CHINA

MARKET OVERVIEW

China's wind energy sector has grown at an exceptional pace since 2005. In 2010, China became the world's leading market for wind energy, both in terms of annual and cumulative market size.

China installed 28.9% of new global capacity in 2012. By the end of 2012, China had installed 75 324 MW of wind power. The Chinese market represented about 27% of the global market in 2012, down from 49.5% in 2010, and 43% in 2011. By the end of 2012, non-fossil fuel energy sources already accounted for 29.5% of China's electricity generation capacity (Global Wind Energy Council (GWEC), 2013).

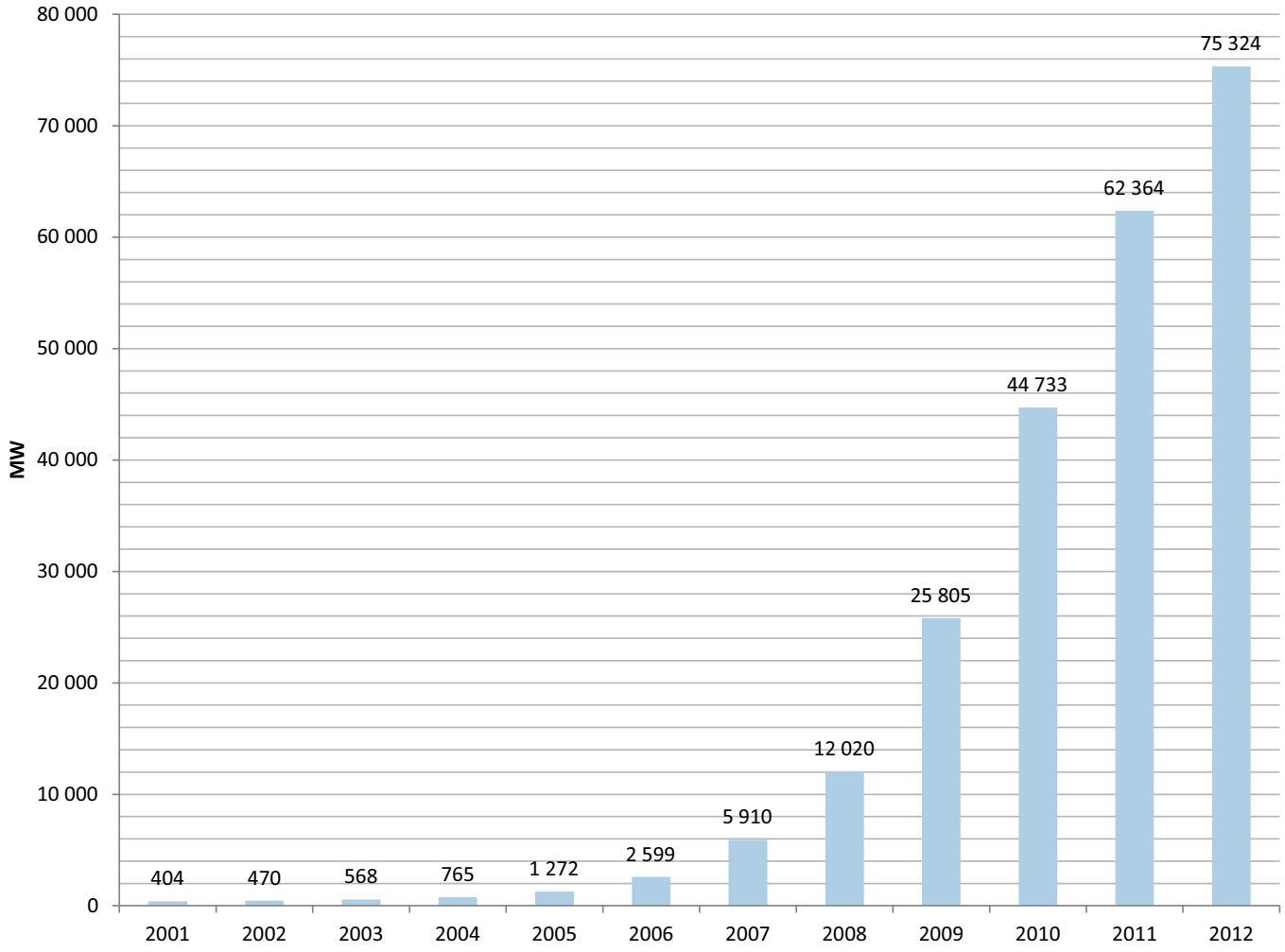

Figure 5: Cumulative Wind Installation (MW) of China (GWEC, 2013)

HISTORY AND EVOLUTION OF POLICY AND REGULATORY FRAMEWORK FOR WIND ENERGY

According to the third National Wind Energy Resources Census, China's total exploitable capacity for both onshore and offshore wind energy is between 700 and 1 200 GW (Junfeng, *et al.*, 2010). Compared to the other leading global wind power markets, China's wind resources are similar to those in the United States (US), and greatly exceed currently estimated resources in Brazil, Germany, India or Spain. China has installed more wind capacity in five years (2007-2011) than either the US or Germany[24] installed in over 30 years of wind power development.

Phase 1:

Demonstration phase (1986-2000)

The first demonstration wind farm was built in Rongcheng, Shandong province in 1986 (Pengfei, 2005). Domestic manufacturing was still at an early stage, with only a few Chinese companies, such as Goldwind, operating in the market. In the initial demonstration period (1986-1993), the main activity was building small-scale demonstration wind farms using grants from foreign donor countries and loans. Government support was predominantly provided through financial backing, such as investment in wind farm projects or in the development of wind turbines (Junfeng, *et al.*, 2007).

The wind industry started to develop slowly in the late 1990s. Many of the projects developed during this period were either highly subsided by the government or non-commercial, and were only using wind turbines with low power ratings (< 500 kW).

At a National Wind Power work meeting (1993), the former Ministry of Electric Power proposed a wind power industrialisation programme. The following year, it was decided that the national utility should facilitate the connection of wind farms to the nearest grid point, and all the electricity generated by wind farms should be purchased[25]. This measure guaranteed the security of investors and helped finance the development of wind farms through loans.

Later, the State Planning Commission decreed that the average electricity price for wind power should be calculated according to the operational period of the turbines, and the loan repayment period should be extended to over 15 years. In addition, Value Added Tax was reduced by half (to 8.5%) for wind power projects. However, the wind industry continued to develop slowly due to unclear policy support, high costs, and the need to operate within the limits imposed by the broader reform of the electricity supply system which was being undertaken to transform the electricity sector into a competitive market.

The first wind target set by China's State Planning Commission was for 1 000 MW to be developed by 2001 under the "Ride the Wind Programme", launched in January 1997. China's State Planning Commission selected a German company, Nordex Balcke-Durr GmbH, as the first foreign partner to develop these projects. Nordex Balcke-Durr and Xian Aero Engine Company[26] completed almost 50% of the Planning Commission's projects. The first 400 MW was financed through Chinese and foreign government loans.

This was the first joint venture set up to develop the planned wind projects. It was designed to initiate an ambitious localisation programme to gradually increase the local content to 80%. Furthermore, as part of China's "Double Increase" plan under the Ninth Five-Year Plan, contracts for over 70 MW of wind power were granted in 1997 to Danish companies Vestas and Micon (Windpower Monthly Magazine (WPM), 1997).

By the end of 2001, 404 MW of wind power had been installed in the country.

Phase 2:

Early commercialisation and tariff setting for wind (2001-2005)

Under its Tenth Five-Year Plan (2001-2005), the Chinese government introduced the concept of a Mandatory Market Share[27] of renewable energy in the national electricity supply (WPM, 2001).

As part of a broader electricity market reform, the government also introduced market-based mechanisms such as concession tendering for wind projects in 2002-2003.

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[24] By June of 2012, the USA had installed over 50 GW, and by the end of 2011 Germany had installed 29 060 MW of wind capacity. The USA is currently the second-largest and Germany the third-largest market for wind power.

[25] The grid tariff was to be calculated as the sum of power generation costs, loan payments and a reasonable profit. The difference between the wind electricity price and the average electricity price would be shared across the whole grid, with the power company responsible for purchase of the electricity.

[26] Xian Aero was the commercial arm of the Aviation Ministry. It was selected as a wind turbine manufacturing partner by the Chinese authorities in 1996 along with Luoyang First Tractor Factory, the commercial wing of the Chinese Machinery Ministry.

[27] The idea of Mandatory Market Share rose from an earlier proposal to place an obligation on provinces to meet a renewable energy quota of 5.5% of total electricity production from either their own generation or through the trade of green certificates. This system was based on a concept similar to the Renewables Portfolio Standard in the USA.

[28] The State Council and the National Development and Reform Commission (NDRC) are China's most powerful and influential clean energy regulators. Other government agencies play supporting roles and regulate more narrow parts of clean energy planning, programme management and implementation.

The objective of the National Development & Reform Commission (NDRC[28]) was to achieve commercialisation of the nascent wind industry by initiating a wind power "concession policy" programme (which went on to become an annual feature of China's wind development process). This programme promoted domestic projects through competitive bidding, requiring wind turbines to be manufactured with 70% domestically produced content (the so-called "localisation" provision).

Under this scheme the investors and developers of wind power projects were selected through a bidding process. The objectives were to expand the rate of development, improve domestic manufacturing capacity, lower power generation costs and reduce electricity prices. At the same time the concession projects were helping identify reasonable tariff levels for wind power in China.

During this period, the tariffs were either determined under these concessions or through government-approved tariffs, depending on the size of the projects. The government-approved tariffs were used for projects of less than 50 MW.

- Tariffs were proposed by the project developers as part of the wind concession tendering process. The government used the tariffs approved through the concession projects as guidance for determining tariffs often in similar sites.
- Up until 2006, the government-approved tariff scheme was still in a phase of trial and testing, and tariffs varied in locations with similar wind resources.

Another reason for undertaking the tendering process was to stimulate the development of large wind farms and create a scale effect to reduce the price of manufacturing and procuring a wind turbine. The "concession policy" created substantial developments post-2003, but a standard tariff structure was not yet in place across the country.

By the end of 2004, the market share of locally made wind turbines had reached 18% (Pengfei, 2005). By the end of 2005, the country had installed 2 559 MW of wind generation capacity.

Phase 3:

Renewable Energy Law and Targets (2005 -2007).

The rapid growth of the wind energy industry in China has been driven primarily by national renewable energy policies. The first Renewable Energy Law, which entered into force in 2006, significantly accelerated the growth of renewable energy. In 2007, the first implementation rules for the law were issued.

Up until this time renewable energy technologies had been marginal, but the Renewable Energy Law now provided a legal framework for their operation and development. The law stipulated that grid companies should prioritise renewable energy over other sources of power. Although it did not include targets and tariff bands for various technologies, the law did provide the basis for follow-up supporting regulations.

These supporting regulations can be divided between those setting targets, and those setting tariffs for different technologies. The former were successful, and the targets provided investors with indicators for gauging investment opportunities.

In addition, the 2007 Medium and Long-term Development Plan for Renewable Energy (NDRC, 2007) set out the government's commitment to renewable energy and put forward national targets and policy measures for implementation. It included a mandatory market share of 1% of renewable energy (not including hydro) in the country's total electricity mix by 2010.

To further encourage the nascent wind industry, the government maintained the 70% local content requirement[29], which encouraged international players to set up manufacturing facilities in China. Almost all

[29] The rule was abolished in 2010, when the domestic industry had been fully established with companies covering the whole supply chain and international players coming to set up their manufacturing facilities in China.

[30] In 2011, there were a total of 29 original equipment manufacturers active in China. In 2011, the top five manufacturers in the Chinese market were Goldwind 3 600 MW(20.4%), Sinovel 2 939 MW (16.7%), United Power 2 847 MW (16.1%), Mingyang 1 177.5 MW(6.7%) and Dongfang Turbine 946 MW (5.4%).

[31] Instead of the grid companies collecting the surcharge directly from the end user, the end user would pay the surcharge into the Renewable Energy Development Fund. Once the surcharges were pooled, the grid company then sought compensation from the fund for the additional cost of purchasing the renewable energy, including the costs associated with integration. This change was quite significant once all payments were pooled into one large fund. It allowed the government to use the fund (USD 689 million in 2009 (USD2011 751 million) and an estimated USD 1 billion in 2010 (USD2011 1.05 billion) not only to compensate grid companies, but also to invest in other renewable energy projects, including R&D (Xinhua, 2009).

[32] The bases are Gansu, East Inner-Mongolia, West Inner-Mongolia, Xinjiang, North Hebei, West Jilin, and Jiangsu Coastline.

of the world's major wind turbine manufacturers set up either an independent manufacturing business or a joint venture with a local company during this period.

After the introduction of the Renewable Energy Law, the Chinese wind turbine manufacturing industry took off rapidly and has since undergone extraordinary development. By the end of 2007, there were 40 domestic turbine manufacturers in China. By the end of 2008 this number had risen to 70, although only 30 of these had commercial products on the market[30] .

International wind turbine manufacturing firms such as Gamesa, General Electric, Nordex, Suzlon and Vestas established manufacturing facilities in China. They led the market until 2007, but by 2008 domestic manufacturers represented half of the total market share. Annual installations in 2008 reached 6 300 MW and the two largest domestic manufacturers, Goldwind and Sinovel, ranked among the world's ten largest wind turbine manufacturers.

In 2009, the Renewable Energy Law was amended to introduce a requirement for grid operators to purchase a fixed amount of renewable energy. The amendment law further reiterated that the grid companies should absorb the full amount of renewable energy produced, with the option to apply for subsidies from a new Renewable Energy Fund to cover the extra cost of of integration.

To finance renewable energy projects, the government put a surcharge per kWh on the electricity price. The surcharge started as CYN 0.002/kWh (USD 0.3/MWh), and was raised to CYN 0.004/kWh (USD 0.6/MWh) in 2008. This income[31] is pooled with other national funding sources into a national renewable energy fund to finance both special renewable energy projects and the feed-in tariff for solar and wind (Xinhua, 2009).

A provision for renewable portfolio standards (also called "mandated market share") was a key element of the 2006 Law. Other market-enhancing provisions included "government-guided" prices for wind power, the obligation for utilities to purchase all generated renewable power, and state guarantees.

Phase 4:

Wind Base Programme, introduction of FIT, offshore projects and amendment of the Renewable Energy Law (2008-2011)

The government started the Wind Base Programme in 2008, and selected seven areas, each to develop more than 10 GW wind capacity. The National Energy Administration selected locations in the provinces with the best wind resources and set targets to be reached by 2020.

According to the plan, the seven designated wind power bases[32] will add a combined total of 138 GW of wind power

Table 3: Annual installed capacity planned for Wind Power Bases in China (MW)

Wind Power Base	2010 (installed)	2015 (planned)	2020 (planned)
Heibei	4 160	8 980	14 130
Inner Mongolia East	4 211	13 211	30 811
Inner Mongolia West	3 460	17 970	38 320
Jilin	3 915	10 115	21 315
Jiangsu	1 800	5 800	10 000
Gansu Jiuquan	5 160	8 000	12 710
Xinjiang	0	5 000	10 800
Total	22 706	69 076	138 086

capacity by 2020, assuming that a supporting grid network is established. By early 2012 the Chinese government had confirmed seven GW-scale Wind Power Bases, with a total of 83 projects.

In terms of annual installed capacity, the provinces benefited significantly from this programme in 2010 (see table 3). The Wind Power Base in Gansu Jiuquan reported the greatest growth – more than 5 GW – while others followed with growths of between 1.8 GW and 4.2 GW.

Transmission bottlenecks have become a significant issue for the seven wind power bases. Many of the projects were reporting delays in obtaining final approval for the wind farms, due to the time required for interconnection, testing, certification, and final approvals. However, these delays were largely associated with personnel and administrative bottlenecks, rather than with infrastructure issues.

In 2009, China introduced a feed-in tariff for wind power generation, which applies for the entire operational period (usually 20 years) of a wind farm. There are four different tariff categories, ranging from CNY 0.51/kWh (USD 0.08/kWh) to CNY 0.61/kWh (USD 0.10/kWh), depending on the region's wind resources. The feed-in tariffs sent a strong signal of long-term financial price stability to the investors.

The Chinese government has continued to promote domestic manufacturing and technology development through a number of initiatives, including competitive bidding. For example, in 2009 seven domestic manufacturers were selected to supply over 5 GW of wind turbines to 25 projects in three sites in Inner Mongolia and Hebei provinces (Renewable Energy Policy Network for the 21st Century (REN21), 2010).

Driven by the global trend towards bigger wind turbines, Chinese firms, including Sinovel, Goldwind, XEMC, Shanghai Electric Group and Ming Yang, are now manufacturing wind turbines with rated capacities of 5 MW or more. Of these, Sinovel has already installed its 5 MW turbine in an offshore project and Goldwind expects to have its 5 MW machine ready for commercial use in 2012-13. This rapid cycle of technological, human and institutional learning has not been witnessed in any other market.

2011 was an important year for Chinese wind turbine manufacturers, as four companies, including Sinovel, Goldwind, United Power and Dongfang Electric, entered the list of the world's ten largest wind turbine manufacturers, and began to expand into overseas markets.

The national wind power generation market is mainly shared among the "Big Five" power producers and a few other major state-owned enterprises. These firms account for more than 80% of the total wind power market[33]. Most of the foreign-owned and private enterprises have only a limited presence in the market.

An update to the 2006 Renewable Energy Law was adopted by the National People's Congress in December 2009 and took effect on 1 April, 2010. Since this revision included detailed planning, a strong co-ordination was required between power sector and transmission planning, and also between the development plans drawn up at local/provincial level and those developed by national ministries. The revised law also clarified the roles and responsibilities of the power companies regarding the interconnection of renewable energy generation to the grid.

Energy storage and smart grids were also addressed in the revised law. The domestic wind energy sector had been growing at such high rates that the process of transmission planning and interconnection could not keep pace with annual wind turbine installations. Some completed wind projects, mostly those that were not coordinated with national planning, lacked transmission access, although this was not a widespread problem (Martinot and Junfeng, 2010).

The provisions guaranteeing the purchase of all renewable energy production by electric utilities were further strengthened. Previously, utilities were only obligated to purchase the electricity if there was sufficient electricity demand. Under the new version of the law, utilities were obligated to buy all renewable energy production. The utilities could then transfer the purchased power to the national grid company. The 2009 revisions to the law also added deadlines and economic penalties for utilities failing to comply with this guaranteed-purchase requirement.

As part of the 2005 law, the Ministry of Finance had established a Renewable Energy Fund and guidelines for the fund were improved and consolidated in 2010. Previously, the fund was meant to provide support to special projects developed solely as demonstration projects. The amended guidelines required the fund to utilise the surcharge to finance the tariffs payments for renewable energy projects. However, since the surcharge did not reflect the overall disbursements, the new revisions also allowed the Ministry to supplement this energy fund from general revenues.

China's first offshore wind power demonstration project, and the first offshore wind project outside Europe, is the Shanghai Donghai Bridge 102 MW offshore wind farm, which started generating power in June 2010.

During the period from May to November 2010, the government launched a public tender for the first round of offshore wind concession projects, adding 1 GW of planned capacity in four projects along the coastline of Jiangsu Province[34].

However these projects, although approved by the National Energy Administration (NEA), led to objections from other government departments seeking to protect fishing rights and other marine interests. In the meantime, the developers realised that the proposed prices were too low (Patton, 2012). Chinese power companies are now drawing up plans for a series of demonstration projects[35], as a way of gaining experience in offshore developments and preparing for the next tenders. By 2011, China had installed 242.5 MW through offshore demonstration plants, ranking third globally, after the UK (2093.7 MW) and Denmark (857.3 MW) (Junfeng, *et al.*, 2012).

In 2010, the National Energy Administration and the State Oceanic Administration jointly published "Interim Measures for the Administration of Development and Construction of Offshore Wind Power". These guidelines could help accelerate China's offshore wind power development as they set out provisions for project approval procedures, as well as criteria for project development and construction. Tender procedures will be the preferred method of selecting the offshore projects, and foreign investors can only hold a minority stake in offshore wind developments. China has set targets for offshore wind development of 5GW by 2015 and 30 GW by 2020.

Another significant change in 2010 was the removal of the requirement for 70% share of domestic content in terms of the value of incorporated materials and components. This requirement was no longer necessary, as all installed wind turbines were now nationally produced (Martinot and Junfeng, 2010).

By the end of 2010, most manufactured Chinese turbines had a capacity of 1.5-2.0 MW, in comparison with earlier years when models lower than 1 MW accounted for a major proportion of the turbine production. Four Chinese companies are among the world's top 10 wind turbine manufacturers.

CURRENT CHALLENGES

Despite its rapid expansion, the Chinese wind power sector continues to face significant challenges, including issues surrounding grid access and integration, reliability of turbines and the development of offshore wind projects. Due to varied wind resources and different technical and economic conditions across China, the developments focused on a few regions and provinces including: Inner Mongolia, the north-west, the north-east, Hebei Province, the south-east coast and offshore islands.

The rapid development of wind power has put a strain on the electricity grid infrastructure, and some projects are delayed by several months before being connected to the national grid. Reports stating that a large share of China's wind power capacity is not grid-connected are based on a misunderstanding due to the methodology used for calculating the installed capacity[36].

Due to a lack of incentives, the Chinese grid operator State Grid was initially reluctant to absorb large amounts of wind energy. An agreement was reached in 2010 to connect 100 GW of wind power by 2015 and 150 GW by 2020. According to figures from State Grid, by the end of 2010, CNY 40 billion (USD 6.1 billion) had been invested to facilitate wind power integration into the national power grid.

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[33] The largest wind power operators, Guodian (Longyuan Electric Group), Datang and Huaneng, expanded their capacity by 1-2 GW each during the year, while Huadian, Guohua and China Guangdong Nuclear Power are following close behind.

[34] The winning bids for these projects ranged between CNY 0.62 and CNY 0.74/kWh (USD 0.10 and USD 0.12/kWh).

[35] These demonstration projects were initially of a smaller size, consisting of several turbines with a maximum capacity of 20-30 MW. However the Rudong project (150 MW) was approved and labeled as a "demonstration project" in 2011. Demonstration projects enjoy a favorable tariff, compared to the low tariff resulting from the bidding process. This mechanism could play a positive role in testing the offshore technology and offshore wind farm management in the country (GWEC, 2011).

[36] For example at the end of 2010 the China Electricity Council published a figure for operational capacity, which included wind farms that had been connected to the grid with a Power Purchase Agreement, having successfully undergone a testing procedure, and for which the national grid operator State Grid had started to pay for the electricity. The accounting method resulted in a time difference of several months, compared to the installed capacity counted by the wind power associations CREIA and CWEA. The associations accounted for turbines that were grid-connected and were delivering electricity, even before undergoing the commissioning and acceptance procedure. This difference in accounting methods explains the gap between installation and grid connection, often reported from China. In other countries with significant wind installations, the common practice is to count all turbines once they are grid-connected and producing electricity.

Expansion of the electricity grid has not kept pace with the development of wind projects, and coordination for grid planning is needed at both national and provincial levels. The areas with the best wind resources are sparsely populated regions where electricity demand is low. For example Inner Mongolia, a region with a very strong wind resource, suffers from severe transmission constraints. High voltage transmission lines could connect Inner Mongolia and similar areas to the rapidly developing eastern parts of China. In 2011, more than 10 billion kWh of wind power was not generated because of wind farm curtailments (Junfeng, *et al.*, 2012).

Locally produced wind turbines are not certified using international standards. The quality improvements of the domestically manufactured wind turbines has not kept pace with the installation rates, although the situation is improving with the emergence of domestic certification agencies. Certification will be a critical element for exporting to international markets.

CONCLUSION

Some of the key factors underlying the growth path for wind industry in China are:

» A strong long-term legislative background;

» A clear tariff structure; and

» A strong industrial base.

The 11th Five-Year Plan period (2006-2010) was instrumental in stimulating the renewable energy industry in China. Much of the regulatory structure was put into place during this period, starting from planning documents to related statutes and regulations. Another key milestone was the passage of the Renewable Energy Law, which stimulated renewable energy R&D and equipment manufacturing, and resulted in the creation of an exceptionally large number of domestic wind projects (the law was amended in 2009).

The development of the policy framework was continuous and it integrated the lessons learnt from ongoing developments, including developing a price curve for (new) renewable technologies versus conventional energy generation. Onshore wind power was supported first, then solar, followed by offshore wind.

The 2006 Renewable Energy Law, and complementary measures such as the pricing policy, obligation on the grid companies to purchase renewable electricity, and cost distribution through the Renewable Energy Fund has accelerated the development of renewable energy

A maintenance engineer inspects a wind turbine at the Nan'no Wind Farm, Guangdong, China. ©2005 Greenpeace/Xuan Canxiong

in China. The 2006 law was complemented by a wind power "concession" programme (2003–2007), which added 3.4 GW through annual competitive project bidding (Martinot and Junfeng, 2010).

The evolution of the Chinese market shows that the determination of differentiated tariffs for each region was a lengthy process and required a cautious and well-researched use of concession tenders. Although the concession tenders were designed to find a realistic tariff for wind farms, the initial criteria for selecting winning bids were primarily based on the tariff. This strategy pushed developers into proposing low prices, thereby endangering the financial viability of the projects. The "lowest tariff" approach ultimately translated into extremely low profit margins for investors.

The Wind Base Programme has become a major driving force for wind development over the last four years. The programme started implementation in 2009 with seven 10 GW-size development areas being selected in six provinces. This major programme provided a large market for the domestic industry and was a turning point for the wind industry development in China. Large-scale concession tenders also played a significant role in promoting the development of the wind power sector during its early stages.

China's wind projects are mostly developed by state-owned energy company/utilities. The government-owned utilities account for almost 80% of the total capacity. The remaining 20% are increasingly supplied by utilities owned by provincial governments. Private enterprise and foreign-owned developing businesses represent a limited share of the total wind capacity of the country.

The Chinese government report "Development Planning of New Energy Industry" calculated that the cumulative installed capacity of China's wind power would reach 200 GW by 2020 and generate 440 TWh of electricity annually, creating more than CNY 250 billion (USD 38 billion) in revenue (Junfeng, *et al.*, 2010).

From the industry's point of view, the country faces challenges in its efforts to expand its renewable energy base. These include the need for expanding R&D institutions dedicated to renewables; improving the operational performance of wind turbines; reducing transmission issues for wind power; addressing delays in testing and certifying new wind turbine installations; conducting more detailed resource assessments; integrating renewables into the overall power sector planning and design at both national and local levels; continued policy development and adjustment; and ensuring the availability of skilled manpower.

ANALYSIS OF ENABLING CONDITIONS FOR WIND ENERGY

Effective rule of law; and transparency in administrative and permitting processes	With the introduction of the Renewable Energy Law in 2006, the wind industry grew rapidly. This law, together with other measures such as a pricing policy, obligation on grid companies to purchase renewable electricity, and cost distribution, accelerated the development of renewable energy. Improved permitting processes are under development. Due to the large developments expected in the future, infrastructure planning also requires coordination at both regional and central levels.
A clear and effective pricing structure	In 2009, China introduced a feed-in tariff for wind power generation, which applies for the entire operational period (usually 20 years) of a wind farm.
Provisions for access to the grid (incentives and penalties for grid operators)	Renewable energy-based electricity generation from approved projects has priority access to the grid.
An industrial development strategy	The government encouraged early joint ventures with foreign manufacturers. It also implemented a local content requirement rule to encourage the local production of wind turbine generators. This rule was later abolished in 2010.
A functioning finance sector	The government, state-owned enterprises, the Chinese Development Bank, international lending institutions and donor agencies have all been instrumental in financing wind projects. Furthermore, China has been the largest beneficiary of support from the Clean Development Mechanism of the UNFCCC, including support for wind projects.
Expression of political commitment from government (e.g. targets)	The Chinese government has declared a target of connecting 100 GW of wind power to the grid by 2015 and 150 GW by 2020.
A government and/or industry-led strategy for public and community buy-in.	Not applicable
An employment development strategy	Not applicable
NOTE	**Long-term national renewable energy policies and targets drive the unparalleled rate of growth of the Chinese wind industry.**

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