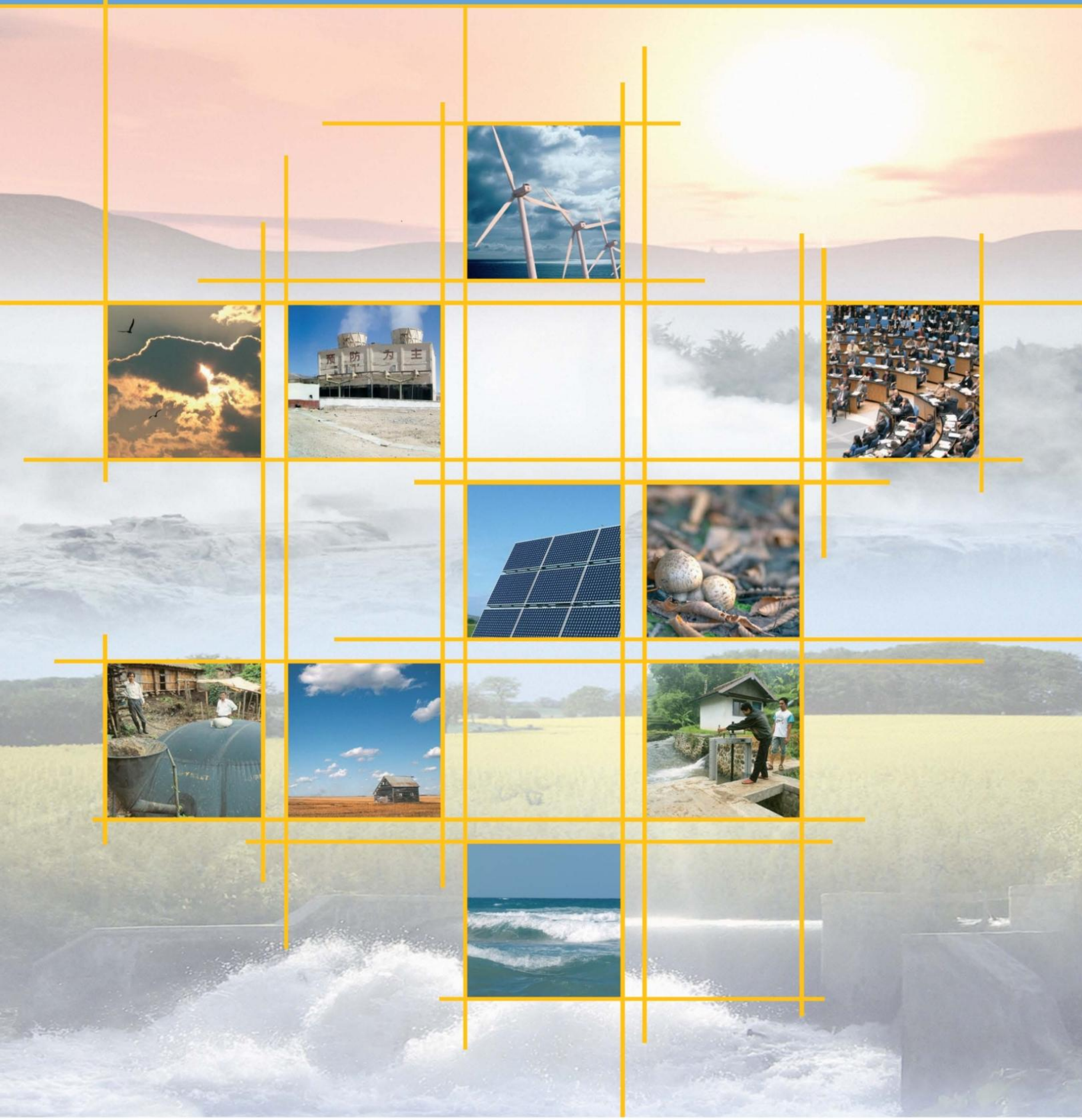
RECOMMENDATIONS FOR IMPROVING THE EFFECTIVENESS OF RENEWABLE ENERGY POLICIES IN CHINA



REN21 Renewable Energy Policy Network for the 21st Century

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October 2009

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REN21 convenes international multistakeholder leaders with the aim to enable a rapid global transition to renewable energy. REN21 promotes renewable energy to meet the needs of both industrialised and developing countries that are driven by climate change, energy security, development and poverty alleviation.

Open to a wide variety of dedicated stakeholders, REN21 connects governments, international institutions, nongovernmental organizations, industry associations, and other partnerships and initiatives. REN21 leverages their successes and strengthens their influence for the rapid expansion of renewable energy worldwide.

Acknowledgement

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1. Introduction

Growing recognition of the important role that renewable energy can play in tackling climate change and ensuring energy security has led to a rapid boom in the industry over the last five years. According to the *Renewables Global Status Report 2009 Update*, annual renewable energy investment has increased fourfold since 2004 to reach USD120 billion in 2008.[1] This was the first year that new power generation investment in renewables was greater than investment in fossil fuel technologies.[2] Between the end of 2004 and the end of 2008, solar photovoltaic (PV) capacity increased sixfold to more than 16 gigawatts (GW), wind power capacity increased 250 percent to 121 GW, and total power capacity from new renewable technologies increased 75 percent to 280 GW, including significant gains in small hydro, geothermal, and biomass power generation. Solar heating capacity doubled to 145 gigawatts-thermal (GWth), while biodiesel production increased sixfold to 12 billion liters per year and ethanol production doubled to 67 billion liters per year. In 2008 alone, more than 27 GW of wind capacity was added worldwide.[3] Of this, more than 8.5 GW was installed in the European Union and United States, accounting for more than 40 percent of total new power installations in 2008 in these regions. Cumulative installed wind capacity in China reached over 12 GW by the end of 2008, continuing its growth rate of more than 100 percent annually.

Grid-connected solar PV continued to be the fastest growing power generation technology. Annual installations of grid-tied solar PV reached an estimated 5.4 GW in 2008, with a 70 percent increase in existing capacity to 13 GW.[4] Other sources of renewable energy, such as biofuels, biomass power, and solar thermal, also showed strong growth.

Although policies supporting renewable energy development continue to expand worldwide, the effect of the financial upheaval on both banks and businesses has had a negative impact on the industry, particularly the capital-intensive solar PV sector. Many construction projects have been delayed, orders have been postponed, and prices have dropped rapidly. Generally speaking, the influence of the global financial crisis and the resulting economic recession is expected to bring challenges to the renewable energy industry, but it has not been as severe as in other industries, and even less so in China.

To deal with the crisis, many countries are embracing renewable energy as an essential economic recovery measure. The EU reconfirmed its target of achieving a 20 percent share of renewables in the region’s energy mix by 2020. The United States is turning to renewable energy as the foundation for reinvigorating its large economy and creating jobs. In early 2009, the government allocated USD150 billion from its USD800 billion stimulus package over 10 years to create incentives for new energy and energy efficiency sectors. The United States House of Representatives also approved a bill in June 2009 meant to address climate change and transform the way the nation produces and uses energy. The bill sets a national target for 20 percent renewable electricity by 2020, although a third of that could be met with efficiency measures rather than renewable energy sources.[5] In addition, Japan announced a 1 trillion yen (USD12.2 billion) investment over five years, South Korea launched a USD36 billion

[1] REN21 Secretariat, *Renewables Global Status Report 2009 Update* (Paris: May 2009).
[2] UNEP SEFI / New Energy Finance , *Global Trends in Sustainable Energy Investment 2009* (Paris. 2009).
[3] Global Wind Energy Council (GWEC), *Global Wind 2008 Report* (Brussels: 2009).
[4] REN21 Secretariat, *Renewables Global Status Report 2009 Update* (Paris: May 2009).
[5] The American Clean Energy and Security Act of 2009 (ACES), 26 June 2009.

package over four years, and Australia was to accelerate an existing AUD500 million (USD370 million) renewable energy fund from the original six years to just 18 months.[6]

China has announced a stimulus package of RMB4 trillion (USD586 billion)[7] to help the economy recover, in which clean energy is one of the main supporting areas. In addition, special programs have been launched for building-integrated PV (BIPV) installation, large-scale solar PV power stations, rural utilization of solar water heaters (SWH), and the construction of gigawatt-level wind farm bases. Although the level of support is not clearly defined, these programs provide positive indications of the potential of China's renewable energy market in the next few years.

2. Status of Renewable Energy in China

Renewable energy has played a major role in helping China meet its rising energy demand, improve its energy structure, reduce environmental pollution, stimulate economic growth, and create job opportunities. The central government has devoted significant attention to the development of renewable energy, dating back to early investments in hydropower deployment in the 1950s. Since the 1980s, government support has enabled the development of wind power, solar power, and modern biomass energy, as well as the testing of other renewable energy sources such as ocean and geothermal energy.

According to the definition in China's Renewable Energy Law, renewable energy refers to non-fossil energy sources, including wind energy, solar energy, hydropower, biomass energy, geothermal energy, and ocean energy.[8] In the case of hydropower, application of the law is regulated by the energy authorities of the State Council and approved by the State Council. While large hydropower is included in China's definition of renewable energy, it is considered to be a more traditional energy approach and is included less frequently in renewable energy articles and reports.

China began building an enabling environment for the renewable energy industry and market expansion in 2001, launching several national renewable energy programs over the subsequent four years, especially for solar PV and wind. These included a concession program to promote the large-scale development of wind power, and the Township Electrification Program, which invested over RMB2 billion (USD293 million) government funds in renewable energy technologies and brought about significant growth in the rural deployment of solar PV systems. The project solved the problem of electrical shortages on a daily basis for about 1.3 million people by building 268 small hydropower stations and 721 PV power plants. In addition, initiatives to improve rural sanitation and boost farmer incomes encouraged the use of biogas in rural households; market promotion efforts helped popularize SWH; and technical R&D and demonstration projects stimulated the development and use of biomass power and liquid biofuels.

Following the adoption of the Renewable Energy Law in 2005 (which became effective on 1 January 2006), China's renewable energy sector boomed, resulting in China taking a leading position globally,

[6] REN21 Secretariat, *Renewables Global Status Report 2009 Update* (Paris: May 2009). For more national government plans, see Chapter 2 of the report.
[7] For more information, please see http://money.163.com/08/1109/19/4QB529IR00252G50.html.
[8] For more information, please see The People's Republic of China Renewable Energy Law (Full Text), www.chinaenvironmentallaw.com/.../renewable-energy-law.doc.

particularly in wind power, solar water heating, and small hydropower. By the end of 2008, China's annual renewable energy use totaled some 250 million tons of coal equivalent (tce)[9], excluding traditional biomass energy (large hydropower is included in the statistics unless otherwise indicates). This represented nine percent of total primary energy consumption, two percent more than in 2005. Hydropower use amounted to 180 million tce, and solar, wind, and modern biomass energy use totaled 70 million tce. This has put China well on its way to achieving its strategic objective of a 10 percent renewables share of primary energy use by 2010.[10]

According to statistics from the China Electricity Council[11], by the end of 2008 total electricity generation from renewable sources amounted to 586.7 terawatt-hours (TWh), including 563.3 TWh from hydropower (both large and small), 12.8 TWh from wind power, and 9.2 TWh from solar PV, geothermal, and biomass power combined. In total, electricity from renewables accounted for 17 percent of national electricity production of 3,433.4 TWh, which represents a two percent increase over 2005.

2.1. Industrial Development of Renewable Energy

China's renewable energy industry and its domestic market have grown significantly as a result of the *Renewable Energy Law of 2005* and the *Medium- and Long-Term Development Plan for Renewable Energy* of 2007. Power generation from wind and solar PV has become a new engine of economic growth in many regions in China, helping to meet local energy needs and create large numbers of jobs. The two industries have created an estimated 400,000 jobs nationwide in recent years.[12] Although not as significant as solar PV and wind in terms of growth rate, other renewable energy technologies are also accelerating, including SWH, biomass power generation, biomass pellet production, and ocean and geothermal energy.

2.1.1. Wind

Wind energy in China has experienced unprecedented annual growth, with total capacity doubling in each of the past four years. By the end of 2008, China's accumulated installed wind power capacity totaled 12 GW[13], surpassing the country's nuclear power capacity (with 9.1 GW[14] currently under operation). At that rate, added wind power in 2009 will account for more than 10 percent of the total power installed this year. A large-scale wind market is taking shape rapidly, and the domestic industry is booming.

The use of wind power in China can be divided into two approaches: off-grid utilization and grid-connected operation. Small wind turbines for off-grid application play an important role in China's wind energy development. By the end of 2008, 74 organizations, including 36 manufacturers, were involved in either the R&D or manufacturing of small turbines. Current production capacity in China is

[9] 1 tce is equivalent to about 0.7 tons of oil equivalent (toe).
[10] Junfeng Li, *Chinese Renewable Energy Industry Outlook 2008.*
[11] China Electricity Council, China Annual Report on Electric Power Industry 2008.
[12] Data collected by Chinese Renewable Energy Industry Association (CREIA).
[13] Pengfei Shi, China Wind Capacity Statistic 2008, available at http://www.cnwpem.com/webdata/down_list/2009-03/20090305131421723.pdf.
[14] Data from Energy Research Institute of the National Development and Reform Commission (NDRC).

about 80,000 units per annum, with 19 different types of units produced with capacities ranging from 100 W to 100 kW (most are 100 W). Production in 2008 was 78,784 units, with a combined capacity of some 76 MW and a market value of around RMB530 million (USD77.5 million). Of the 2008 output, 38,957 units were exported to more than 30 countries around the world, 50 percent more than in 2007. (see Table 1.)

Table 1. Off-Grid Wind Turbine Production, Installed Capacity, Output, Tax and Export Collection 2002-2008

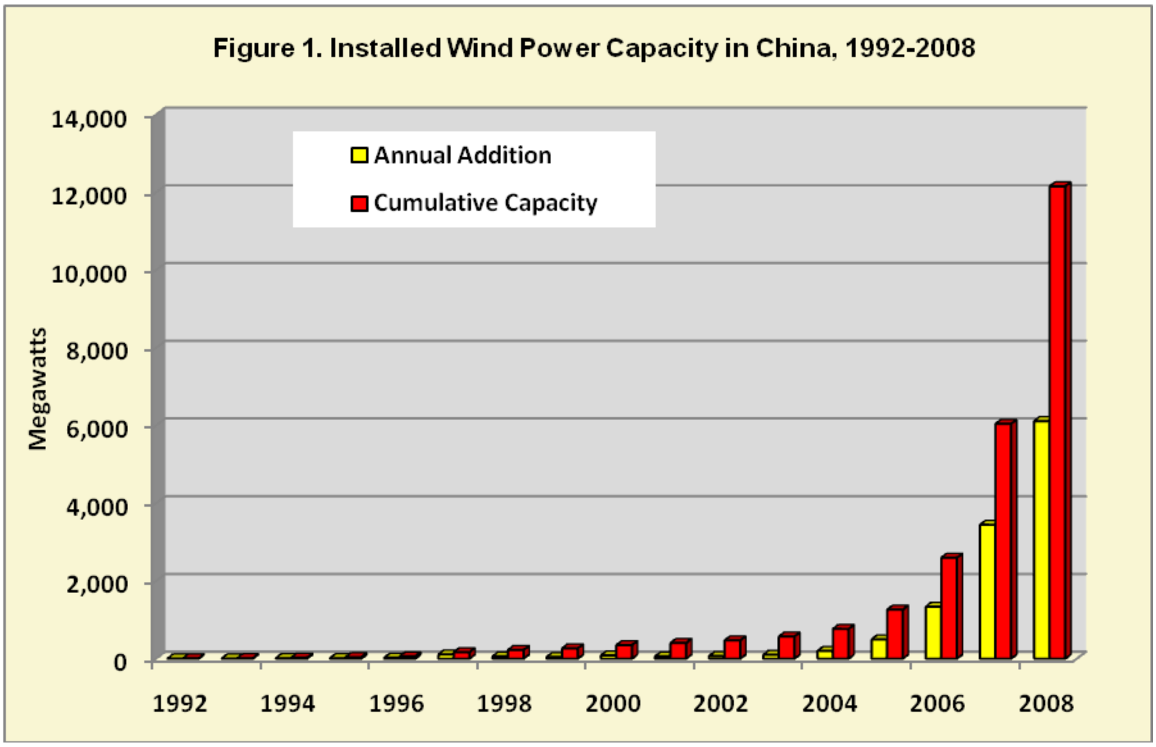
Year	2002	2003	2004	2005	2006	2007	2008	Total
Production (unit)	29,658	19,920	24,756	33,253	50,052	54,843	78,784	291,366
Installed Capacity (kW)	8,873.2	6,083.7	11,300.2	12,020	51,740.8	35,014.6	75,796.5	200,829
Output (million RMB)	70.596	47.405	66.537	84.72	170.908	317.944	529.928	1288.038
Tax (million RMB)	9.845	6.606	7.759	9.929	14.16	37.49	100.227	186.017
Export (unit)	1,484	2,484	4,189	5,884	16,165	19,520	38,957	88,683

Production of small wind turbines can date back to early 1980s. They are widely used in remote areas of China, providing electricity to more than one million households in rural areas. By 2008, some 380,000 small turbine units, with a combined capacity of 75 MW, had been deployed to supply electricity in remote areas. About 300,000 of the units (ranging from 100 W to 10 kW) are currently in operation. China is now home to the largest small-turbine industry and market in the world.[15]

Chinese manufacturing of grid-connected wind turbines started in the 1980s, but development remained slow for many years. Before 2005, the few existing wind turbine manufacturers had limited capacity, producing units of less than 600 kW in size. The market was dominated by imported turbines, which accounted for more than 80 percent of the Chinese market share.

During the 11th Five-Year Plan (2006–2010), rapid wind energy development led to an increase in total installed capacity from 1.25 GW in 2005 to 12 GW in 2008. (see Figure 1.) Annual growth has kept at over 100 percent for more than five years. In terms of installed wind power capacity, China jumped from 10th place globally in 2004 to 4th place by the end of 2008.

[15] Defu Li, data collected by China Association of Agricultural Machinery Manufacturers (CAAMM).



The wind manufacturing industry in China is growing faster than the market. More than 70 domestic wind turbine manufacturers have emerged, and the number of component producers has surpassed 100. These companies are capable of producing turbines ranging in size from 0.75 MW to 3 MW. Leading turbine manufacturers include Goldwind, Sinovel, Dongfang Steam, Vestas, Suzlon, and GE, with the support of component manufacturers such as Nanjing Gear-box, Huiteng Blade, Tianfu Blade, and Lianzhong Motor. Total production capacity in 2008 neared 10 GW[16], enough to meet domestic market demand and to enable exploration of the export market.

The development of offshore wind in China is still at its very early stage. In the 11th Five Year Plan the government has encouraged the industry to learn from international experience on offshore wind development and to explore the potential opportunities in coastal provinces, such as Shanghai, Zhejiang and Guangdong. The plan set a target of setting up one to two offshore wind farms of 100 MW by 2010. In the same year, the National Development and Reform Commission (NDRC) also put offshore wind development as one of the major R&D priority in the 'Renewable Energy Industry Development Guideline'. The first offshore wind power project in China was installed and went online in 2007 at Liaodong Bay in the Northeast of the Bohai Sea with a total capacity of 1.5 MW with an investment of RMB40 million (USD5.4 million). In 2009, the first offshore wind farm started its construction at Shanghai Dongdaqiao with a total capacity of 100 MW. Three machines were installed in April 2009. The construction of the wind farm is expected to finish by the end of 2009 and to provide electricity from wind to the 2010 Shanghai Expo.[17]

Under targets proposed in the *Medium- and Long-Term Development Plan for Renewable Energy*, total installed wind power capacity is mandated to reach 5 GW in 2010 (a goal that was increased to 10 GW

[16] Statistic contribution by Pengfei Shi.
[17] European Wind Energy Association (EWEA), Oceans of Opportunity: Harnessing Europe's largest domestic energy resource, available at http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/Offshore_Report_2009.pdf

in 2008, although actual capacity reached 12 GW by the end of 2008) and 30 GW in 2020. During the 11th Five Year Plan (2006–2010), China will pursue some 30 large wind power projects with a capacity of more than 100 MW each. These will be built in areas with abundant wind energy resources—including the country's East coast and Northern provinces—that will eventually form seven wind power bases with GW-size capacity in regions such as Jiangsu, Hebei, Jilin, Xinjiang, Gansu, and Inner Mongolia, stimulating a wider market for wind energy development.

Although China has not yet officially announced the amendment of its 2020 wind power target (30 GW), experts and government officials predict that domestic installed wind-power capacity may reach as high as 100–150 GW by that year.[18] With its abundant wind resources and rapid increase in power demand, China is expected to soon become the global leader in the wind market, especially since its new installations in 2008 ranked second only to the United States.

Government's support programme for wind industry started in 2003 with the concession tendering programme (five rounds have been conducted). Projects of over 50 MW are approved by the NDRC, and less than 50 MW are approved by provincial governments, but prices for those projects are checked and approved by the NDRC. The only exception is Guangdong Province, which makes its own decisions on prices for wind power. Some of the projects under 50 MW go through the concession process, but are not included in the five rounds of national concession tendering. The aim of the concession scheme was to encourage lower prices for wind power, however, the tariffs offered by winning concessions were too low to be viable. To remedy this situation, the rules for evaluating bids were modified for the fifth national concession round to discourage unreasonably low bids, which improved the situation somewhat, but did not fundamentally change it.[19]

An NDRC announcement regarding the Improvement of Wind Power Tariff Regulations was issued in July 2009 with an aim to regulate wind power prices so as to ensure smooth and sustainable development of the wind power industry. It calls for benchmark feed-in tariffs for onshore wind power for specific wind resource regions. In proportion to wind resource and project development conditions, it was decided to split the national territory into four wind resource regions and set benchmark prices for wind power accordingly.[20]

2.1.2. Solar PV

China's solar PV industry is also growing rapidly and the country became the world's largest PV cells producer in 2008. Domestic output of PV cells expanded from less than 100 MW in 2005 to 2 GW in 2008, experiencing a 20-fold increase in just four years.[21] More than 20 Chinese companies have successfully engaged in initial public offerings (IPOs), and eight companies now rank among the top 20 PV-cell manufacturers worldwide.

China's domestic solar PV industry, however, has suffered from major market barriers, including

[18] Qi Li, Vice Minister of the National Energy Administration, Speech on Clean Energy Power Development Summit, Beijing, China, 22 June 2009.
[19] Global Wind Energy Council, http://www.gwec.net/index.php?id=125.
[20] For more information, please see http://www.cresp.org.cn/english/encontent.asp?id=1092.
[21] Sicheng Wang, China PV Development Report 2008.

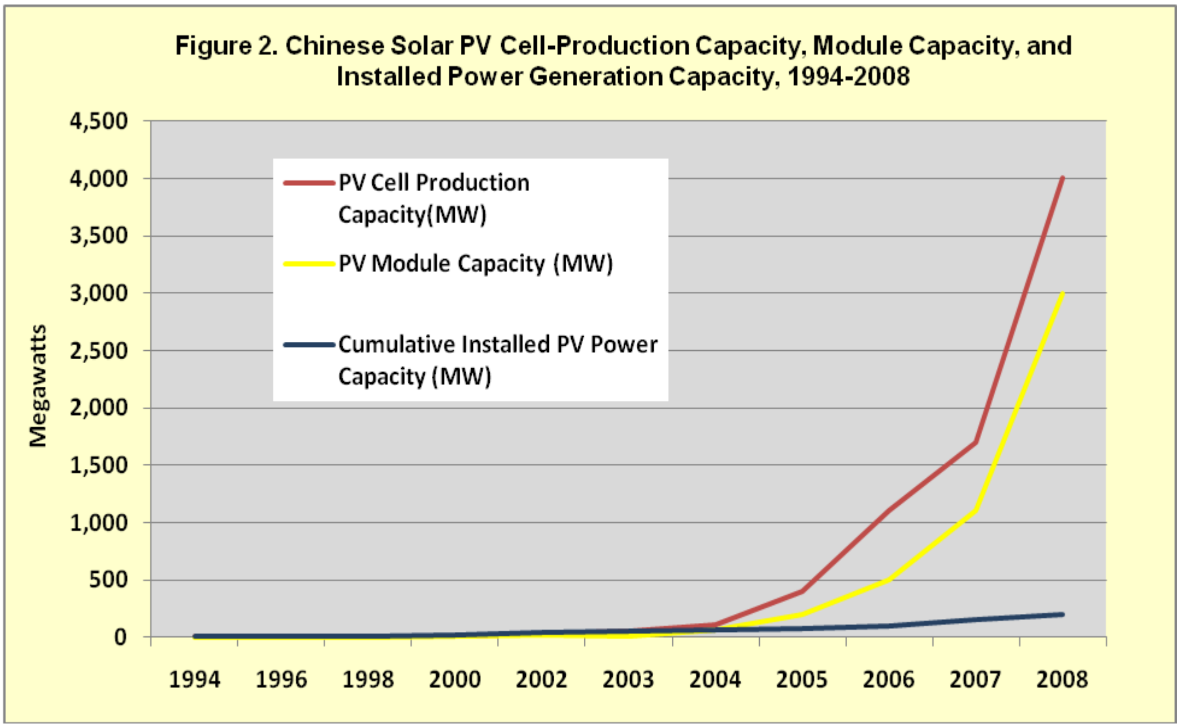
excessively high production costs and the shortage of silicon material. The PV market share in China remains tiny, with more than 95 percent of the country's PV-cell products exported to Europe, United States, and elsewhere. In late 2008, driven in part by the financial crisis, the cost of PV power generation in China dropped to about RMB1.5–3 (USD0.22–0.44) per kWh[22], providing a positive signal to stimulate domestic deployment.

Encouraged initially by the Township Electrification Program, Chinese PV manufacturing has experienced steady growth. The program implemented between 2002 and 2004 led to the creation of a RMB4.7 billion (USD687 million) fund to build small-scale independent renewable power stations in 1,065 villages and towns in 12 provinces. Most of the stations rely on solar PV, although some use hybrid wind-and-solar systems or small hydropower. In total, some 17 MW of PV modules were installed through this program.[23]

Starting in 2004, strong demand from the international PV market, especially from Germany and Japan, triggered a rapid increase in Chinese production of crystalline silicon and solar cells and modules. Domestic output of PV panels jumped from less than 10 MW in 2000 to 2 GW by the end of 2008, ranking China first in the world (see Figure 2.) Several domestic manufacturers, including Suntech, have become internationally competitive.

In 2006, several Chinese PV manufacturers began investing in silicon materials in response to an imbalance in the global PV production chain. (The limited capacity in upstream production of silicon ingot/ wafers, compared with the large capacity of downstream production, triggered scarcity and a rapid rise in the price of polysilicon on the international market.) By 2007, Chinese polysilicon production capacity was 4,310 tons, and the actual production was only 1,130 tons. By 2008, capacity reached 20,000 tons, with total annual production of 4,500 tons, making China a world leader in solar PV production capacity. This trend is expected to continue, with manufacturing capacity likely to exceed 5 GW in 2010.[24]

[22] Statistic collected by CREIA.
[23] Junfeng Li and Sicheng Wang, China Solar PV Report 2007, China Environmental Science Press.
[24] Fang Lv, China PV Report 2008.



(Source: Sicheng Wang, China PV Report 2008)

Since September 2008, the price of PV modules in the world market has decreased steadily, from USD5 per Watt-peak (Wp) to USD2.5 per Wp by end of March 2009.[25] This has driven down the cost of PV electricity generation in China, which has affected the industry severely. But it also opens the door for domestic deployment of solar PV, offering an affordable price for the Chinese market. The domestic market is now emerging as a driving force in China's solar PV industry, and as a result, analysts are paying closer attention to local policies and measures and their influence on the domestic market.

In 2008, China's cumulative PV installation capacity reached 150 MW.[26] Some 40 percent of this is provided by independent PV power systems that are used to supplying electricity to remote districts not covered by the national grid. Market shares of solar PV for communications, industrial, and commercial uses have also increased. BIPV systems, as well as large-scale PV installations in desert areas, are being encouraged. Solar PV modules were integrated in Beijing's Bird's Nest stadium, which was built for the 2008 Olympic Games. And the government launched the first 10 MW concession program for PV in the Gansu Desert in 2009, with a grid-connection price of RMB1.09 (USD0.16) per kWh. Within the next few years, this will be expanded to a 100 MW program in surrounding regions. Local governments in Beijing and elsewhere have supported the use of solar power on roofs and for street lighting.

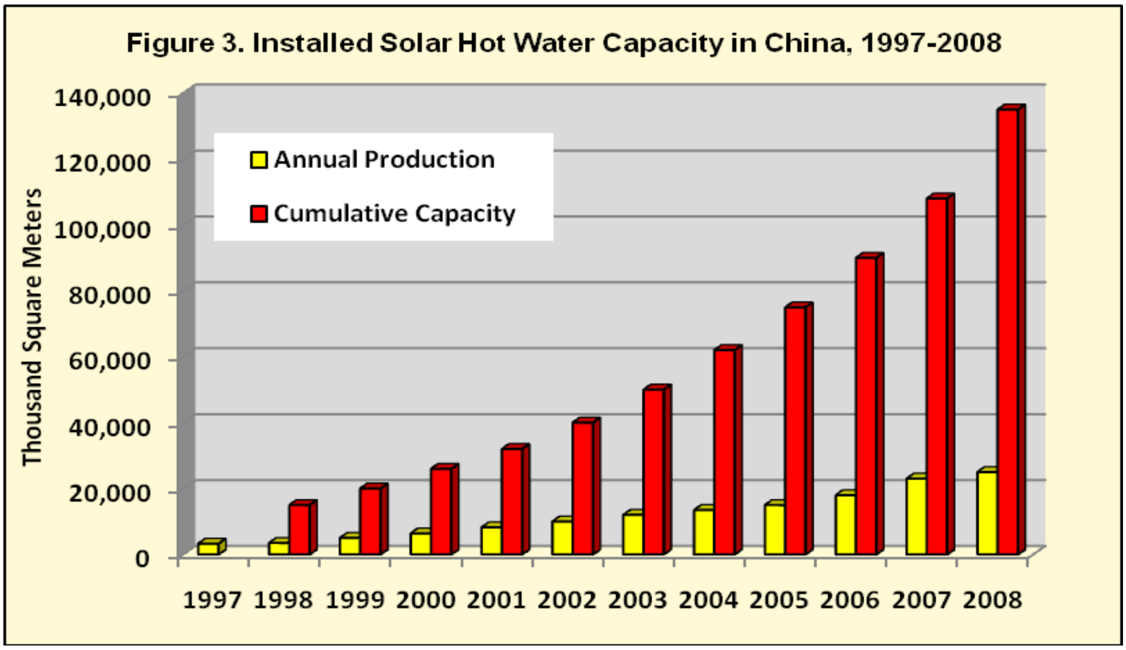
In early 2009, the government began to provide subsidies for BIPV projects. The subsidy amounts to RMB20 (USD2.93) per Wp to help develop the technology and spur a scaling-up of the Chinese solar PV market. It is likely that the 2010 and 2020 national targets for solar PV (400 MW and 1,800 MW, respectively) announced in 2007 will be increased substantially. Experts in the industry predict that Chinese installed capacity could reach 1 GW in 2010 and 20 GW in 2020.[27]

[25] Data collection by CREIA.
[26] China Energy Development Report 2009, National Energy Administration.
[27] Data collected by CREIA.

In July 2009, the Ministry of Finance, the Ministry of Science and Technology, and the National Energy Administration announced another program, the so-called Golden Sun Demonstration Project, aimed to facilitate the growth and expand the scale of the PV power generation industry through fiscal subsidies (e.g. subsidize 50 percent of investment for solar power projects connect to grid and 70 percent to independent PV power generating systems in remote regions).

2.1.3. Solar Water Heating

The most widely applied solar thermal technology in China today is solar water heaters (SWH), which is used to meet domestic water heating needs, thereby playing a vital role in improving the quality of life in small and medium-sized cities. By the end of 2008, the total area covered by SWH collectors was 135 million square meters, and annual production capacity exceeded 25 million square meters[28], a 10-percent increase over 2007. (see Figure 3.) Chinese utilization and annual production of SWH accounted for more than 50 percent of the world total in 2008.



SWH is an emerging and rapidly expanding industry in China. The technology has been broadly commercialized, and the industrial chains for raw material processing, engineering design, product development and manufacturing, and marketing services are well established. Related production of glass, metal, insulation materials, and vacuum equipment has also advanced.

By the end of 2008, there were more than 1,300 SWH manufacturers operating at scale in China.[29] The country is positioning itself as the world leader in both technology advancement and production of vacuum-tube solar heating systems, with Chinese products dominating more than 90 percent of the global market. Vacuum-tube systems are widely applied in China, with annual output exceeding 16

[28] According to information from Energy Research Institute of NDRC.
[29] China Solar Energy Industry Network, http://www.tyn360.cn/XX_News.Asp?ID=4495 (in Chinese language).

million square meters, and are also being exported to Asia, Europe, and Africa.

In recent years, continuous improvement in building-integrated SWH has led to the implementation of a wide range of projects in collaboration with architects and real-estate developers. This work is well regarded in the construction sector in terms of design, construction, and quality control. Rapid economic development in China's rural areas has also provided a prime opportunity for promoting the use of SWH in villages, including through village-transformation projects. Beijing and other cities have begun using SWH to generate heat for rural households.

By the end of 2005, the Ministry of Construction had issued specifications for building-integrated SWH systems, and some localities had also issued policies and measures to expand the SWH market. In April 2007, the NDRC and the Ministry of Construction organized a National Solar Thermal Utilization Conference, during which local governments were encouraged to issue local mandatory regulations for the use of SWH and to pledge additional financial support for dissemination of the technology. With these measures, the market for SWH has been able to expand further.

Excluding hydropower and traditional biomass applications, SWH accounted for more than a third of China's renewable energy consumption in 2008—equivalent to 25 million tce.[30] Because of the country's vast solar potential and the maturity of the technology, SWH is already more competitive compared with electric water heaters, the total energy costs over the life of the system are taken into account. On average, the price of SWH is around 20 percent higher than that of electric or gas water heaters, although the prices for both SWH and conventional water heaters vary widely according to their performance. The price at the low end of the SWH range has reached cost-competitiveness, making the products suitable for the rural market. Thus, solar thermal applications are expected to play an important role in China's renewable energy usage, including in the future energy supply.

In addition to SWH, other areas of solar thermal application have been developed and expanded in China including solar space heating and cooling, seawater desalination, and industrial heating. Research and demonstration in these areas has already begun.

China continuously promotes BIPV and building-integrated SWH systems, and also carries out pilot projects for solar space heating and cooling. Household SWH systems are widely promoted and used in villages and small towns, especially with the subsidy for rural utilization, which amounts to 17 percent of the purchasing cost.

The national goal is to expand the total collection area for SWH to 150 million square meters in 2010. Including other solar thermal applications, such as solar cook stoves and solar houses, the annual capacity of solar heat is projected to provide more than 30 million tce of renewable energy by 2010.[31]

[30] Junfeng Li, China Renewable Energy Development Status and Outlook 2008, Caijing Journal, Forecast and Strategies for 2009.
[31] Medium and Long-Term Development Plan for Renewable Energy in China, available at http://www.chinaenvironmentallaw.com/wp-content/uploads/2008/04/medium-and-long-term-development-plan-for-renewable-energy.pdf.

2.1.4. Small Hydropower

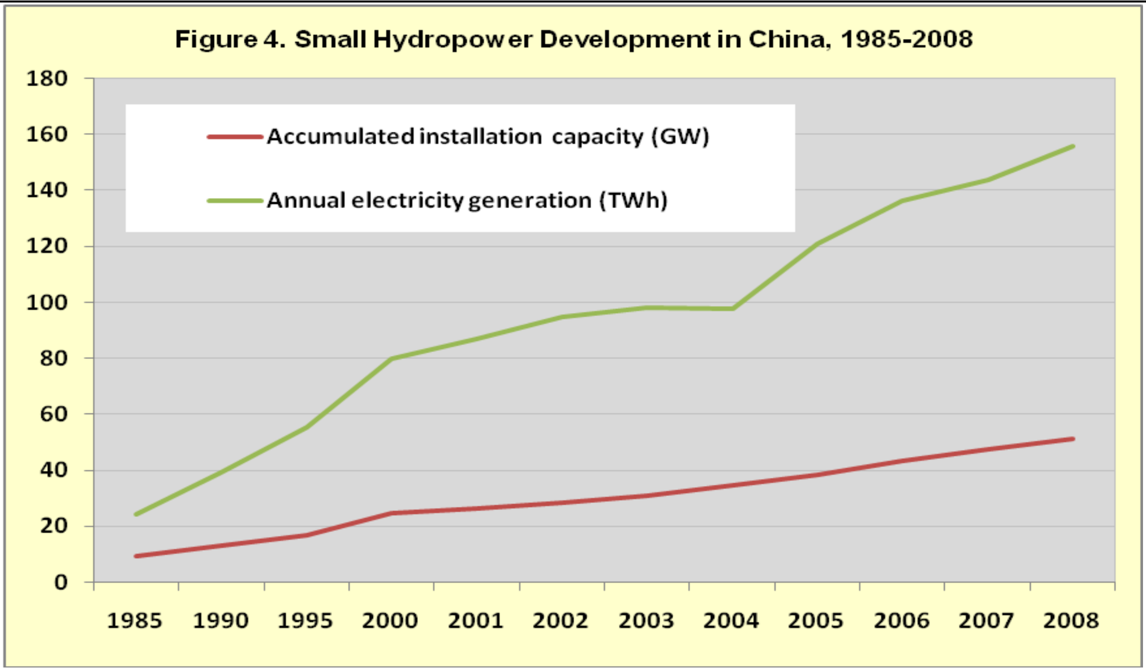
From an engineering perspective, small hydropower (SHP) is classified as one of the lowest-end technologies of the hydropower family. However, the definition tends to vary by country. In China SHP is defined as hydropower with a capacity of below 50 MW.[32] It is an important renewable energy source and is often referred to as “rural hydropower” because of its close link to economic development and electrification in rural areas. Under the Chinese classification system, hydropower stations fall into five basic grades: grades IV and V usually require less engineering work and are referred to as Small-1 and Small-2 stations, with a defined capacity of up to 50 MW and 10 MW, respectively. Most of the hydropower stations are smaller than 10 MW. Table 2 shows the share of different types of small hydropower in China.

Table 2: Distribution Status of Small Hydropower Stations in China 2007

Capacity		<1MW	1~10MW	10~25MW	25~50MW	Total
Station	Unit	36,984	7,463	653	217	45,317
	%	81.6	16.5	1.4	0.5	100
Installation Capacity	MW	10,701	18,992	9,800	7,896	47,389
	%	22.6	40.1	20.7	16.6	100
Annual Power Output	GWh	25,917	60,970	40,337	16,477	143,701
	%	18.0	42.4	28.1	11.5	100

Small hydropower in China had been developed and encouraged as part of rural development, rural electrification and water policies before the renewable energy law was implemented, and the scope of development is large. The SHP development has improved the production and living conditions of local people, promoted rural economy, and made significant contribution to the rural environmental protection. SHP is able to advance quickly compared with large-scale hydropower because of its specific characteristics. These include lower engineering requirements, shorter construction period, lower total investment cost, little to no displacement of local people, limited impacts on the local environment during construction, and a shorter supply-and-distribution system and smaller grid losses due to the close proximity to the user.

[32] China Energy Dictionary (1985 Edition).



By the end of 2008, some 50,000 SHP stations had been built in China, and 3,611 MW was added that year, resulting in a cumulative installed capacity of 51 GW. (see Figure 4.)[33] This is roughly equivalent to the total installed SHP capacity in the rest of the world and represents about 30 percent of China's total installed hydropower capacity. Although the country's SHP stations are small in scale, they have a large combined impact and play a significant role, especially in rural and mountainous areas.

2.1.5. Biomass

Based on the current technical circumstances of biomass energy use in China, key areas of development are biogas, biomass power generation, and liquid biofuels. The major uses of biomass in China are for power generation and heat generation, rather than for biofuel production as in Europe and United States.

A variety of biomass energy sources exist, with diversified technology applications. Potential feedstocks include crop residues, forestry residues, oilseed plants, dedicated energy crops, household wastes, and other organic wastes. Currently, China's annual crop residue (straw stalk) available for energy use amounts to 150 million tce, and available forestry residues total 200 million tce, both of which can be processed into fuel for biomass power. The potential land area for cultivating oilseed plants and energy crops (including jatropha curcas, rapeseed, ricinus communis, lacquer tree, Chinese goldthread tree, and sweet sorghum) is estimated to meet the annual feedstock requirements of 50 million tons of liquid biofuel. Industrial organic wastewater and poultry-farm wastewater can theoretically produce nearly 80 billion cubic meters, or 57 million tce, of biogas, with methane being the major component.[34]

Biogas technology in China is well advanced, and household biogas digesters have been built and used

[33] Jiandong Tong, China Small Hydro Development Report 2008.
[34] Medium and Long-Term Development Plan for Renewable Energy in China, available at http://www.chinaenvironmentallaw.com/wp-content/uploads/2008/04/medium-and-long-term-development-plan-for-renewable-energy.pdf.

in rural areas for several decades. Since 2003, the government has supported the construction of these digesters on a vast scale using National Treasury Bonds, with annual funding of more than RMB2.5 billion (USD366 million). In 2009, the funding was increased to RMB5 billion (USD731 million), and for the first time, large-scale biogas projects were included in the support scheme.[35] With government policy support, biogas power has become a significant industry and has gained huge market potential. Larger biogas projects have been initiated at poultry farms, food processing facilities, wineries, and urban sewage treatment plants.

By the end of 2008, China had built 32 million household biogas digesters nationwide, 140,000 biogas digesters on wastewater purification pools, and more than 28,300 biogas projects on livestock farms and industrial wastewater treatment sites.[36] With annual methane output of some 10 billion cubic meters, these initiatives supply quality fuel for cooking and heating to an estimated 80 million rural people. A national fund of more than RMB700 million (USD102 million) has been designated specifically to support the infrastructure and capacity building required to maintain existing biogas digesters. Professional post-construction services are expected be provided to rural installations to enable effective operation of the digesters.

Aside from biogas utilization, other biomass energy applications in China are still in the initial development stages. Although China has mastered the technologies of both generating biomass power from farming, forestry, and municipal wastes and producing biomass pellets, these have not yet reached commercialization phase. It is worth noting that venture capital firms have begun seeking out viable biomass technology projects in China, which may speed commercialization of these applications nationwide.

In 2006, the installed capacity of biomass power in China exceeded 2,200 MW, including 1,700 MW from bagasse (stalk residue), 50 MW from rice hulls, 400 MW from municipal waste, and additional power from several small biomass gasification demonstration projects.[37] By the end of 2008, installed capacity had reached 3,136 MW.[38] China continues to face difficulties in reaching its biomass power capacity targets of 5,000 MW for 2010 and 30 GW for 2020.[39] The main challenge for domestic biomass development is feedstock collection.

Biofuels are considered a potential substitute for oil, and China has introduced incentive schemes to stimulate biofuel R&D as a way to close the gap between petroleum supply and demand. It has carried out several demonstration programs for ethanol production, with an annual throughput of 1.3 million tons[40] and has started to be mixed in the gasoline as transportation fuel in several provinces. In 2007, however, the government restricted production of biofuel from food feedstocks, and Chinese ethanol development has since slowed. By 2010, the production capacity for ethanol is projected to reach 2 million tons and for biodiesel to approach 2 million tons.[41]

[35] For more information, refer to Ministry of Agriculture website.
[36] Data cited from Ministry of Agriculture.
[37] Zhongying Wang and Junfeng Li, China Renewable Energy Industry Report 2007, China Chemical Industry Press.
[38] Qin Shiping, China Biomass Development Report 2008.
[39] Medium and Long-Term Development Plan for Renewable Energy in China, available at http://www.chinaenvironmentallaw.com/wp-content/uploads/2008/04/medium-and-long-term-development-plan-for-renewable-energy.pdf.
[40] Refer to footnote 39.
[41] Refer to footnote 39.

2.1.6. Other Renewable Energy Sources

The potential for using geothermal energy to generate power in China is limited, and the known resources exist mainly in Tibet. However, most regions of China have the potential to tap geothermal energy for heating purposes, and development in this area is rapid. Geothermal applications in space heating, hot water, and farming are experiencing 10 percent annual growth.[42] Geothermal energy currently provides space heating over some 30 million square meters in China and supplies 600,000 families with hot water.

Development of ocean energy, such as tidal and wave power, is currently in the pilot and demonstration stages. Mainland China and nearby islands are rich in ocean energy resources, but these have not yet been sufficiently developed. With more than 18,000 kilometers of coastline, China has a theoretical tidal energy reserve of 1.1×10^8 kW and annual power generation capacity of as high as 2.75×10^{13} kWh. More than 190 tidal power plant sites could be developed to achieve more than 500 kW in installed capacity, and coastal resources could be used to generate some 3×10^7 kW. According to a resource survey and extrapolation to 424 harbors where the installed capacity is more than 200 kW, China's potentially developable coastal tidal energy resources are capable of reaching a total installed capacity of as high as 2.18×10^7 kW, with annual generation capacity of 6.24×10^8 kWh. These resources are unevenly distributed, with as much as 80 percent in Zhejiang and Fujian provinces (61 percent and 22 percent, respectively), 5 percent in Guangdong province, and 4 percent in Liaoning province.[43]

2.2. Renewable Energy Policies and Regulations

Chinese renewable energy policy has accomplished its role as a general support tool to boost rural energy deployment. In recent years, it has entered into a new phase to provide a combination of both principal policies and specific measures tailored to each renewable energy technology. In 2005, China issued the national Renewable Energy Law as an umbrella framework, followed by specific regulations and measures supporting the development of wind, solar, and biomass sources. The concession program for wind energy, for example, lays out the conditions for a bidding process for wind farm development, including criteria related to the tariff level, components, and performance.

Many countries use fiscal support as a tool to promote renewable energy deployment, and China is no exception. Chinese fiscal support schemes can be divided into subsidies, tax policies, pricing schemes, and a reward scheme for green production.

The government departments responsible for regulating China's renewable energy development include the State Council (for planning economic development), the National People's Congress (for setting legislation), the National Development and Reform Commission (for project approval and price-setting schemes), the National Energy Administration (for coordination of national renewable energy development), the Ministry of Finance (for fiscal support), the Ministry of Science and Technology (for R&D support and improvement), the Ministry of Construction (for trade and import/

[42] Zaisheng Han, China Geothermal Development Report 2008.
[43] Tong Wang, China Ocean Energy Development Report 2007.

export regulations), the Ministry of Environmental Protection (for project environmental impact assessments), the Ministry of Agriculture (for regulation of rural energy deployment), and the National Bureau of Forestry. Other stakeholders, in particular the state grid companies, are also essential for the implementation of renewable energy regulations. Policy implementation is a complex process, and it can be challenging to ensure that the interests and benefits of various stakeholders are reflected in the regulations to the maximum extent.

2.2.1. Laws and Regulations

Prior to adoption of the national Renewable Energy Law in 2005, a variety of Chinese laws had encouraged the development and utilization of clean energy, particularly renewables. These include the Electricity Law of 1995, the Energy Conservation Law of 1997, and the Law for Prevention and Control of Air Pollution of 2000 (see text box below). These laws, however, provided little guidance on utilizing renewables, since at that time renewable energy comprised only a small part of the national economy and was considered only in the context of rural energy. The situation has changed since the inception of the national Renewable Energy Law.

Electricity Law (1995): Enacted to guarantee and promote development of the electric power industry; to safeguard the lawful rights and interests of those who invest in, manage, or consume electric power; and to guarantee the safe operation of electric power.

Energy Conservation Law (1997): Formulated with a view to facilitating energy savings throughout society, improving efficiency and the economic benefits of energy use, protecting the environment, guaranteeing national economic and social development, and meeting people's livelihood needs.

Law for Prevention and Control of Air Pollution (2000): Formulated for the purpose of preventing and controlling atmospheric pollution, protecting and improving the human and natural environments, safeguarding human health, and promoting the sustainable development of economy and society.

The Renewable Energy Law of the People's Republic of China, which entered into force in January 2006, serves as a milestone for elevating renewables to a strategic position in China. It provides the framework for legislative initiatives designed to secure the future development of renewable energy. The goals of the law include increasing the domestic energy supply, optimizing the energy structure, ensure energy security, protecting the environment, and realizing sustainable development of the Chinese economy and society. Targets for achieving a 10 percent renewable energy share in the country's total energy consumption by 2010 and a 15 percent share by 2020 are considered quite ambitious.

The law identifies four schemes to guide renewable energy development in China. The "cost-sharing scheme" requires that the additional cost of renewable energy generation be shared by the end-users of electricity nationwide, averaged as a surcharge to users of as little as RMB0.002 (US cent 0.03) per kWh. The "feed-in tariff scheme" requires that a fixed amount (differentiated according to each renewable energy technology) be added to the price for all renewable energy generation connected to the grid. Currently, the feed-in tariff is enforced directly for biomass power, whereas for wind and solar PV power a regional feed-in tariff system is applied based on a bidding price that varies by location. The "mandatory grid-connection system" requires grid companies to purchase all electricity generated from renewable energy, under any condition. Finally, the "national target system" sets the 10 percent and 15 percent renewable energy targets for 2010 and 2020, respectively.

Most of the regulations have been formulated within the framework of these four schemes. In early 2007, the NDRC issued regulations for renewable power generation, emphasizing the approval procedure for projects and clarifying the responsibilities of both power producers and grid companies. A special regulation was also issued to set the pricing scheme for renewable power generation, outlining two tariffs: the Government Fixed Price and the Government Guidance Price. The latter refers to the tariff awarded to bid winners through competitive tendering. The incremental cost of renewable power above the benchmark feed-in tariff for desulfurizing coal-fired power is to be shared among the sales volume of electricity in power grids at the provincial level or above. For biomass power, a subsidy of RMB0.25 (US cent 3.7) per kWh is added to the benchmark price for coal and applies for a period of 15 years for projects built after January 1, 2006. The subsidy was increased to RMB0.35 (US cent 5.1) per kWh in late 2008.

A draft amendment to the Chinese Renewable Energy Law was submitted to the country's top legislature on August 24, 2008, the Standing Committee of the National's People's Congress. Under the draft amendment, a government fund for renewable energy development aiming to support the industry and strengthen governmental marco-economic regulation will be financed by a surcharge on retail power tariffs, along with a contribution from the Ministry of Finance. The surcharge currently generates about RMB4.5 billion (USD658.86 million) each year for power grid companies. However, since this surcharge is considered as revenue, grid companies have to pay about one-third of it to the government as value-added and income taxes. Under the draft amendment, power grid companies will receive all of the revenue generated from the surcharge. It also sets a minimum target for the amount of electricity that power grid companies must buy from renewable energy projects.[44] If the amendment is passed, strong incentives will be provided to the grid companies who are currently working at a loss.

2.2.2. Subsidies

Fiscal incentives for renewable energy development in China originate from both the central government and local governments. Subsidy programs cover activities such as rural hydropower construction, renovation of rural grids, installation of rural household biogas digesters, and wind and solar power generation in remote areas.

At the national level, subsidies include:

- **R&D for the development and industrialization of core renewable energy equipment.** This includes key components for wind turbines and advanced silicon technologies for solar PV.

[44] China considering renewable energy development fund 24 August 2009, available at http://news.xinhuanet.com/english/2009-08/24/content_11937062.htm.

The total R&D subsidy is around RMB4 billion (USD585 million) for initiatives such as the Ministry of Science and Technology's 863 and 973 programs and the NDRC's industrial support program. In addition, RMB2 billion (USD290 million) is allocated for R&D and demonstration of biofuels.

- **Construction of renewable energy generation systems.** The largest subsidy program for renewable energy nationwide (and China's largest subsidy package for renewable energy to date) is a special RMB10 billion (USD1.46 billion) fund to support construction of the Three Gorges hydropower station. In addition, the Ministry of Agriculture has increased its funding for biogas utilization in rural areas from less than RMB1 billion (USD146 million) to RMB5 billion (USD731 million). This funding supports the construction and maintenance of household biogas digesters, and some of it will go to the construction of large-scale biogas utilization sites. For solar PV, the Ministry of Finance launched a subsidy of RMB20 (USD2.93) per watt in March 2009 to support the installation of BIPV systems (with capacity of more than 50 kW peak)—a support that is calculated to cover more than 50 percent of the system cost (also cut the power generating cost by around half to about RMB1 per kWh).

- **Township Electrification Program.** This well-known program, carried out between 2000 and 2003, focused on rural utilization of off-grid solar PV systems, using solar and small-scale wind energy to electrify more than 1,000 towns in western China. The total subsidy was over RMB2 billion (USD293 million), and the initiative benefited more than 100,000 people. At the local level provinces such as Xinjiang, Qinghai, and Inner Mongolia continue to subsidize farmers with between RMB100 and 300 (USD14.6 and 43.9) per family for the purchase of PV module and small wind turbine systems.

- **Subsidies for rural end-users.** In early 2009, China launched a subsidy program for the rural use of household electrical appliances, including SWH. Under the program, consumers will be subsidized directly for 17 percent of the cost of the units. International programs such as the World Bank's Renewable Energy Development Program also provided subsidies for solar PV installation and other small-scale renewable energy in remote areas of China during 2002–2007, establishing a strong market for the distributed use of renewable energy.

- **Production subsidies.** To encourage the collection and processing of a wide variety of wastes for more-efficient energy use, a subsidy of RMB130–150 (USD19–22) is provided for every ton of biomass pellets made from agricultural or forestry residues. Also, in August 2008, a regulation was issued stating that the manufacturer of the first batch of locally made megawatt-level wind turbines (50 units) could apply for an award of RMB600 (USD87.8) per kW. Certification will ensure that the units qualify for the award conditions and criteria.

2.2.3. Tax Policies

Tax incentives for renewable energy development have been limited in China. National policies include a reduced 6 percent VAT collection from small hydropower projects, a 50-percent tax reduction for wind power projects, and a tax reduction or exemption for imported renewable energy equipment that China is not able to produce domestically. Several local governments also offer favorable taxation policies for the use of renewables. In the regions of Xinjiang and Tibet renewable energy companies are treated as high-tech industries, enabling them to apply for an income-tax reduction or exemption. And since 2000, the government of Guangdong province has regulated that any income tax levied on renewable energy projects during the credit repayment period will be refunded in full. Even so, China lags behind most countries in using tax measures to create incentives for renewable energy deployment.

2.2.4. Pricing Schemes

China has introduced a variety of preferential pricing schemes for renewable power generation. The price level is determined by several factors, including the source of the renewable energy and the project location.

- **For wind power**, a concession program has been implemented since 2003. The bid price has been considered one of the key elements for winning the concession. Due to the limited number of projects and the large number of participating developers, the proposed bid prices have been lower than the cost of developing the wind power projects. Currently, the tariff for wind power is fixed and is classified into four levels according to local wind resources. The region with the richest wind resources, located mainly in China's north and west, has a tariff of RMB0.51 (US cent 7.4) per kWh; the region with modest resources, mainly in the east and along the southern coastline, has tariffs of RMB0.54 (US cent 8.2) and RMB0.58 (US cent 8.5) per kWh; and the region with relatively low wind resources, in the middle of the country, has a tariff of RMB0.61 (US cent 8.9) per kWh.

- **For solar PV power,** prior to 2009, when the market was small, the approved feed-in tariff rate was applied on an individual project basis and ranged between RMB4–9 (USD0.58–1.32) per kWh. Since early 2009, the government has established price regulation with a concession program in Western China's Dunhuang region. The first round of bidding for a 10 MW program resulted in a price of RMB1.09 (USD0.16) per kWh. This price level is expected to be applied to local projects in surrounding regions with similar solar resources. Because the pricing system for solar PV is still at the early stages, however, there are uncertainties. A learning period will be required to conduct a clear mapping exercise before introducing a more detailed pricing scheme.

  In addition, the 'Golden Sun' program with incentives for the deployment of 500 MW of large-scale solar PV throughout the country was launched in July this year under the collaboration of Ministry of Finance, Ministry of Science and Technology and National Energy Administration. These three government agencies have recently issued a circular on implementing the Global Sun Pilot Project, stating that efforts will be made to accelerate the scale-up of commercial application and development of PV technology through combined financial subsidy, R&D support, and market pull. Within the coming two to three years, financial subsidies will be made available to support the PV projects at a scale of 500MW or above. The circular also states that priority support will be given to PV grids and independent PV systems, and to the infrastructure capacity building of related industries, including silicon material purification and grid operation. Subsidies will have an upper limit in line with the state-of-the-art of the technology and market demand. In principle, a subsidy up to 50 percent of the total cost will be allowed for building a grid connected PV system. For the off-grid PV system built in the remote areas without electricity supply, the subsidy may go up to 70 percent of the total construction cost. Infrastructure capacity building projects will be subsidized mainly through discount government loans.[45]

- **For biomass power**, a feed-in tariff is provided for all projects. In 2008, the subsidy of RMB0.25 (US cent 3.7) per kWh for a 15 year period was increased to RMB0.35 (US cent 5.1) per kWh.

To cover the incremental cost of renewable power over coal-fired power (which normally has a tariff of around RMB0.3–0.4, or US cent 4.4–5.9, per kWh), a surcharge of RMB0.001 (US cent 0.014) per kWh is levied on electricity consumers nationwide. In 2007, this was increased to RMB0.002 (US cent 0.029) per kWh. To begin implementing the scheme, the NDRC issued two documents in 2007—the *Provisional Administrative Measures on Pricing and Cost Sharing for Renewable Energy Power Generation* and the *Relevant Regulations on the Administration of Power Generation from Renewable Energy*—that established a relatively clear pricing system for renewable power. The tariffs are divided into a Government Fixed Price (a direct, government-approved price) and a Government Guidance Price (a government-approved price set through a competitive tendering process).

2.2.5. Investment Policy

In addition to the financial support from the Chinese government for R&D, demonstration projects, and key equipment manufacturing, China's Treasury Bond also supports renewable energy. The former National Economy and Trade Commission, for example, included a demonstration wind farm program using domestically manufactured turbines in the National Key Technology Renovation Plan of 2000, utilizing the 4th Special Fund of China's Treasury Bond. A special interest-free loan is now in place for rural energy, targeting small wind turbines, solar thermal and medium- to large-scale biogas projects, and a soft loan was established for small hydropower construction. Such loans are applied on a project basis.

2.2.6. Planning and Support

China is one of the first countries to implement a national renewable energy strategy, building on both existing and more-recent laws and regulations. A *National Plan for Promoting Household Biogas Utilization* was issued at a very early stage, resulting in the installation of more than 30 million biogas digesters in China's rural areas. A comprehensive plan for rural energy, including small hydropower, was considered in the *Plan for Rural Electrification* of 1985. In 1995, the Supreme People's Court (SPC), the State of Science and Technology Commission (SSTC), and the State of Economics and Trade Commission (SETC) jointly formulated an *Outline for China's New and Renewable Energy Development Towards 2010*. The program defined clearly the objectives of renewable energy

[45] Available at, http://www.solarbuzz.com/news/NewsASGO84.htm.

development in the 1996–2010 period:

- *Phase One (1996–2000):* Use R&D and demonstration projects to elevate most renewable energy technologies to a level near or equal to advanced international standards. Commercialize some of the mature technologies, extend their application, and develop markets gradually. Improve on traditional, low-efficiency biomass energy consumption by making wider use of wind, solar and hydro energy to help electrify remote areas and islands.
- *Phase Two (2000–2010):* Disseminate renewable energy technology on a wider scale; create advanced, international standard industrial and technology research systems; achieve large-scale production; and increase the total development and use of all new and renewable energy sources from 300 million tce at present to 390 million tce.

The national plan for renewable energy development has gained more attention since 2007, when the NDRC issued the *Medium- and Long-Term Development Plan for Renewable Energy*, emphasizing the 10 percent and 15 percent national renewable energy targets for 2010 and 2020, respectively. The plan also outlines a Renewable Portfolio Standard (RPS) target, stating that in areas covered by large-scale power grids, the non-hydro renewables share of total generation will reach 1 percent by 2010 and exceed 3 percent by 2020. Power generators with a self-owned installed capacity of over 5 GW will be required to have a non-hydro renewables share of 3 percent by 2010 and more than 8 percent by 2020. China's key economic growth plan is the National Five-Year Plan. Renewable energy was explicitly included in both the 10th and 11th Five-Year Plans (2001–2005 and 2006–2010) and is expected to hold a prominent place in the 12th Five-Year Plan (2011–2015).

In addition to the national plan, China has launched several national programs to help achieve its renewable energy targets. The Ride the Wind Program, launched in 1996, has supported the cooperative development of domestic wind turbine manufacturing, using a joint-venture approach to encourage local manufacturers to collaborate with pioneering international companies. The National Treasure Bond Program has provided financial support for technological advancement and market expansion of renewable energy at the early stages of development, including wind market development since 2000. R&D programs such as the 863 and 973 programs are providing technological support for the growth of the industry, which is also important for achieving the national renewable energy targets in a sustainable way.

2.2.7. Industry Support

The Chinese government has provided various financial supports, such as tax breaks, investment subsides, and bonuses, to facilitate the commercialization of renewable energy. These include the designation of special funds for manufacturing key equipment and deploying technologies to encourage solar thermal as well as wind and solar PV power generation. This support has accelerated the localization of renewable energy manufacturing. China is now home to the largest SWH industry in the world as well as to several large solar PV companies, including Suntech, Tianwei-Yingli, LDK, and Trina Solar. In the wind sector, strong capacity has been established in companies such as Sinovel, Goldwind, Dongfang Steam, and Windey, as well as in components suppliers such as Chongqing Gear, Nanjing Gear, Huiteng Blade, Zhongfu Lianzhong, and Yongji Motor.

Since 2002, the NDRC has overseen a concession program covering wind farms larger than 100 MW in capacity. This program has driven down the cost of wind power from about RMB7,000 (USD1,025) per kW to about RMB5,000 (USD732) per kW. Furthermore in July 2005, the NDRC issued requirement requested that in order to sell wind turbines in China, the local component rate shall form at least 70 percent of the product cost[46], which forced large international wind turbine makers to set up factories or joint ventures in China and boosted the development of domestic wind manufacturing. As a result, this has increased local manufacturing capacity from about 25 percent to 75 percent. China's wind industry has attracted large domestic manufacturers as well as many foreign producers, including GE, Vestas, Gamesa, and Siemens. The launch of seven wind power bases of more than 10 GW each has provided further stimulus for the industrialization of wind power in China, moving the country toward global leadership in wind manufacturing.

By August 2008, China had completed five rounds of wind concession programs and approved 49 wind farm projects in Guangdong, Jiangsu, Inner Mongolia, Jilin, Gansu, and Hebei provinces. Most of the projects have begun construction, with a current installed capacity of 1.2 GW (out of a total designed capacity of 8.8 GW). The rest of the projects will be completed by 2010. By then, the associated annual electricity generation will reach 17.6 TWh, leading to estimated greenhouse gas reductions of 17.6 million tons.

The five rounds of wind concession programs were implemented from 2003 to 2008, following restructuring of the power system and the separation of electricity production and transmission. The concession programs played an important role in ensuring a committed on-grid tariff for wind power. The utilities were responsible for building the transmission lines and transformer stations and for connecting the wind power to the grid. The program attracted both domestic and foreign investors, helping to lower the tariff and avoid monopolization. The program also requires a high degree of localization for turbine components. Because local governments and utilities were not as supportive of developing wind power, the central government's concession program has made a significant contribution to the rapid development of large-scale wind farms in China.

In addition, in April 2008, the Chinese Ministry of Finance issued a new regulation on tax refunds for importing large wind turbines (2.5 MW and above) and key components, and use such revenue for technology innovation and capacity building. The tax rebate is not returned directly to the company, but to the State, which will establish special programs to channel the money back into the wind industry.[47]

In August 2008, the Ministry of Finance issued another incentive policy on funding support for the commercialization of wind power generation equipment. According to this regulation, for all the domestic brands (with over 51 percent capital investment from China) the first 50 wind turbines over 1MW will be rewarded with RMB600 (USD88) per kW from the government. The rule specifies that the wind turbines must be tested and certified by China General Certification and must have entered the market, been put into operation and connected to the grid. The regulation further requires that the rewarded turbines must be domestic manufactured components and share the awards proportional with component manufacturers.[48]

[46] NDRC, Statement Regarding the Regulatory Requirements for Wind Power Projects, July 2005.
[47] Information from the Chinese Wind Energy Association.
[48] Refer to footnote 47.

3. Challenges Facing Renewable Energy Development in China

So far, the influence of the global financial crisis on China's renewable energy industry has been limited. This is especially true in sectors such as wind-turbine manufacturing, solar hot water, and rural biogas production, which rely more heavily on the domestic market and have maintained their rapid growth. Renewable energy development in China, however, still faces a variety of challenges. These include:

- **Grid connectivity.** China faces large barriers to grid connectivity and electricity transmission from renewable energy sources such as wind power. This will likely be the major constraint to large-scale solar PV development as well, as the domestic market expands. China's grid capacity currently lags behind the peak-hour supply of electricity generated by renewables. Because renewables have accounted for only a small share of total electricity generation, there has been little incentive for grid companies to invest in innovation. Meanwhile, the economic recession has reduced electricity demand, which makes it even less interesting economically for utilities to invest in infrastructure to accommodate power generated by renewables. In 2009, the situation has begun to improve, and companies are now preparing to upgrade China's grid to accept renewable power from several large-scale wind and solar bases now under construction. Many grid companies are beginning to seek technical solutions to enable proper connectivity for large-scale wind farms and solar PV parks.

- **Policy enforcement.** Although China is a world leader in renewable energy policy, there are some failures in enforcement. For example, the Renewable Energy Law stipulates that utilities must buy all of the electricity generated from renewable sources. However, in some cases wind power producers, as well as those implementing BIPV, have faced significant difficulties in connecting to the grid and obtaining a government-approved price.

- **Wind industry development.** Several challenges have been identified during the growth stage of China's wind industry. For one, existing R&D capacity lags behind rising industry demand. Most of the manufacturing technologies available in China are imported technologies, particularly wind turbine designs and the technologies for key components such as gearboxes. R&D initiatives are conducted mainly within individual companies, and there is a shortage of R&D capacity in universities, as well as in research institutes and academies, most of which lack technology innovation centers. Another challenge is the lack of local expertise in the public and private sectors, including both technicians and senior strategists / planners. The current high demand for human capital in the wind industry can be overcome by introducing more training and professional courses on wind and other renewable energy sources in universities, research institutions, technical schools, and even business schools.

- **Solar PV industry development**. The challenges facing China's solar PV industry are even bigger than those facing the wind industry, because they originate largely from the demand side. The PV industry, with its high dependence on overseas markets, has been affected by the reduced (or interrupted) demand resulting from the global financial crisis. Although the crisis is expected to have only a short-term negative impact on demand, it has increased business risk within the industry. Currently, the most sustainable solution for China's solar PV industry is to explore the domestic market. Recent guidance from the central government has created a willingness to invest in a strong and stable domestic solar market.

- **Lack of a Renewable Energy Industry Association**. China has yet to establish an official national renewable energy industry association to effectively coordinate industry development and to bridge the industry and policymaking process in a formal way (similar to the National Renewable Energy Laboratory in the United States, Risoe in Denmark, and ECN in the Netherlands). China's existing renewables-related industry associations are scattered among more than 10 different larger industry associations, making it very difficult to effectively coordinate the implementation of renewable energy policy. This also delays the timing for considering renewables issues within each industry.

4. Recommendations

To address the challenges listed above (and assuming that renewable energy will be considered a major solution to economic recovery and energy security in the future), the following recommendations are suggested for the government of China:

1. **Clarification of the feed-in tariff system.** China's Renewable Energy Law uses a feed-in tariff system for renewable power. However, the pricing system is too complicated and it takes considerable time for investors, especially international and small private investors, to understand how it works. It is therefore critical that policymakers in China improve the renewable energy price structure and clarify the feed-in tariff system. The most effective solution would be to establish a fixed-price structure for each technology based on its specific characteristics (e.g., resource potential, geographical distribution, and technological maturity).

2. **Greater transparency in the Renewable Energy Fund system.** China's Renewable Energy Fund has been in place for approximately four years. However, it is unclear how much of this funding is distributed annually, what types of technology are eligible to apply for the funding, and what precisely the application procedure entails. It is therefore essential to set an annual budget for the Fund that specifies which technologies are eligible for the funding and that clarifies the disbursement procedures and other criteria for the eligibility of various stakeholders.

3. **Adopt smart-grid technology for improving renewable energy grid connectivity.** Over the next five to ten years, China plans to construct several gigawatt-level wind farms and generate a large amount of grid-connected solar PV. Without smart-grid technology, it will be nearly impossible to connect large amounts of this renewable power to the electricity grid, particularly at peak hours. The Chinese government should therefore begin planning how to deploy smart-grid technology to maximize renewable energy connection to the grid.

4. **Increase support for renewable energy R&D and demonstration activities.** Given that China plans to develop the world's largest renewable energy market in the next decade, the country will need to address its shortage of R&D and demonstration efforts. China does not yet

have a national institution fully dedicated to energy research and related activities. To meet the needs of renewable energy development and to scale up deployment, both national and local R&D capacity should be strengthened, and specialized national research and innovation institutions should be established.