five-year plan (2001-2005) and a development programme for high-tech,[15] biomass facilities are being developed mainly for electricity generation. This segment is estimated to have considerable market potential.

Landfill gas use

With support from the UNDP/GEF project "Promoting Methane Recovery and Utilization from Mixed Municipal Refuse", waste disposal sites in several towns were examined for their suitability for power generation from landfill gases. Studies on this were completed in mid-2004. The first pilot plant in Anshan has already been completed and started operation in mid-2004.

Enterprises and research institutes

There are now 200 enterprises that produce biomass facilities or components. Of major importance in the research sector is the Biomass Development Centre (Beijing), which groups a variety of technical institutes as members. A network of political and scientific institutions and companies exists for the development, demonstration and dissemination of biomass technologies.

Solar energy

There is a lot of potential for solar applications in China. Average energy per day amounts to over 4 kWh/m^2. The sun usually shines for more than 3,000 hours a year, especially in the west of the country.

Although the high investment costs are an impediment to rapid market dissemination in the near future, electricity generation from solar energy in large-scale photovoltaic and solar thermal systems has a long-term future in China.

Market for photovoltaic technology

At present, the primary impetus comes from government-sponsored programmes to improve rural power supply. An estimated 150,000 solar home systems and 80 photovoltaic school facilities were installed in 2001. About 20 MW PV capacity was installed in 2002 alone, almost half of the 43.5 MW total at the end 2002. In the course of the Township Electrification Programme another 20 MW PV capacity was installed from 2002 to 2004, reaching a total of 60 MW at the end of 2004.

Local module production

In 2004, solar modules with a capacity of about 70 MW_P were produced in China, annual production capacity at the end of 2004 amounting to over 100 MW.[16] At present, the largest manufacturer is still the Chinese/Australian joint venture Wuxi Suntech Energy with an annual production capacity of 120 MW_P. Then comes the Japanese company Kyocera, which started a production line for 12 MW_P in Tianjing in October 2003. Nanjing PV Tech. Co. plans to install China's biggest PV production plant with an annual capacity of 100 MW_P in 2005. Other components for PV systems are also produced in China, such as charge regulators and pumps. In 2004, altogether more than 40 enterprises with over 10,000 employees were involved in the production, distribution and installation of PV systems and components. In the GTZ-assisted project for rural electrification, initiatives are underway to improve the long-term quality of local manufacturing by stepping up cooperation with the German solar energy industry.[17]

According to plans by NDRC and its rural electrification programmes it has initiated aim at installing about 80 MW of PV capacity nationwide by the end of 2005. This capacity could rise to over 300 MW by 2010. [18]

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15 This is the so-called 863 Research Programme.

16 This data does not distinguish amongst wafers, cells and modules and everything is subsumed under 'solar'.

17 See also GTZ: Solarenergie: Strom für ländliche Gebiete – Kooperationsmöglichkeiten für die deutsche Solarindustrie im Rahmen der technischen Zusammenarbeit in den Provinzen Qinghai und Yunnan in: Sonne, Wind und Wärme; June 2003.

18 Chinese Renewable Energy Industries Association (CREIA) (2001): New and Renewable Sources of Energy in China – Technologies and Products. In the course of the 11th five-year plan, about 260 MW (off-grid) will be installed.

Grid connected solar energy systems

Larger on-grid systems are only operated occasionally. In 2004, the nation's largest plant with a total capacity of 1 MW went on line in Shenzhen. At present, the first large-scale PV facility with an installed capacity 8 MW_p is being planned as a pilot plant in Xinjiang Gansu Province. Project finance has not been secured by now, however.

Constraints on future development

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

- Only government-based system suppliers receive public assistance; loans for panel suppliers and installation firms are generally rare.
- Poor maintenance and servicing reduce the lifespan of the systems.
- No institutional facilities provide credit and finance for solar home systems.

Geothermal energy

Despite considerable resources in China, power generation from geothermal sources has hardly been developed at all so far. The potential that can be used directly for electricity generation due to its high temperature (> 150°C) is estimated at 5.8 GW. There is technical potential along the east coast opposite Taiwan (Taiwan Geothermal Zone) and in the Yunnan Geothermal Zone in the Autonomous Region of Tibet.

Merely 30 MW installed capacity is spread over a 25 MW geothermal energy power station in Yangbajing in Tibet and a number of smaller demonstration projects.

Of the 255 prospective sites for geothermal electricity generation identified in China, ten are scheduled for development by 2010 with a potential output of 300 MW. A long-term development plan by the government envisages installed capacity amounting to 75-100 MW in 2010.

Rural electrification

Degree of electrification

Thanks to grid expansions and rural electrification programmes, approximately 98% of the population can now be supplied with electricity. Of the remaining 30 million people without power supply, particularly in the western and northern provinces of the country,[19] about 23 million are scheduled to receive basic supply through the very ambitious Brightness Programme by 2010.

In the peripheral areas, renewable energies are an economical alternative to grid supply and a more appropriate and environmentally cleaner option than conventional diesel stations. The energy needs in the remote areas correlate particularly well with the solar and windpower and micro hydropower potential, so that these alternative energy forms seem predestined for electrifying rural areas in China. The high potential in some regions will even allow renewable energies to be used for on-grid electricity generation, particularly in windpower.

Township and Village Electrification Programme

At present, several national development programmes, partly with bilateral and multinational support, are being carried out to improve rural power supply.[20]

One of the world's most ambitious programmes is the Township Electrification Programme (Song Dian Dao Xiang), which is implemented under the National Brightness Programme. Financed with about US$ 560 million, almost 20 MW in PV systems or hybrid PV wind systems and 274 MW in small hydropower stations have been installed within only two years by the end of 2004 and connected to mini power grids.

While the first programme phase comprised over 1,000 municipalities with approximately one million inhabitants, a second phase from 2005 to 2010 will include another 10,000 municipalities (Village Electrification Programme - Song Dian Dao Cun) and PV village systems as well as solar home systems with a total capacity of 265 MW. About US$ 2 billion is earmarked for

19 Tibet is the province with by far the largest percentage of households (approx. 80%) with no power supply.

20 Including a GTZ project to improve the framework worth 7.1 million Euro, KfW assistance amounting to 18.2 million Euro for village electricity generators and the Silk Road Illumination Project promoted by the Dutch government with 13.8 million Euro, involving Shell.

this. Altogether 23 million people will be supplied with power by 2010.

The Township Electrification Programme is supported by GTZ and KfW. The aim in the long run is for commercially self-supporting power supply systems. GTZ provides training for the local teachers, who then train the local technicians responsible for operating and maintaining the facilities.

Due to the tight deadline for the ambitious targets, some of the generating and grid systems installed were of poor quality and inadequate scale. To identify technical problems as soon as possible and determine the influence of electrification on the life and working conditions of the users, a comprehensive technical and socio-economic monitoring system has been established, also with support from GTZ.

Programmes and projects in international cooperation

Capacity Building for the Rapid Commercialization of Renewable Energy (CCRE)

The GEF-supported project, Capacity Building for the Rapid Commercialization of Renewable Energy (CCRE), was launched by UNDP in 1999 with the aim of developing commercial industrial sectors in renewable energies.[21] With financial support from the Australian and the Dutch governments, the project contributes to institution building and to implementing demonstration projects. Under this project, the Chinese Renewable Energy Industries Association (CREIA) was founded as an intermediary between industry and public authorities to liaise between national and international project developers and investors. Among others, additional measures include training specialist staff, policy advice, demonstration facilities and product certification. On behalf of the NDRC, the project is currently conducting a study on the reliability and availability of village power stations and the local operation and maintenance capacities to obtain information for designing the village electrification programme. GTZ is also involved in this study.

Renewable Energy Development Program (REDP)

The Renewable Energy Development Program (REDP) supported since 2001 by the World Bank and GEF aims at developing the market for photovoltaic technologies and establishing the commercial viability of windpower development in the coastal regions.

In the PV component of REDP, local solar companies are given financial and institutional support for the procurement, installation and maintenance of 300,000 to 400,000 solar home systems with a total capacity of 10 MW_P. These systems will be sold to households in the rural regions of six northwestern provinces, with a subsidy of US$ 1.50 per Wp sold. Altogether, a subsidy of US$ 27 million has been agreed. By the end of 2004, about 175,000 plants had been sold and installed with a total capacity of 3.5 MW_P. A pilot phase under the Village Electrification Programme is planned to receive financial support of up to US$ 20 million in the provinces Xinjiang, Inner Mongolia and Tibet.

To promote windpower development, REDP is supporting the erection of two windparks with altogether 20 MW near Shanghai with a soft loan amounting to US$ 13 million. Another World Bank-CRESP project is due to start in autumn 2005.

Cooperation with Germany

Financial and technical assistance from German institutions for renewable energies is largely provided in the rural regions of China. Since the beginning of the 1990s, the German Federal Ministry for Economic Cooperation and Development (BMZ) has been devoting increasing attention to photovoltaic technology and windpower.

A GTZ project, **Rural Infrastructure and Vocational Training**, aims at commissioning small village hydropower stations and putting them to long-term use in Tibet. This comprises appropriate operator schemes, irrigation measures and vocational and technical education to secure productive electricity use for economic development in these municipalities.

21 Included are PV and wind hybrid systems for municipal grids, biogas from industrial and agricultural waste, solar thermal energy and on-grid windparks and power/ thermal cogenerators run with bagasse.

Since the end of 2001, GTZ together with SDPC (now NDRC) has been conducting a programme called **Renewable Energies in Rural Areas** to promote the use of renewable energies in Qinghai, Yunnan, Gansu Provinces and the Autonomous Region of Tibet. The Township Electrification Programme in particular has received support through local operator training, quality assurance measures and other services. To ascertain the socio-economic impacts of improving rural energy supply an impact monitoring system has been established and NDRC is being given advice in system design and tariffs.

Under Financial Cooperation (FC), KfW contributes to decentralised power supply by installing approximately 300 PV diesel hybrid village power stations in the provinces Xinjiang, Qinghai, Yunnan and Gansu. Local maintenance capacity is also being built up and technicians trained for these systems under Technical and Financial Cooperation.

The development of windpower capacity in China has been promoted through extensive KfW programmes to erect windparks (in Hainan, Zhejiang, Guangdong, Inner Mongolia and in Xinjiang) with public funds from bilateral Financial Cooperation and capital raised on the market.

To support these projects and the national expansion programmes, the China Long Yuan Power Group and the China Electric Power Research Institute (CEPRI) are currently setting up a national **Research and Training Centre for Wind Energy** together with GTZ. The centre focuses on further training, advice and applied research with the aim of improving professional-technical capacities in private and state institutions for the nationwide development of grid-connected windpower.

Under the **TERNA Wind Energy Programme** and other projects, advice to the Chinese government in drafting the legal framework is provided.

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Annex

Allocation of targets of 20,000 MW windpower by 2020 in China

No.	Province	Capacity installed at end of 2004	New Construction 2005	Total Capacity 2005	New Construction 2010	Total Capacity 2010	New Construction 2015	Total Capacity 2015	New Construction 2020	Total Capacity 2020
		MW	MW	MW	MW	MW	MW	MW	MW	MW
1	Hebei (inkl. Beijing)	35.1	84.5	119.6	1,000	1,120	600	1,720	780	2,500
2	Jiangsu				450	450	700	1,150	850	2,000
3	Inner Mongolai	135.1	30.0	165.1	230	400	1,000	1,400	600	2,000
4	Fujian	12.8	9.4	22.2	150	170	500	670	830	1,500
5	Guangdong	86.4	21.5	107.9	150	260	500	760	740	1,500
6	Liaoning	126.5		126.5	100	230	320	550	650	1,200
7	Gansu	52.2	11.9	64.1	100	160	200	360	640	1,000
8	Xinjiang	113.1	8.5	121.6	100	220	200	420	580	1,000
9	Jilin	30.1		30.1	300	330	300	630	370	1,000
10	Zhejiang	34.5		34.5	50	80	100	180	620	800
11	Shandong	33.6	2.3	35.8	170	210	200	410	390	800
12	Shanghai	4.9	19.5	24.4	100	120	200	320	280	600
13	Heilongjiang	36.3		36.3	50	90	100	190	410	600
14	Jiangxi						100	100	400	500
15	Ningxia	55.3	35.2	90.5	50	140	100	240	160	400
16	Hainan	8.8		8.8		10	130	140	260	400
17	Guangxi						50	50	150	200
18	Shanxi						50	50	150	200
19	Guiyhou						50	50	150	200
20	Shaanxi						50	50	150	200
21	Henan						50	50	150	200
22	Tianjin						50	50	150	200
23	Hubei		13.6	13.6		13.6	100	110	40	150
24	Yunnan						50	50	100	150
25	Hunan						50	50	100	150
26	Chongqing						50	50	50	100
27	Sichuan						50	50	50	100
28	Tibet						50	50	50	100
29	Anhui						50	50	50	100
	Total	764.4	236.3	1,000	3,000	4,000	6,000	10,000	10,000	20,000

The present study on the PR China is based on the GTZ study "Energy-policy Framework Conditions for Electricity Markets and Renewable Energies – 21 Country Analyses". It was published under the TERNA Wind Energy Programme in June 2004.

Since the editorial deadline for the third edition of the country study, developments on the Chinese electricity market have been rapid. The production capacity grew by 51,000 MW in 2004 and a law for the promotion of renewable energies was adopted.

This study investigates the electricity market and the respective actors in the PR China. It analyses the energy-policy framework conditions and closely examines the status of and promotion policy for electricity generation on the basis of hydropower, wind power, solar power, biomass and geothermal energy. The study is rounded off by information about rural electrification, as well as programmes and projects in international cooperation.

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