((No Authorized Official Translation))

The China Renewable Energy Development Plan 2006-2010

China National Development and Reform Commission (NDRC)

Table of Contents

Preface

Renewable energy (RE) is a fundamental resource for China and plays a significant role in it's energy supply, allowing China to meet its growing energy demand, promote energy conservation, mitigate environmental pollution, and advance the national economy. The Medium and Long-Term Development Plan for RE in China, promulgated under the guidelines of the Renewable Energy Law of People's Republic of China (RE Law), was created with the purpose of accelerating the development of RE and to better meet the requirements for attaining sustainable, social, and economic development. The plans are based on China's RE resource potential, technology, and industrial status, as well as, the borrowing of the globes most progressive practices. The following fifteen year plan puts forth, the guiding principles, objectives, targets, priority sectors, policies, and measures for the development of RE in China, up to the year 2020.

The China National Economic and Social Development Planning Guidelines, for the eleventh Five-Year-Plan period (2006-2010), were approved by the fourth session of the tenth Chinese National People's Congress. Clearly stated in the guidelines, RE production and consumption is encouraged to increase its share in the total energy portfolio. Increases will be achieved through the implementation of financial and mandated market share policies, in addition to, taxation and investment incentives. The China Renewable Energy Development Plan for 2006-2010 (the Plan) has been formulated and released with the purpose to effectively implement the guidelines and fulfill the objectives, targets, and tasks defined in the Medium and Long-Term Development Plan for Renewable Energy in China. The current situation, challenges, guiding principles, objectives, targets, priority sectors, incentive policies, and accompanying measures for RE development in China during the eleventh five-year-plan period (2006-2010) are proposed to ensure the implementation of the RE Law and fulfillment of the objectives defined in the National Economic and Social Development Planning Guidelines for 2006-2010. The Plan will be an overview of the plan for national renewable energy activities and will be used to steer the RE sectors in China.

The adoption and development of RE has received a great degree of attention from the international community, particularly in the past decade. Nations support their RE strategies through legislative instruments and incentive policies. So much so that, renewable technologies have become the fastest growing sectors of the international energy industry. So far, hydropower has become an important part of the energy package, while wind power, solar energy, and biomass energy technologies are maturing and developing speedily. In addition, liquid biofuel technologies play an increasingly significant part in replacing partial oil products, and contributing to the agricultural economy.

RE resources are abundant in China. Applications of hydropower, biogas, and solar thermal technologies have achieved great progress. Wind power, biological liquid fuels, and solar PV generation have all witnessed fast development in recent years. The Chinese government attributes the development and utilization of RE resources as a means towards solving the emerging gap between energy supply and demand in China, reducing pollutant discharge, optimizing China's energy structure, promoting a recycling-based economy, and promoting rural construction concerns. China has aspirations both, to increase the RE contribution of its total energy use, and to create favorable conditions for large-scale development and utilization of RE. During the five-year-plan period, China plans to achieve this by, continuing to develop hydropower, speed up development of biomass, wind power, and solar energy, and to foster RE utilization in rural areas.

1. Present Situation

1.1 Development Status

During the national tenth five-year-plan period (2001-2005): hydropower projects of different capacities were developed at an improved pace and a wind power concession program was adopted, aiming to promote scale wind farm development. Additionally, solar photovoltaic (PV) generation and hybrid solar-wind power systems progressed notably for home RE electricity supply, along with a national rural electrification program, which was aimed at addressing power

supply problems for remote, non-grid access areas. Also, rural household biogas digesters were actively applied to improve the rural environment and increase farmer income. Through market expansion, the extent of solar water heater installations was further enlarged. In tandem with pilot and demonstrative projects, biomass generation and biological fuels were actively promoted through technological research and development. The RE Law in 2005 marked a new era of renewable energy development in China.

1.1.1 Renewable Energy Utilizations

During the tenth five-year-plan period (2001-2005), renewable energy has fast developed in China. Significant progress has been achieved in hydropower, biogas, liquid biofuels, wind power, solar energy and other RE technologies. RE plays an increasingly more important role and has favorable development potential.

As of the end of 2005, the total installed capacity of hydropower in China had reached 117 GW (including 7GW pump storage hydropower plants), or 23% of total electricity generating capacity, with an annual power generation of 395.2 TWh (16% of the total power generation).

Biogas has been steadily promoted inline with rural economic and environment programs. By the end of 2005, the total number of household biogas digesters reached 18 million. Additionally, about 1,500 large-scale biogas plants have been built, for both livestock farms and organic industrial effluents, producing about 8 billion m^3 of biogas annually; which can provide daily-life fuel for nearly 70 million rural residents. By the end of 2005, the installed capacity of biomass power in China reached 2GW, of which, the power capacity from sugar cane residue (bagasse) was about 1.7GW and about 200MW from MSW incineration and hand-fill. The rest of the afore-stated installed biomass power capacity was from gasification of agricultural, forestry wastes, or biogas generation.

In order to alleviate shortages in oil supply, China has launched a biofuel R&D initiative and pilot program. As of the end of 2005, the production capacity for bio-ethanol, using food grains as feedstock, was 1.02 million tons. In addition, the technology for producing bio-ethanol from non-food-grain feedstock, has already reached a commercialization stage. The technology of biodiesel from non-edible oil plants such as *Jatropha Curcas* and *Pistacia Chinesis* is at a small scale experimental phase.

In order to speed up wind power development, the national wind power concession program was adopted in China, with the aim to encourage, large wind farm development, local manufacturing of wind power equipment and facilities, and innovative technology research and advancement. By 2005, more than 60 wind farms were connected to the power grid in China, with a total installed capacity of 1.26GW. There are also about 250,000 small wind turbines operating off-grid in remote areas. The total installed capacity of these small systems was around 50MW.

To solve the problem of power supply in grid un-covered region, the Song Dian Dao Xiang (sending electricity to the un-electrified township villages) program was carried out and PV distribution was greatly promoted by the program. By the end of 2005, the cumulated installation of PV in China reached up to 70MW. PV powered village systems were installed in 12 county towns, more than 700 townships, and 500,000 solar home systems were distributed. PV industry has been significantly developed.

In order to expand solar thermal installations, China has actively promoted building integrated solar water heater applications. Such that the SHW market has been expanded effectively and solar thermal equipment production and installations have grown steadily. By the end of 2005, the total solar heat collecting areas of solar water heaters installed to date in China have reached 80 million m^2.

In 2005, the total amount of renewable energy utilized (excluding traditional uses of biomass energy) in China was about 166 million tce. This accounts for 7.5 percent of the total national primary energy consumption, which results in 3 million tons less of annual SO_2 emissions and 400 million tons less of annual CO_2 discharge. Development of RE in China has become a very important approach to solving the energy crisis, protecting the environment, and advancing the

rural economy.

Box 1. Major renewable energy targets and achievements by 2005				
RE development	In 2000	Development targets for 2000-2005	Achievements by 2005	Annual growth rate
Power generation				
hydropower (MW)	79,350	100,000	110,000	6.7
grid-in wind power (MW)	340	1,200	1,260	30
small off-grid wind power systems (K)	150		250	11
solar PV generation (MW)	19	53	70	30
biomass generation (MW)	1,700		2,000	3
Biogas				
Biogas production ($10^9 m^3$)	3.5	4.0	8.0	18
Number of household biogas digesters (Million households)	8.5	10	18	16
Heat supply				
by SWHs ($10^6 m^2$)	26	63	80	25
by geothermal 10^6 tce/a)	1.2		2	11
Biofuels				
bio-ethanol (10^4 ton/a)			102	
biodiesel (10^4 ton/a)			5	
Total RE utilization (10^6 tce/a)	120	136	166	6.7

1.1.2 Technologies and Sector Development

During the tenth five-year-plan period, RE technologies and industrial sectors gained strong progress in China. The industrialization of hydropower, biomgass and solar thermal utilization technologies and services have advanced in order to support the large scale and fast development of RE. At the same time, the new technology like biomass utilization, wind power and solar PV have reached good results in terms of development.

In hydropower, the manufacturing of power generation equipment and engineering technology are maturing. The ability of making 700 MW hydropower generators has been achieved based on imported foreign technology. Now, China already has a competitive ability in the manufacturing of hydropower equipment and hydropower engineering and a full system has been built in program design, engineering, operation and management.

Biogas technology is gaining progress and maturing. A standardized production and system construction have been reached for home use biogas digesters and related components. Service

networks have been established in rural areas and are qualified to provide after-sale services. Technology got engineering medium and large scale biogass generation has matured and there are professional teams in charge of design and construction. The service system is good enough for large-scale distribution of biogas utilization. The technologies for biomass power generation; bio-fuel and biomass pellets are well developed and have a good basis for large scale utilization.

Technology of wind power is ready for industrialization. Technology and utilization for off-grid small wind turbines have had a long history in China and have a good basis for industrialization. Based on foreign technology and self-development, the ability of making grid-tied wind turbines of 600kW up to 1.5MW has been realized.

China's solar PV cell and module manufacturing capacity has grown rapidly. During the period of the 10th Five-year Plan, demand for solar PV increased rapidly in the domestic SDDX program and the international market. The Chinese PV industry has developed very rapidly and the annual production capacity of solar PV products exceeded 500 MW.

Commercialized solar thermal technologies were greatly improved during this period and scale solar water heater production capacity has also been established. The annual production capacity of solar water heaters in China has reached 15 million m^2, making China the largest producer in the world. There are over 1000 SWH manufacturing companies, producing about 12 billion Yuan in annual production value. Solar cooker and solar house technologies have continued improving. Additionally, production capacity of the various solar thermal products can meet market demand at a basic level.

Box 2. Key RE projects and activities during the tenth five-year-plan period (2001-2005)

Hydro resource re-assessment: According to the results of the 2003 nation-wide Hydropower Resource Assessment, China's total hydro energy potential capacity for an annual generation is at 6190 TWh, with an average power of 694GW. While the potential capacity of technically exploitable hydropower is at 542GW, with an annual power generation potential of 2470TWh. The total potential capacity of economically feasible hydropower is 400GW with an annual capacity of hydropower 1760TWh.

Large hydropower projects: From 2001 to 2005 China completed extra large and large hydrological power plants, which included, The Three Gorges project left bank plant (9.8GW), Dachaoshan (1.35GW) and Gongboxia (1.5GW). Since the Gongboxia station became operational in September 2004, China's total hydropower installations have been more than 100GW. During this period, China started to build a number of large hydropower projects, including the Xiaowan station on the Yunan Lancang River (4.2GW), Longtan station on the Guangxi Hongshuihe River (4.2GW), Goupitan project on the Guizhou Wujiang River (3GW), Pubugou station on the Sichuan Daduhe River (3.3GW), Jinping's most upper stream station on the Sichuan Yalong River (3.6GW), and the Xiluodu project on the Jinsha River (12.6GW). These large hydro power stations will generate a total of about 80 million kilowatts of electricity upon completion..

Rural biogas development: During the planning period, China enhanced its investment in biogas development by using 1 billion Yuan per year of the national debt, between 2003 and 2005. In this period rural biogas entered a period of fast development. By the end of 2005, the total number of household biogas digesters reached 18 million. About 700 large-scale biogas plants of livestock farms had also been built. Developing biogas has been recognized as one of the most important measures for rural development and environmental protection.

Small hydro for fuel: With aims to protect the environment and to cope with the fuel shortage threatening rural everyday life, China implemented a pilot program titled, "Small Hydro for Fuel", at the forestation areas along the upper stream of the Yangtze and Yellow River valley. The first group of pilot projects was implemented in 26 counties (towns) in 5 Chinese provinces of Guizhou, Sichuan, Yunnan, Guangxi and Shanxi. By 2005, the small hydro for fuel projects successfully benefited 200 thousand people, reducing 160,000 tons of fire wood consumption, restoring 300,000 Mu forest land, and protecting 1.56 million Mu of existing forest.

Bio-ethanol fuel pilots: Between 2001-2005 bio-ethanol fuel pilot projects were implemented in China. Four projects were established and consisted of a total of 1.02 million tons of annual capacity. They were Heilongjiang Huarun Ethanol Co. Ltd (100,000 t/a), Jilin Ethanol Fuel Co. Ltd (300,000 t/a), Henan Tianguan Ethanol Fuel Co. Ltd (300,000 t/a), and Anhui Fengyuan Biochemical Co.Ltd (320,000 t/a). Also piloted, was a project which mixed ethanol into gas to be used by vehicles, done in the following locations: Heilongjiang, Jilin, Liaoning, Henan and Anhui provinces, as well as in 27 cities in the Hebei, Shandong, Jiangsu, and Hubei provinces.

Wind resource assessments: In order to better prepare China for large scale wind power development, a nation-wide wind resource assessment and wind farm activity site selection has been conducted, since 2003. These efforts aim to find the most suitable wind farm sites and are based on historical data from weather stations across the country, as well as landforms, transportation conditions, and local power grid capacity. According to the updated assessment results, China's total technically exploitable wind power capacity could be as much as 300GW.

Wind power concession program: To encourage scale wind power development in China, the NDRC started the wind power concession program in 2003. Chinese Government confirms coordinating a power grid connection and purchasing all the electricity generated by the concession projects. Investors and developers are selected for wind power concession projects through a competitive bidding process which improves domestic manufacturing capacity and reduce costs and tariffs. Three batches of biddings for concession projects were implemented during the tenth five-year-plan period with a total installed capacity of 1.6GW.

"Power to the Villages" program: During 2002-2004 China successfully implemented the Song Dian Dao Xiang (sending electricity to the township villages) program, which was established to address the lack of electricity problems which plague the towns and villages of the remote western regions of China. A total investment of 4.7 billion Yuan consisting of special central and local government funds was used to bring electric power to 1,065 rural townships and villages in 12 provinces, including, Inner Mongolia, Qinghai, Xinjiang, Sichuan, and Shannxi. These villages received renewable electricity supply systems including PV, PV, wind hybrid, and small hydro power stations.

1.1.3 Policies and Measures

From 2001 to 2005, aggressive efforts were made towards renewable energy policies. Improved policy support has created a favorable legislative and policymaking environment, allowing RE development to accelerate in China.

Box 3. Policies and measures effective during the tenth five-year-plan period (2001-2005).

Legislations: China's Renewable Energy Law was promulgated on Feb 28, 2005 and came into effect in the beginning 2006. The RE Law stipulates that the development of RE is the liability of the nation and all citizens. Follow-up supporting policies and management regulations have also been made. According to the RE Law, a Renewable Energy Mid- to Long-term Development Plan

was promulgated, consisting of well defined objectives and specific targets regarding RE development.

Incentive policies: China will gradually invest more government funds towards RE as well as provide financial and tax incentives. The issued incentive policies consist of, garbage generation projects and a tax rebate on wind power. Public budget subsidies and tax exemptions will also support biofuels. A large amount of special funds from the central and local governments will be spent towards power systems in non-electricity areas, rural biogas digesters, and R&D of RE technology and sector development.

Special support for technology and RE industrialization: China will invest more than 1 billion Yuan towards RE technology R&D and industrialization. In particular support will go towards, solar PV generation, grid-connected PV stations, solar thermal, and hydrogen and fuel cells under the national science and technology programs; such as the Technology Breakthrough Program, the 863 Program, and the 973 Program and industrialization program.

1.2 Existing Problems

Although China has achieved great progress in terms of it's RE development and policy systems, some problems still exist. Particularly problems arise in technologies, as well as market and policy measures, which are currently unsatisfactory for sustained RE development in China. Some of the main problems are identified as follows:

(1) Lack of incentives. Under the current technologies and supporting policies, only hydropower and solar water heaters are capable of competing in the respective market. However, most renewable technologies are less competitive in the energy market due to their higher cost, dispersed resources, and small scale and/or unstable production. Strong incentive policies are vital. Policy mechanisms for wind power, biomass, and solar PV are still incomplete, weak, and lack persistent and concentration. A long-term support for sustainable RE development has yet to be established.

(2) Unhealthy RE market system. Historically, China's RE development lacked a clearly defined set of objectives and strategies, or a stable market demand. Although national policies on a renewable market are gaining strength, there is still a lack of mandated market policy. A stable RE market has not yet been created, making market driven forces for renewable products weak.

(3) Weak technology development capability and RE industry. Aside from hydropower, solar thermal, and biogas, many RE technologies are underdeveloped. Insubstantial R&D, in tandem with a weak manufacturing capacity, has resulted in big gap between Chinese and international advanced technologies, in terms of product quality and production. Meanwhile, incomplete systems of, renewable resource assessment, technical codes, product testing and certification, and a lack of trained personnel, has resulted in a failure to meet the fast growing market and resulted in a poor service system to support China renewable energy industry.

1.3 Challenges and Tasks

During the period of the tenth five-year-plan, China's RE development faced the following major challenges:

(1) **Fast growing demand for energy requires additional energy supply sources.** As China enters the 21st century, its economy is gaining momentum. The fast development of the manufacturing industry and urbanization has resulted in a tremendous demand for energy. The intensifying demand has added unprecedented pressure on energy production and supply. Expanding energy supply sources is critical to securing social and economic development. In particular, development of renewable energy sources will become one of the most important

national energy strategies for China.

(2) **Consumption of large amounts of fossil fuel resulted in increasingly serious environmental issues. Clean energy technologies are required for sustainable development.** China relies on coal for its total energy production. The fast rising energy consumption results in increasingly serious environmental issues, especially air pollution. This has a negative impact on the economy and affects people's livelihood and health. Along with the fast economic and social development, demand for energy products will keep growing. Demands for energy supply and environmental problems will add tighter constraints on China's sustainable development strategies. Therefore, development of clean renewable energy technologies will become the only solution towards sustainable objectives.

(3) **The *Building Socialist New Countryside Programme* is a new drive towards RE development and utilization.** A less developed rural economy and poor local energy supply conditions, has left China's rural residents dependent on straw and firewood fuel for cooking and heating energy sources. By 2005, there were still approximately 11.5 million people without access to a power utility service. Speeding up the utilization of biogas, straw-fueled generation, small hydro, solar and wind energy in renewable, resource abundant rural areas will contribute to promoting clean, quality, and modern energy sources in China's rural areas and to sustain the rural economy.

(4) **Development in RE has received widespread attention and recognition in China making it a good time for large scale RE utilization.** RE is an important resource, playing a significant role in enabling China's energy supply to meet its growing energy demand, promote energy conservation, mitigate environmental pollution, and foster the national economy. Especially in recent years, very strong progress has been achieved in China's RE technologies. RE has entered an industrialized stage for scale development. In particular, the promulgation and implementation of the RE Law established widespread recognition of the importance of RE development and utilization. Such recognition has only further encouraged broader investment in RE. Now is better a time than ever for large scale RE development in China.

In line with the new campaign which advocates for, building a, resource-saving environmentally friendly society, in a tandem with the *Building Socialist New Countryside Programme*, calls for a long-term approach towards RE utilization and development. China will conduct the following critical RE development tasks over the next five years:

(1) **Scale up RE development and expand areas of application in which to mitigate energy and environmental pressures.** China relies heavily on coal due to its relatively scarce reserves of oil and natural gas resources. This heavy reliance on fossil fuel is not conducive to developing a harmonious social, economic and environmental dynamic. At the same time, China has abundant resources of hydro, biomass, wind power and solar energy sources. These renewable energies can be developed at a large scale. Therefore, it is a top task for 2006-2010 to speed up hydropower, biomass energy, wind power and solar energy in order to increase their share in the total energy consumption.

(2) **Promote rural renewable energy applications under the *Building Socialist New Countryside Programme*.** Areas with no electricity are remote, thinly populated, and lack power facilities. Small scale RE generation systems can therefore be an effective solution for off-grid electrification. A large number of rural residents suffer from lack of fuel, particularly clean fuel sources, the absence of which harms farmer families' quality of life. Addressing the no-electricity problem is crucial and can be solved by promoting solar electricity, clean fuel, waste processing and ecological environment, all of which will make for a recyclable rural economy.

(3) **Support technology advancement and industrialization. Create conditions for large scale RE development.** China has a relatively weak capacity towards technological innovation in the areas of wind power, biomass, and solar generation. Weak innovation and poor sector capacity has seriously hindered large scale RE development and utilization. Improving current RE technologies and creating developed industrial systems are fundamental. During the eleventh

five-year-plan period, R&D capabilities in the areas of wind power, biomass and solar energy will be significantly improved and a complete set of RE sectors will be established. If large enough, market demand forces will help drive new technologies and expand their industrial capacity. A solid foundation for RE technologies and sectors will be established.

2. Guiding Principles and Objectives

2.1 Guiding Principles

RE development in China should follow the general guiding principles: (1) carry out a scientific outlook of development, resource-saving and environmentally-friendly society; (2) conscientiously implement the Renewable Energy Law; (3) adopt RE development as one of the key strategic measures to achieve China's goals of establishing a moderately wealthy harmonious society, and to realizing sustainable development; (4) speed up the development and application of hydropower, wind power, solar energy, biomass energy, bio-fuels and other renewable energy technologies and sectors; (5) Lay a solid foundation for scaled RE development.

2.2 Development Objectives and Targets

The overall objectives for China's RE development in the coming 5 years are as follows: to Increase the proportion of RE in the total energy consumption, resolve the problems regarding lack of electricity for populations of remote, off-grid areas, resolve problems of fuel shortages for daily life needs in rural areas, stimulate RE technology, and promote the development of RE industries.

Specific targets:

(1) By 2010, China is expected to raise the share of RE in total primary energy consumption to 10 percent. The total national renewable contribution will be as much as 300 million tons of coal equivalents (tce). Of the total share of RE, 190GW of the total installed capacity will be from hydropower, 10GW from wind power, 5.5GW from biomass generation, and 300MW from solar generation. Additionally by 2010, the total biogas output in China will reach 19 billion m^3 and a total solar water heater collecting area of 150 million m^2 will be installed. China will also increase its annual capacity of ethanol fuel to 2 million tons from non-edible agricultural materials and produce 0.2 million tons of biodiesel each year.

(2) China aims to use clean and renewable energy to provide electricity to populations of remote, off-grid areas in addition to resolving fuel scarcity problems in such areas as well. By 2010, through RE projects and power grid construction and extension, about 11.5 million rural residents will benefit from the electrification program, 40 million rural households will use home biogas digesters, over 1 million tons of biomass fuel pellets will be produced annually, 4700 large biogas systems for livestock farms will be developed, and a total of 50 million m^2 solar thermal collectors will be installed in rural areas. China will also implement a green energy pilot program in 50 selected counties which have rich RE resource potentials.

(3) China will actively promote the development of RE technologies and industries through increasing RE innovative technology systems and R&D capacities. Technology transfer and international collaboration will be encouraged in order to diversify technology based activities. By 2010, China will be able to produce domestically a basic level of its main renewable energy equipment. Hydropower equipment and solar water heater products will have strong competitive capacity in the global market. Domestic wind power equipment manufacturers will be capable of batch production of over 1.5MW wind turbines. Biomass generation equipment using agricultural and forestry residues and solar PV polycrystalline materials will generally be made in China.

Box 4. Main targets to be achieved by the end of 2010.

Renewable Technologies	**Capacity**		**Annual production**		**K tons of coal equivalent/a**
	Targets	Unit	Targets	Unit	
Renewable electricity	**205880**	MW	**710.6**	TWh	**248240**
Hydropower	190000		665		232750
Grid-in wind power	10000		21		7350
Small off-grid wind power	75	($30x10^4$sets)	0.08		30
Solar PV generation	300		0.54		190
Biomass generation	5500		24		7920
From agricultural and forestry residues	4000		16		5280
From biogas	1000		5		1650
From garbage	500		3		990
Biogas			**19**	$G m^3$	**13650**
Household biogas	40	Million households	15		10860
Large livestock farm biogas	4700	System	1		500
Industrial waste biogas	1600	System	3		2290
RE thermal					**31300**
Solar water heater	150	Mm^2			27000
Solar cooker	1	Million sets			300
Geothermal					4000
For heating	30	Mm^2	1×10^8	GJ	

For hot water	600	K households			
Bio-fuels		Mt			**3800**
Biomass fuel pellets	1				500
Bio-ethanol	3				3000
Biodiesel	0.2				300
Total					**300000**

3. Overall Plan and Priority Sectors

3.1 Hydropower

3.1.1 Development Objectives and Targets

(1) **Guiding Principles.** Under the guidelines of a scientific outlook towards development, China will maintain an equal emphasis approach towards project development, resettlement, and environmental protection activities. Particular focus will be made towards improving resettlement of dam area populations and strengthening pre-project investigations. Under such reforms, hydropower projects will be better planned, ensuring greater harmony between humanity and nature and as such, provide sustained social and economic development in the country.

(2) **Objectives and Targets.** From 2006 to 2010, China will newly install hydropower that will reach a capacity of 73 million kilowatts; including the pump storage energy plants, totaling 13 million kilowatts. By 2010, the total nationally installed hydropower capacity will reach 190GW, including mid and large hydro stations of 120GW, small hydropower of 50GW, and pump storage plants of 20GW. A standard hydropower capacity, completed, will account for 31% of the national technically exploitable capacity.

3.1.2 Sector Plan and Key projects

(1) **Development Arrangements**. Based on successful resettlement and environmental protection efforts, China will speed up hydropower development in western province areas, improve hydropower project development efficiency, and scale up the "electricity transmission from west to east regions" project. China will also continue to develop hydro energy resource potentials in the central China areas. In eastern China, hydropower technical improvements will be strengthened to further exploit local hydro energy resources and to ensure power stations safely operates, and finally, to maximize their functions. Suitable pump storage stations will be built for thermal power dominated utility grids and end side grids, from distant power sources. By 2010, conventional hydropower installations in the western region will be as much as 95GW, or 55% of the nations installed hydropower capacity, accounting for 21% of developable capacity.

Of the above installations, 27GW and 17GW will be installed in hydro resources most abundant provinces, Sichuan and Yunnan respectively, accounting for 22.5% and 17% of the developable potential. In the central China region, the conventional hydropower capacity will be installed to a 50GW scale, or 30% of the national total capacity, accounting for 68% of the developable potential in the region. Another 25GW will be installed in the eastern China areas, or 15% of the national total installations. With these new installations, all hydropower potential of the eastern China region will have been developed. China's water pumping stations are mainly located in eastern and central China, of which the eastern China pumping stations will have a capacity of 12.8GW, accounting for 2/3 of the national capacity, while a 6GW water pumping station capacity

will be installed in the central China region, or 1/2 of the nation's capacity. Plus a 1.2GW pumping storage power capacity installed in western China, will make the national capacity of water pumping stations be as much as 20GW.

(2) **Key Projects**. Priority drainage areas for hydropower development are in the Jinsha River, the Yalong River, the Dadu River, the Lancang River, and the Yellow River. China will aggressively develop its hydropower bases along the Nu River hydropower project. While continuing to develop a group of large power stations, including the Yangtze River's Three Gorges Dam, the Jinsha River's Xiluodu, the Yellow River's Laxiwa, the Yalong River's Jinping first phase project, the Wujing River Goupitan and Penshui, the Hongshui River's Longtan, the Lancang River's Xiaowan and Dadu River's Pubugou. As well, a series of very large and super large hydropower stations will be started, including the Xiangjiaba, Baihetan, Guanyinyan, Ludila, Longpan, Liyuan and Ahai projects along the Jinsha River. Jinping phase II, Guandi and Lianghekou projects on the Yalong River, Dagangshan, Changheba, Luding, and Shuangjiangkou station on the Dadu River, Jinghong, Nuozhadu, and Gongguoqiao on the Lanchang River, Yangqu, Banduo, Mardang on the Yellow River and Liuku and Saige power stations on the Nujiang River.

During these five years, several hydropower reconstruction and expansion projects will be implemented, for example at the Hunan Dongjiang station and the technical improvement project at the Jilin Fengman station. Small hydro projects will be developed in eight provinces of priority and fifteen small hydro bases will be established. A group of water pumping stations at Guangdong's Shenzhen, Inner Mongolia's Hohhot, Anhui's Xiangshuijian, Fujian's Xianyou, Zhejiang's Xianju, Liaoning Huairen, Hebei's Fengning, and Jiangxi's Hongping will begin being established.

Box. 5 The hydropower development plan

Hydropower Bases: In water energy resource abundant river drainage areas, China has planned thirteen hydropower bases. They are located in the Jinsha River, Yalong River, Dadu River, Lancang River, Nu River, Wu River, upper stream of the Yangtze River, Nanpan River's Hongshui River valley, upper stream of the Yellow River, middle stream of the Yellow River north, and western Hunan, Fujian, Zhejiang, Jiangxi and the northeast bases. By these hydropower bases, the planned hydro installation will be 280GW, with an annual generation capacity of 1200TWh.

Priority of small hydro provinces: The priority of small hydro provinces refers to those with rich small hydro resources and well developed small hydropower capacities of 3-4GW installations. By 2010, eight such "small hydro provinces" will be developed, in areas including, Sichuan, Fujian, Guangdong, Yunnan, Zhejiang, Hubei, Guangxi, and Hunan.

Small hydro bases: Small hydro bases will be built in water resource rich and well developed centralized areas with an installed capacity of small hydropower over 1GW. During the eleventh five-year-plan period, fifteen small hydro bases will be built in China, including the bases of Shaoguan and Qingyuan, in the Guangdong province, Sanming, Longyan, and Ningde in Fujian, Lishui in Zhejiang, Ya'an, Aba, and Liangshan in Sichuan, Shiyan, Enshi, and Yichang in Hubei, Hunan Chenzhou, Guangxi Guilin, and Jiangxi Ganzhou.

3.1.3 Manufacturing and Industry Development

China will further improve its capabilities in resource investigation, project design, construction, management and equipment manufacturing. Key construction techniques to be developed, include, those which will allow for constructing high dams over 300 meters, and under complicated geological conditions, those which will enable large underground tunnels and high degree slope fixing, as well as high water head and a large flood flow discharge techniques, etc. China will continue its efforts in local manufacturing of traditional hydropower turbines and pumping station turbines. Introducing internationally advanced technologies will encourage innovation and strengthen technical improvement in hydro-power equipment. In particular, design and production in technology research for over 60MW grade run-through type, GW level mix-through type hydro

turbines, and 300MW above pumping storage turbines will be carried out. Hydropower equipment manufacturing technologies with Chinese IPR will be developed.

China will also develop hydropower projects relating to environmental protection technologies, implement environmentally friendly project design, and construct techniques and environmental protection measures. Meanwhile, issues of ecological water use, low temperature water, fish migration, and wild life protection must be properly solved.

Renovation of old power stations and drainage optimal dispatch techniques will be studied. Policies and a system of drainage optimal dispatch procedures will be established to improve hydropower systems' economic and social benefits.

3.1.4 Implementation and Supporting Measures

(1) China will reevaluate and improve its policies regarding, land acquisition compensation and resettlement of hydropower project sites, increase the rates for compensating residents in dam flooding areas, and enhance the post-project assistance measures. The interest of emigrants from dam sites must be carefully looked after by conscious implementation of the "Management Regulations on Compensation for Land Acquisition and Resettlement of Large Water and Hydropower Projects" and relevant post-settlement assistance policies. Resettlement for new hydropower projects must also be well planned and implemented.

(2) Preparation for resettlement from hydropower projects will be improved. The scope of resettlement and action plans must be consistent with the project plans. China will create job opportunities for new settlers, and study and pilot the long-term mechanisms of compensating dam flooded land. Resettlement management and supervision activities will be strengthened. Post-project assistance must be well implemented so that resettled populations will be well taken care of and genuinely benefit from national policies and from the project's outcome, as well as obtain opportunities for the projects future development. (3) China will award great importance to the environmental impact assessment (EIA) activities and strengthen environmental protection during hydropower project development. The EIA Law will be strictly enforced. Regulations of the EIA for the river valley hydropower plan and for each individual hydropower project must be strictly implemented. In particular, ecological environmental study and protection will be strengthened, due to the hydropower project development on international river bodies, such as Lancang River and Nujiang River.

Box. 10 The priority river drainages to be developed between 2006-2010 and key hydropower projects	
Priority drainages	Key hydropower projects
Jinsha River	Xiangjiaba, Baihetan, Guanyinyan, Ludila, Longpan, Liyuan, Ahai
Lanchang River	Jinghong, Nuozhadu, Gongguoqiao, Lidi, Huangdeng
Dadu River	Dahangshan, Changheba, Luding, Shuangjiangkou, Houziyan
Yalong River	Jinping phase II, Guandi, Lianghekou, Yagen
Upper stream of Yellow River	Jishixia, Yangqu, Ganduo, Ciha, Maerdang
Wujiang River	Silin, Shatuo, Yinpan
Mid-lower stream of Nujiang River	Liuku
Hongshui River	Guangzhao, Dongqing, Mamaya

(4) Continue efforts in project preparation activities. From 2006 to 2010, China will invest more on preparing activities of important hydropower project plans, including the projects on the upper streams of the Jinsha, Lancang, Nujiang, Yaluzangbu and other major rivers in Tibet. The investigations from preparation activities will provide information for future sustainable hydro energy development.

(5) Establish improved, relevant hydropower policies as well as establish an open competition and regulated market. China will continue to study its administrative system, in line with the socialist market economy system, to meet the requirement of hydro power in China. In particular, China will enhance its policy instruments for hydropower investment, project development, and administration, to encourage leadership roles for large drainage companies in hydropower development. China will also encourage non-state-owned investors in hydropower project development and enhance the management to ensure a healthy and regulated hydropower sector.

3.2 Biomass Energy

3.2.1 Guiding Principles and Development Objectives

(1) **Guiding Principles**. China will aggressively develop biomass power generation, biogas, biomass pellets, liquid bio-fuels, and other clean and efficient biomass technologies. It aims to promote industrial and commercial biomass development in China, speed up its biomass industry and biomass technology market, foster the rural economy, increase farmer income, mitigate environmental pollutions due to crop waste and organic waste discharges, and contribute to the *Socialist New Countryside Program*me. China will exploit and utilize, in a justified way, those marginal land resources used to grow energy crops and energy plantations. And will do so without overwhelming land with grain production or depredating the national environment. Balanced development will be realized between biomass energy and other predisposed biomass utilizations.

(2) **Development Objectives**. By 2010, the installed capacity of biomass power will reach 5.5 GW, the increase (newly added amount) of the use of non-food-grain bio-ethanol fuel will be 2 million tons, and the annual use of bio-diesel will reach 200,000 tons. The annual use of biogas will reach 19 billion m^3 from 40 million rural household biogas digesters and 6300 large scale biogas projects, Utilization of biomass pellets from agriculture and forestests will reach 1 million tons. During the five year development, China will establish a basic scale and commercialized biomass sector, as well as cultivate a group of backbone enterprises in biomass energy technology and equipment manufacturing.

3.2.2 Sector Plan and Key Project

(1) **Biomass Generation**

Biomass power includes generating power by using biomass from agriculture and forestry/forest product wastes, MSW, and biogas. The priorities for biomass power development are as follows:

Power generation from agricultural residues: From 2006 to 2010, China will reach a new capacity of 1.2 million kilowatts in, large part, thanks to agricultural biomass power. This amount, in tandem with the existing capacity of 1.8 GW biomass generations (which comes from sugar-cane and crop residues) will allow the accumulated biomass power installations in China to reach as much as 3 million kilowatts. Key biomass power projects will be developed in China's grain and cotton production regions by using crop straws, food processing wastes, and sugar cane residues. Small biomass gasification systems will be developed in townships. Lastly, piloting of the biomass power projects shall be well summarized and extended to a scaled level of development.

Biomass power from forest/forestry residues: By 2010, biomass generation from forests and/or forestry residues will be developed to reach a 1 million kilowatt capacity. In the key forestry areas, three major forest, forestry residues (harvesting wastes, forestry residues and wood processing wastes), and sanitation cutting wastes will be used as fuel to generation electricity. While in the "three north" region and southern China areas, residues from forestry management at large scale commercial forests, in addition to, ecological forests will be utilized for biomass fuel. Energy plantations are encouraged in desert and hilly land areas as biomass resources.

Biogas-fueled power: By 2010, China will have installed a 1 million kilowatts capacity of turbine systems to be fueled by biogas. Large biogas generation projects will be built in the eastern coastal regions, in suburbs of large cities and important water bodied protection areas. This will be done in conjunction with the large waste of farm livestock and urban sewage processing projects, as well as organic waste water processing projects for paper making, vineyards, printing and dyeing, and leather product industries.

Municipal solid waste generation: By 2010, China will reach a capacity of 500MW of MSW power. These MSW fueled thermal power projects are mainly located in the economically developed and land resource scarce areas, especially in the large cities of southern China (mostly the municipalities, provincial capitals, coastal, and tourist cities). Land fill gas collection and power generation projects will also be developed in some large land fill sites which have resource recycling capabilities.

(2) Liquid Bio-Fuels.

Constrained by both grain yield and arable land resources, China will encourage ethanol fuel production from sweat sorghum stalks, tuberous cropes and other non-grain biomass materials as well as biodiesel from *Jatropha Curcas, Pistacia Chinesis*, and cotton seeds used for feedstock.

Ethanol fuel. Ethanol fuel production will be done by planting sweat sorghum and using stalk as raw materials. Production will occur in the vastly poor land areas of northeastern China and the Shandong province. In Guanxi, Chongqing, and Guangxi province, various kinds of tuberous crops will be used to produce ethanol fuel. Pilot projects of ethanol fuel production from conventional crop straws and stalks are also being planned. By 2010, China aims to utilize (an additional) 2 million tons of bio-ethanol from non-food-grain feedstock.

Biodiesel. China plans to encourage biodiesel technologies through pilot projects using Jatropha, oil tung, Pistacia Chinesis, cotton seeds and other oil crop materials. By 2010, a 200,000-ton annual production capacity of biodiesel from oil plants is expected.

(3) Biogas and biomass gasification.

China considers gasification technologies to be very important in dealing with organic wastes and protecting the environment in rural and urban areas. China will make full use of biogas and biomass gasification technologies to produce fuel from agricultural and forestry residues for rural residents. During the eleventh five-year-plan period, biogas technology will be promoted in very rural communities through the building and distribution of 22 million new household biogas digester systems. By 2010, the total number of household biogas digesters will reach 40 million with an annual biogas yield of about 15 billion m^3. During the 5 year planning horizon, China will also speed up the construction of scale livestock farming biogas projects and projects of industrial waste water and urban sewage processing facilities. A total number of 6300 large biogas projects will be implemented with an annual biogas capacity of 4 billion m^3.

Box. 3. Key biomass fuel projects planned for 2006-2010.

Biogas projects: In conjunction with efforts to control and alleviate water pollution, China has planned a number of large-scale biogas projects. Most implantation is planned for eastern costal areas which are relatively economically developed and suburbs of large, inland cities. Large biogas projects are also to be constructed adjacent to important water bodies (e.g. Taihu Lake, Chaohu Lake, Dianchi Lake, Huaihe River, Haihe River, Liaohe River, Yangtze Three Gorges Dam area, and along China's South-to-North Water Transfer Project route) and at vegetable

production bases. The aim is to produce clean fuel gas from industrial and agricultural waste water resources.

Bio-ethanol production projects: China will conduct large-scale ethanol fuel pilot projects by using non-edible-grain biomass feedstock. Pilot projects consisting of planting 1 million Mu sweat sorghum for ethanol fuel is planned for the Shandong province's of the Yellow Sea delta area, Inner Mongolia's Yellow River bank area, as well as in the Heilongjiang, Jilin, and Xinjiang provinces. In Guangxi, Chongqing, Sichuan, and Hainan, piloting bio-fuel ethanol production capabilities from tuberous crops, such as cassava and sweat potato, have also been planned.

Preparation for industrial biodiesel production: Pilots for biodiesel from urban waste oil are planned in the cities of Beijing, Shanghai, Chongqing, Chengdu and Guangzhou. China will also test the woody oil crop cultivation, plantation, and biodiesel projects for demonstration and large area plantation of oil crops.

Promoting biomass pellet fuel: Capacity for dense biomass pellets, from crop residues, food processing wastes, and forestry residues, will be increased in China's major grain production areas and forest farm regions. The increased capacity will be used to provide biomass pellet fuel for rural and township residents and industrial users.

(4) Biomass pellets

Biomass pellets refer to solid biomass fuel condensed by specially designed equipment, They have the advantage of being easy to store, transport, and use. Biomass pellets are known for their clean and high combustion efficiency. Priorities towards biomass pellet development will include:

1) Biomass pellets can be made from crop residues and can be used for cooking and heating. Excess of pellet fuel can be sold in the market for cash.

2) In major grain and cotton crop areas, large capacity biomass pellet factories will be establish to produce pellet fuel for residents and industrial users.

3) In the natural forest reserves and large forest farm areas, residues from forestry management and harvest wastes can be processed into pellet fuel for cooking and heating. This will help reduce the current damage to forests from firewood consumption.

Biomass pellet pilots and demonstrations are planned for the eleventh five-year-plan period. By 2010, pellet fuel consumption is expected to reach 1 million tons.

3.2.3 Equipment and Industrial Development

(1) Technology Development and Equipment Manufacturing

Biomass generator facility. From 2006-2010, R&D and the manufacturing of biomass generation systems, fueled by agricultural and forestry residues, in addition to MSW, will be carried out in China. These efforts will be based on pilot projects, technology transfer, and innovation activities. The aim is to master the biomass generation technologies. For large biogas generation equipment, a series of biogas generator systems from 500KW to 1MW capacity, will be developed and manufactured to meet the market demand for landfill and biogas generation. Based on current experiences and lessons of small biomass gasification generation, a small biomass gasification fueled generator system of a 500-200KW capacity, will be developed and manufactured and a specialized gasification turbine system and component production capabilities will be established in China. Lastly, improvements will be made towards technical coding, testing, and certification facilities.

Biogas technology and equipment. China will research and develop landfill gas recycling technologies and equipments. Through improved biogas equipment manufacturing and project developing capacities, manufacturing technical process and equipment technologies will also be improved.

Other equipment. R&D in other biomass equipment techniques will be further advanced, including that for straw bundling and carrying equipment, shrub biomass collectors, special purpose transporting vehicles, and biomass pellet machines. Industrialization and standardization of the manufacturing process will be a focus.

(2) Services

With respect to biomass generation, service sectors providing stable fuel supplies, for large biomass generation projects, will be established. Fuel supply logistics systems will provide services in biomass production, collection, storage, inventory, and delivery. Through piloting, small biomass energy technical service providers will be established in rural areas to provide reliable biomass gasification generation and pellet processing equipments. Technology service companies will provide technical assistance for large biogas generation projects. China will also establish a service sector to support liquid bio-fuel production and marketing activities.

(3) Energy crop production system

Biomass fuel and raw material supply are important for biomass generation and liquid bio-fuel production. China will establish technical service facilities of fuel forest and shelterbelt forest cutting and management. Energy plantation is encouraged to supply fuels to the biomass power plants. Considering conditions of land resources and agricultural production, China aims to build scaled feedstock bases and large scale liquid bio-fuel production plants, while selecting and breeding energy plantation species. Land use for energy crops will be carefully planned. Through strengthening production and management, a complete service sector for energy crop production, management, purchase, storage and, supply will be established.

(4) Implementation and supporting conditions.

1) Renewable technology research and development, as well as industrialization projects are planned for biomass power generation, liquid biofuels, and biomass pellet fuels. These projects will support enterprises in their R&D activities towards new techniques, equipment and product development. In addition they will support technical coding, standard, and certification activities. Selecting and culturing energy crops is planned in order to provide technical support for energy crop production and energy plantation.

2) China aims to implement a group of pilot projects, with the support of a special fund, of biomass power generation, biofuel, and biomass pellet fuel. Purchase and subsidy procedures for liquid biofuel from non-edible grain feedstock must be prepared and implemented as soon as possible.

3) China aims to make greater efforts in biofuel technical codes and standards, in addition to promoting the biofuel products market. Oil product sales companies should study and make an effective biofuel promotion plan, which is in accordance with the requirements for biofuel pilot projects arrangements. .

4) Biogas projects shall be implemented in line with processing organic waste water discharged from papermakers, vineyards, printing and dyeing works, leather makers, and large livestock farms. Supervision will be enhanced for landfill biogas utilizations.

3.3 Wind Power

3.3.1 Guiding Principles and Development Objectives

(1) **Guiding principles.** In order to reduce wind power cost, and enhance wind power market competitiveness, China will promote wind power development; and will do so by expanding its wind farm capacity, fostering wind power technology advancement, and improving wind turbine manufacturing capabilities. (2) **Objectives.** During the planning horizon, China will build a 9GW wind power capacity. By 2010, wind powers' total capacity will reach 10GW. Production capacity of domestically produced wind turbines will be increased, including 5GW turbine systems and 8GW components. An established manufacturing capacity will provide strong support to the accelerating the development of wind power after 2010. In remote un-electrified areas, small wind

generator systems will be actively promoted. By 2010, 300,000 such systems will be installed with a total accumulating capacity of up to 75MW. Lastly, 8000 generator systems wil be able to be manufactured each year.

3.3.2 Sector Plan and Key Project

China plans to construct about 30 large wind farms, with over 100MW for each farm and 5 Gegawatt –scale wind power bases. Very large wind farms with installed capacities of 10GW or more will be prepared and started in Gansu, Inner Mongolia, and eastern coastal areas.

In wind resource abundant areas of northern China (including northeast, north, and northwest China areas), large and super large wind farms will be developed including, gegawatt wind power bases in Hebei, Inner Mongolia, Gansu and Jilin provinces. By 2010, the total installed wind power of Hebei and Inner Mongolia will be more than 2GW and 3GW respectively. New project capacities will be as much as 3GW and 4GW as well. In Gansu, the installed wind power will be over 1GW and another 4GW capacity will be complete or under construction. Total wind power in Jilin and Liaoning will reach 500MW and another 1GW capacity wind farm construction has started and will be complete soon.

Box 8. Major wind power projects and their locations.

Areas	Province	Capacity (MW)		Location
		Completed and started capacity	Operational	
Priority	Hebei	3000	2000	Zhangjiangkou, Chengde, Huanghua
	Inner Mongolia	4000	3000	Huitengxile, Huitengliang, Dali, Damao, Tongliao, Bayannaoer
	Jiangsu & Shagnhai	2000	1000	Rudong, Dongtai, Dafeng and Qidong in Jiangsu; Chongming, Haihui in Shanghai; Offshore wind power pilot project
	Gansu	4000	1000	Yumen Changma, Anxi, Baiyin
	Jilin	1000	500	Taonan, Taobei, Tongyu, Shuangliao, Changling
	Liaoning	1000	500	Fuxin, Changtu, Kangping
	Xinjiang	1000	400	Dabancheng, Ala Shankou
	Subtotal	16000	8400	Jimo, Qixia, Weihai, Dongying
General	Shandong	600	200	Huilai, Nanao, Lufengjiadong, Xuwen, Chuangdao
	Guangdong	600	300	Helanshan, Zhongning
	Ningxia	500	300	Pingtan, Putian, Zhangpu, Gulei
	Fujian	400	200	Jiamusi, Yilan
	Heilongjiang	200	100	Daishan, Changnan, Cixi
	Zhejiang	250	100	Zuoyun, Youyu, Shenchi
	Shanxi	250	100	Zuoyun, Youyu, Shenchi, etc.

	Subtotal	2800	1300	
Others		1200	300	
Total		20GW	10GW	

In economically developed coastal provinces, such as, Jiangsu, Shanghai, Fujian, Shandong and Guangdong, wind power development will be accelerated through taking advantage of the strong local economy and market demand. In particular, very large wind farms of over 1 GW capacity will be planned for the Jiangsu and Shanghai coastal regions. By 2010, the total installations in the areas will be more than 1GW. In other areas consisting of strong wind resources and market conditions, several tens of 100MW scale wind power projects will be constructed.

In other wind resource potential provinces, small wind farms will be actively developed in China. Near offshore wind power technologies will be investigated and offshore wind resource assessment and pilot projects will be prepared. One or two 100MW capacity offshore wind farms will also be established for the purposes of technological experimentation and gaining experience.

3.3.3 Equipment and Industrial Development

(1) Technology Advancement and Equipment Manufacturing

China aims to strengthen its wind power technologies through innovation and technology transfer, as a means to better establish its manufacturing capabilities for wind power equipment. Strong national support, an introducuction of internationally advanced technologies and the re-innovation of Chinese companies, with a strong focus on strengthening R&D capacities, will all contribute to help develop China's wind power technologies and products. During the eleventh five-year-plan period, China will continue to encourage batch produced, local, wind turbines and their applications, as well as their upgrade towards the new generation of MW grade wind power systems. While creating basic domestic wind turbine manufacturing capabilities, China has had 1.5MW or more of wind turbine technology, in addition to offshore wind turbine technology of 3MW level. Such goals shall be sought out through technology transfer, joint venture, and innovative R&D activities. China will take advantages in local equipment manufacturing technologies and market size, in order to establish a high-tech and competitive wind turbine, and component manufacturing sector.

Box 9. Priority wind power sectors in China.

GW-capacity wind power bases: GW wind level power bases will be developed in areas with rich wind resources, good grid facility, and large power demand. Planned areas include, Zhangjiakou in Hebei, Anxi and Changma in Gansu, Huitengxile in Inner Mongolia, Baicheng in Jilin and coastal in Jiangsu and Shanghai.

Supporting local wind turbine manufacturing: Based on the market for large wind farms and GW wind power based projects, China will encourage local manufacturing of wind turbine systems and components. While enhancing over all manufacturing capabilities, China will especially support several domestic wind power equipment manufacturers with strong R&D potential. Experimental national wind farms will be established. And wind turbine testing and certification facilities will also be supported.

Piloting near offshore wind farms: Demonstrative near-offshore wind farms will be established in coastal areas of Jiangsu, Shanghai, and Guangdong provinces in order to gain experience and lessons in offshore wind resources assessment, wind farm planning, construction, installation, operations, and maintenance. Based on these experiences, offshore wind power equipment technologies will gradually be mastered.

(2) Basic Research and Training Activities

China plans to set up basic research programs in wind technology at national research institutes and universities. The focus of the programs will be to conduct theoretical,. In addition, practical studies will take place on topics of wind energy resources, fluid dynamics, mechanical intensity, electronics for power and power grid, etc. The research programs will be implemented with the support of technical training programs in order to build up a team of qualified technical personnel, with graduate degrees based on the requirements of wind power development in China. Particular wind power curricula and specialties will be developed at selected universities and colleges. Meanwhile, short term technical training activities will also be organized to meet the requirements of qualified wind power talents which are currently at a shortage.

(3) Strengthening wind power service sector

China will encourage and support the following: service providers of wind resource assessment, wind farm planning, production standardization, technical coding, equipment testing, and certification activities. A number of wind power technical service provider organizations and a complete wind power service sector will be established in China, including 2-3 business test wind farms to provide testing facilities for wind turbine product certification and R&D activities in China.

3.3.4 Implementation and Supporting Measures

(1) Based on the continuing national efforts in wind resource survey and assessment, China will begin detailed wind resource investigations and wind farm site selection activities, in order to prepare for large wind farm projects (especially the GW-level super large wind power bases). Investigations and projects will be based on a consideration of, resource potential, infrastructure, power grid conditions and power markets.

(2) China will improve the grid-in wind power tariff system as well as implement a wind electricity tariff and cost sharing policies. Utility companies should conduct studies on wind power grids with respect to, connection planning, design, and experiment in line with national plans for wind power sector, improve technical conditions, dispatch procedures, and ensure smooth connections and operations of wind power projects.

(3) China aims to improve its wind turbine technology and manufacturing capabilities. Domestic companies will be encouraged to conduct innovative wind power R&D and technology transfer. In the bidding of government investment and wind power concession projects, developers and manufacturers will be teamed with proposal packages to encourage locally made equipment and technology innovation.

3.4 Solar Energy

3.4.1 Guiding Principles and Development Objectives

(1) **Guiding principles.** China will continue to promote solar water heater applications. In high areas of solar potential, obligations for integrating solar thermal with residential building will be adopted and solar houses and solar stoves will be encouraged in rural areas. Through developing a stable market demand, solar PV generation will be actively promoted. Solar thermal generation technologies will also be developed and piloted.

(2) **Objectives**. By 2010, China will install a total of 150 million m^2 solar water heaters. Installed solar generation capacity will be at 300MW. MW-capacity grid-tied solar PV generation projects and 10MW level solar thermal generation projects will be piloted. These projects will contribute to China's solar power industry and will be a solid foundation for solar generation scale applications and technology development.

3.4.2 Sector Plan and Key Project

(1) Solar Thermal

From 2006-2010, China will continue to foster and accelerate solar thermal utilization which includes, promoting solar water heaters, solar houses, and solar cookers, in rural and small towns. In addition to, solar water heaters and building integrated solar thermal at municipalities, centralize solar hot water systems, and piloting solar space heating and cooking projects. Pilot projects of solar powered sea-water desalination and other industrial size solar application projects will also be implemented in order to provide alternative solutions to fresh water supply in coastal Chinese cities and gain experience for large scale industrial applications. By 2010, China's total SWH production capacity will be 20 million square meters. 10-20 large solar thermal product manufacturers with a 500,000 m^2 or more capacity, and strong innovation potentials will be developed.

(2) Solar PV

Electrification in non-grid-access areas: Solar PV home systems or small solar PV power stations will be established to solve the daily-life power supply forremote areas of Tibet, Qinghai, Inner Mongolia and Xinjiang. A total capacity of 100MW solar generation systems will be realized.

Start Urban PV application projects: In large and medium size Chinese cities with good solar energy resources, solar PV applications will be encouraged for solar roofs and solar lightings. Solar PV systems can be built for landmark public buildings, newly-built residential houses, close managed communities, tourism spots, traffic, and landscapes. Large capacity solar PV systems will be installed for important events such as, the Beijing Olympics, Shanghai Expo, and Guangzhou Asian Games. By 2010, the total installed urban solar PV applications will be as much as 50MW.

Solar PV grid-connected power station pilots: In the solar rich provinces of the west, such as, Tibet, Gansu, Inner-Mongolia, Ningxia, and Xinjiang, large scale grid-connected solar PV stations will be built with a total capacity of 50MW.

(3) Solar Thermal Generation

Pilot projects for solar thermal power generation will be planned and implemented in the Gobi/desert areas of Inner Mongolia's Erdos and Gansu's Yellow River corridor region, the Hami area of Xinjiang, and Lhasa of Tibet, as well as some selected areas in Beijing, all of which will allow for an installed capacity of about 50MW.

3.4.3 Equipment and Industrial Development

(1) Technology Development and Equipment Manufacturing

China will focus on a construction of production based solar water heaters, improving SWH efficiency. By means of technology R&D and sector support, highly pure polycrystalline silicon material production technology and capacity will be mastered. Key technologies and techniques for solar thermal generation will be improved through piloting, technology transfer, and innovative R&D.

(2) Industrial system development

China will establish a complete quality assurance system and technical testing capabilities to improve overall product quality and ensure a healthy solar energy market. The efforts will also include developing methods and technical codes for solar resource assessment to support large scale solar energy development.

Box 10. Priority solar technologies and development areas		
Technologies	Planned capacity targets (MW)	Priority development areas
1. Grid-connected solar PV	100	Tibet, Gansu, Inner-Mongolia, Ningxia, Xinjiang, etc.

Rooftop systems and landmark building systems	50	Beijing, Shanghai, Guangdong, Jiangsu and Shandong, etc.
Large-scale Solar PV stations	50	Lhasa, Dunhuang and Erdos, etc.
2. Solar power for remote marginal areas and off-grid PV applications	150	Tibet, Qinghai, Gansu, Xinjiang, Yunnan, and Sichuan, etc.
3. Solar thermal generation	50	Inner Mongolia,etc.
Total capacity	300	

3.4.4 Implementation and Supporting Measures

(1) Solar thermal obligation policy. During the five years of the eleventh five-year-plan period, China will study and formulate the standards which will obligate solar thermal installation for buildings. Solar obligations will be applied for government invested buildings and commercial used buildings in solar rich provinces. Supporting policy instruments for solar water heater applications will gradually be strengthened..

(2) China will provide subsidies from the national budget for demonstrative projects of electrification, solar roof, and landmark building PV and grid-connected PV stations. A solar power feed-in tariff will be pre-specified by the government and an additional cost, compared with conventional thermal power standard prices, will be shared according to renewable power tariff policies.

Box. 11. Priorities for solar energy development.

Solar water heater promotion plan: Solar water heaters are strongly encouraged in solar rich provinces. Solar thermal obligations will be implemented and expanded to buildings of public schools, hospitals, hotels, and other buildings with large amounts of hot water demand. New residential buildings must install SWHs and be prepared to allow for solar thermal system installations.

The City Solar Rooftop Program: Rooftop solar PV projects will be implemented in large cities such as Shanghai, Beijing, as well as cities in Guangdong, Jiangsu, and Shandong. By 2010, the total nationally installed capacity for the rooftop systems will be 50MW.

Large-scale grid-connected solar PV stations: The stations will be constructed in solar abundant Tibet, Inner Mongolia, and Gansu etc, with a total planned capacity of 50MW.

Solar thermal generation pilots: In the large, open, areas Inner Mongolia, Gansu, and Tibet, solar thermal power stations, with 10MW capacity, will be piloted.

(3) China will make technical standards and management regulations for the stand-along renewable power generation systems. Technical codes for solar PV lighting units, building integrated PV (BIPV), large-scale grid-connected PV stations, and solar thermal generation systems will also be formulated and promulgated before 2010.

3.5 Rural Renewable Energy Applications

3.5.1 Guiding Principles and Development Objectives

(1) Guiding principles

China will ascribe great importance to rural renewable energy towards its national development strategy. Large increases of investment and greater efforts will be made to promote utilizing crop residue and animal farm waste into renewable energy sources. Biogas and solar PV technologies will be encouraged in the *Green Energy Demonstration County Programme*. In rural areas, renewable technologies and services will help to resolve daily issues over energy use for China's vast rural population. In addition they will help to improve rural production and living conditions and protect the ecological environment. The use of renewable energy will effectively raise rural incomes and increase the speed of social and economic development in rural areas.

(2) Objectives

By 2010, the total number of household biogas digesters shall reach 40 million with an annual production of biogas at about 15 billion cubic meters. Also by this time, 4700 large livestock farm biogas projects will be established. Total collector areas of solar water heaters shall reach 50 million square meters and up to 1 million solar cookers will be in use.

3.5.2 Sector Plan and Priorities

(1) Electrification at non-grid-access areas

China will continue to utilize small hydro, wind power, solar PV, and other renewable energy technologies to solve power supply problems for no grid access rural regions. In small hydro resource potential areas, small hydro projects will be developed, as a priority. In the areas of no water energy resources, small solar PV stations, hybrid wind-PV stations, small wind generators, solar home systems, and small wind-PV hybrid systems, will be installed to provide electricity to over 1 million households lacking power grid supply infrastructure.

(2) Rural home biogas applications

In central and Western China "Grain-for-Green" programme areas, crop producer areas, husbandry areas, and along the South to North Water Transmitting line areas, in minority populated areas and schistosomiasis and fluorosis endemic areas, home-used biogas applications will be promoted.

(3) Livestock farm biogas projects

Livestock farm biogas applications will be encouraged in Eastern coastal areas and in large city suburbs. Priorities for the biogas projects will be given to the vegetable bases and large river bank areas（Tai lake, Chao lake, Dianchi, Huai river, Hai river, Liao river, Three-Gorges area along Zhangjiang river and along the line of South to North Water Transmitting Engineering）. The biogas projects will be planned in line with agricultural product sector development strategies.

(4) Other small-size renewable energy applications

According to available resources, small biomass gasification generations, biomass solid-forming pellet fuels, solar energy applications, small wind generators, and micro-hydro power projects, efficient stoves, and other renewable technologies will be encouraged to distribute in rural areas.

(5) Building RE demonstration counties

For provinces rich in RE resources, demonstrative Green Energy Counties will be encouraged, by requiring that RE applications contribute to more than 50% of their daily life energy uses and that biomass wastes are basically utilized. By 2010, 50 of such green counties will be established in China.

3.5.3 Equipment and Industrial Development

(1) **Improving technology innovation and manufacturing capacities.** R&D and demonstration

of straw biomass gasification, biogas generation and biomass solid-forming pellet fuel technologies will be the focus. Through technological innovation and integration, biomass energy driven, resource development models will be established. RE equipment manufacturing will be developed for special rural market.

(2) **Strengthening quality assurance and standards.** Improve awareness of existing standards and ensure the implementation of technical standards, codes and guidelines. Along with developed technologies, standards for new techniques, new products, and new equipments will also be developed.

(3) **Improve services for rural renewable energy.** This effort involves project development, training, basic services, and technical assistance in order to ensure smooth development of rural renewable energy in China.

Box 12. Rural renewable energy applications.

Home biogas digesters: Home biogas applications will be promoted in Sichuan, Chongqing, Guizhou, Hunan, Hubei, and Shannxi mainly. By 2010, 40 million rural household biogas digesters will be installed in China.

Speed up the electrification of non-covered grid regions. Small hydro, solar PV, wind power, and other RE technologies will be promoted as a means to providing power supply to populations without power grid access in Tibet, Qinghai, Inner-Mongolia, Xinjiang, Yunnan, Gansu, etc..

Promote biomass solid-forming pellet techniques. Biomass pellet fuel, processed from crop residues, food processing wastes, and forestry residues, will be promoted as a means to providing fuel to local residents for production and daily life use.

Building Demonstrative RE counties. "The Green County program" will be implemented in economically developed and renewable energy rich regions, including, Jiangsu, Shandong, Guangxi, Sichuan, Northeast provinces, and Inner Mongolia. By 2010, 50 such models will have been promoted through counties in China.

3.5.4 Implementation Measures

(1) Rural renewable energy applications should be incorporated into China's new socialist countryside program. Plans for rural biogas projects, small hydro fuel and biomass pellet fuel projects will be fully implemented. Commitment of government funding will be ensured for rural renewable energy applications.

(2) Authorities responsible for rural energy programs should actively commit themselves to piloting, summarizing, and promoting rural biomass pellet fuel, gasification co-generation projects.

(3) China will formulate and implement rural RE tax policies and regulations aimed to encourage public and private investment in RE service companies and to ensure extensive renewable energy applications in vast rural areas in China.

4. Environmental Impact Analysis

Utilization of renewable energy technologies regarding hydropower, wind power, solar generation, and solar thermal, discharge neither pollutants nor greenhouse gases. In addition, utilization can help lessen China's coal consumption and therefore the environmental deterioration caused by coals' exploitation. Biogas technology can convert livestock farm wastes, industrial waste water, and urban sewages into energy, providing an important solution for clean production. Power generation from biomass fuel emits very small amounts of pollutants and zero green house gases. Energy crop plantation on salinate fields, hilly lands and barren lands can be combined with forestation, forest restoration and green-hill activities. Therefore RE development and utilization

will play an important part in environmental protection. By 2010, China's use of RE will be equivalent to 300 million tons of coal, hence reducing about 4 million tons of SO_2 discharge each year, reducing NO_x discharge to about 1.5 million tons, less smoke and dust emissions by about 200 million tons, reducing emission about 600 million tons less of CO_2 emmissions, and saving water use by about 1.5 billion cubic meters, and avoiding forest damage by about 150 million Mu as well. However if not careful, RE development can also make a negative impact on the ecological environment. Therefore scientific approaches must be adopted for RE utilization, which includes, following the laws of nature and strengthening environmental protection. For instance, hydropower development must pay attention to protecting wildlife habitats, especially aquatic animal ecology, and preventing geological disasters and maintaining water and soil preservation, as well as protecting natural reserves. Wind power projects must coordinate with wetland protection and bird games and tourism reserve areas, to avoid damage to birds, and to reduce the impact of noise and light pollution. Biomass energy utilization should be prevented from secondary pollution. The over use of land resources, forest, and natural resources must be strictly prohibited.

The development and utilization of RE in China will help save large amounts of fossil fuels and reduce pollutant and greenhouse gas emissions, and hence contribute to the harmonious development of both humanity and nature.

5. National Incentive Policies and Measures

In order to achieve the objectives and targets of the plan, the following policies and measures will be adopted to support the development of RE:

(1) In order to fully implement the RE Law, government authorities should make strong efforts in formulating and improving national supporting policies and management regulations towards renewable energy, with clearly defined objectives. Developing renewable energy will become important inductors for building the resource preservative and environmentally friendly society. RE policies and management regulations must be fully implemented, including RE grid-connection, feed-in tariffs, and cost sharing policies, financial and tax incentives.

(2) National authorities should create management regulations and guidelines for a special renewable energy fund. A necessary financial budget will be planned for supporting renewable technology research and development, pilot project development, rural renewable energy applications, resource assessment, standardization, and local manufacturing activities. China will also provide tax incentives on RE technology development and utilization, technical research and development and equipment manufacturing.

(3) China aims to establish its RE market through aggressive national incentives in funding, tax, price and mandated market share policies. China will continue to invest government funding and implement concession projects to facilitate a stable RE market. Utility companies should plan and study renewable power grid connections and ensure its purchase. Oil sales companies should implement national plans for biomass, ethanol, and biodiesel sales in the market and be prepared for purchase and sales of biofuels.

(4) China will accelerate its RE technology advancement and sector development, by incorporating renewable technologies into national science and technology programs and supporting key technologies and the industrialization of biofuels, wind power, biomass generation and, solar PV. A national administration for renewable energy R&D will be established, responsible for integrating technical resources, improving services, speeding up education and training, improving R&D and overall innovation and service systems in order to foster China's RE technology and service capabilities. China will strongly support domestic RE equipment manufacturing and integration and will speed up its basic technology and industry for renewable energy development and utilization.