

**China**

**Renewable Energy Report**



**APCTT-UNESCAP**

**Asian and Pacific Centre for Transfer of Technology  
Of the United Nations – Economic and Social  
Commission for Asia and the Pacific (ESCAP)**

This report was prepared by Prof. Xi wenhua, director-general of Gansu natural energy research institute/UNIDO international solar energy center under a consultancy assignment given by the Asian and Pacific Centre for Transfer of Technology (APCTT).



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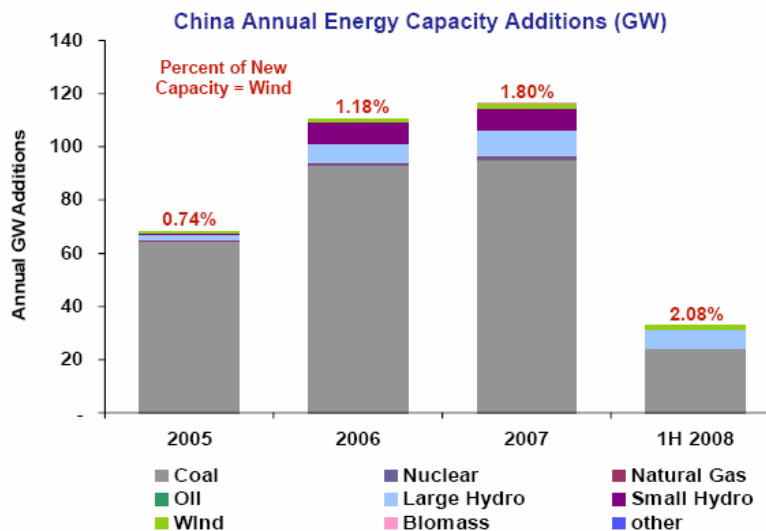
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## I Introduction

It is so important for China to have the safe, low-cost and environment-friendly sustainable energies to supply 1.3 billion populations. In the year of 2006, the total energy consumption is in the second place around the world, which is twice more than ten years ago. Further more for the electricity consumption it is twice compare to the year of 2000. The power is mainly supplied by the coal-fired power and hydropower. At the moment, half of the oil depends on importing from other countries. It is so urgent and pressure to seek for the alternative technologies and energies since we are facing worse and worse condition everyday as energy safety, power shortage, air pollution etc. The alternative technologies and energies is how to improve the energy efficiency, cleaner coal technology, nuclear technology and renewable energies as well. Also as we all know that the climate change is one of the elements worsen the condition.



China Annual Energy Capacity Additions(GW)

On the research and application of the renewable energy, China has been in the top place around the world. Nearly 10 billion dollars has been invested in the field of renewable energy, which is in the second place, just behind Germany. Most investments focused on the small hydropower, solar water heaters and wind power. Meantime, the fund invested

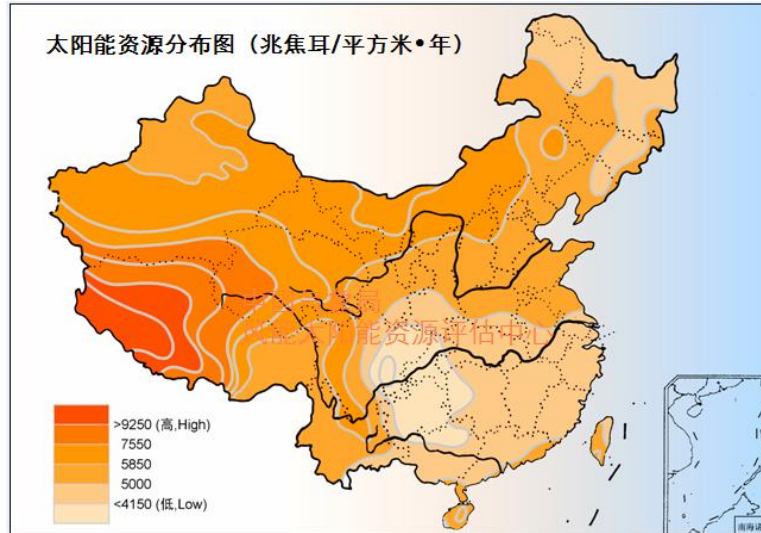
in the large hydropower is 6 to 10 billion dollars per year. In the year of 2005, the Renewable Energy Law was adopted by China, which provides a strong support to have the development of the renewable energy as a prior filed. Currently renewable energy contributes 8% to the primary energy supply and 16% to the power, which will be increased to 15% and 21% in 2020.

## **1. Introduction of part of renewable energy resources**

### **1.1 Solar Energy**

#### 1.1.1 Solar energy resource

Based on observation data obtained at 655 national weather stations in the past 30 years and model computation result. China is a solar energy rich country with total annual radiation of about 120-280W/m<sup>2</sup>. An isoline with radiation strength of 180W/m<sup>2</sup> stretches from mid Inner Mongolia westward to mid Yunnan along the east side of Tibetan Plateau. This line divides China into two sections: the northwest part with radiation above 180W/m<sup>2</sup> and southeast part with radiation below 180W/m<sup>2</sup> on most land. Annual total solar radiation descends as you move eastward, while the Tibetan Plateau is a stable high solar radiation area. The highest radiation values are observed at Tibetan Yaluzangbu River valley with the maximum value above 280W/m<sup>2</sup>. Solar energy resource potential is correlated with the maximum value above 208W/m<sup>2</sup>. Solar energy resource potential is correlated with geographical latitude, landforms and atmospheric circulation conditions. It is therefore both seasonal and geographical. If we assume that only those areas with radiation strength above 160W/m<sup>2</sup> are feasible to develop for the solar power, about one third of China's territory can be considered for potential solar power capacity, China's annual solar energy exceeds 6 billion J/m<sup>2</sup>. The total ground-received solar energy each year is equivalent to 1700 billion tce and has great potential for commercial development.



### China Solar Energy Resource Distribution

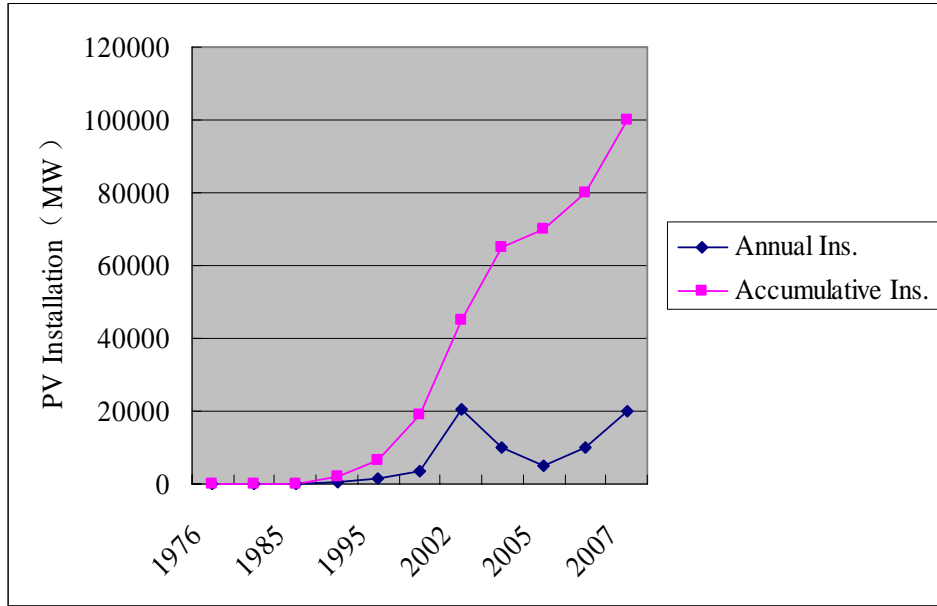
#### 1.1.2 Solar Photovoltaic

Chinese photovoltaic cell and module production made up about 1% of global output before 2002. But China's photovoltaic industry has developed rapidly since 2004 due to strong demand in the international PV market, especially in Germany and Japan. Annual production of PV cell and components had jumped considerably every year. China produces 25MW of high purity silicon materials, 580MW of silicon ingots, 500 MW of wafers, 1400MW of cells and 1080MW of modules. Chinese solar manufactures contributed more than 10% to the world photovoltaic market in 2006, ranked 3<sup>rd</sup> only after Japan and Europe. It is expected that by 2010 China will become one of the largest solar cell manufacturers in the world, with annual production capacity of 1GW.

Compared with the fast expanding photovoltaic manufacturing sector, the domestic Chinese photovoltaic market has grown slowly. It is very important to study the situation and develop an aggressive strategy for promoting the development of both the manufacturing sector and the domestic market.

### China PV Annual Installation and Accumulative Installation (KWp)

Year	1976	1980	1985	1990	1995	2000	2002	2004	2005	2006	2007
Annual Ins.	0.5	8	70	500	1550	3300	20300	10000	5000	10000	20000
Accumulative Ins.	0.5	16.5	200	1780	6630	19000	45000	65000	70000	80000	100000



#### 1.1.3 Solar Thermal

Solar thermal applications mainly include solar water heaters(SWH), solar thermal generation, solar fueled stoves and solar heated houses. Currently solar water heater system are industrially produced on the large scale in China.

By 2006, 90 million m<sup>2</sup> solar water heaters were installed in China. Annual production capacity was nearly 20 million m<sup>2</sup>, an increase of 30% from 2005. Actual production in 2006 was 18 million m<sup>2</sup>. 20% more than 2005 output, China's production and use of SWH comprises one half of the world's total. The Commercialized SWH industry has created a complete supply chain of raw material processing, product R&D, engineering design, and marketing services. Meanwhile it drives related industry development in glass, metal, heat reservation material and vacuum equipment manufacturing and is becoming a fast growing new sector. There are currently more than 1300 SWH manufacturers in China producing on a significant scale. In particular, the Chinese

patented vacuum tube technology is internationally advanced. The vacuum tube SWHs are widely used in China. With annual production of over 16 million m<sup>2</sup>, comprising 90% of the global market sales. These high quality SWH products are exported to dozens of countries in Asia, Europe and Africa.

### **China SWH annual production and total installations between 2001 to 2006**

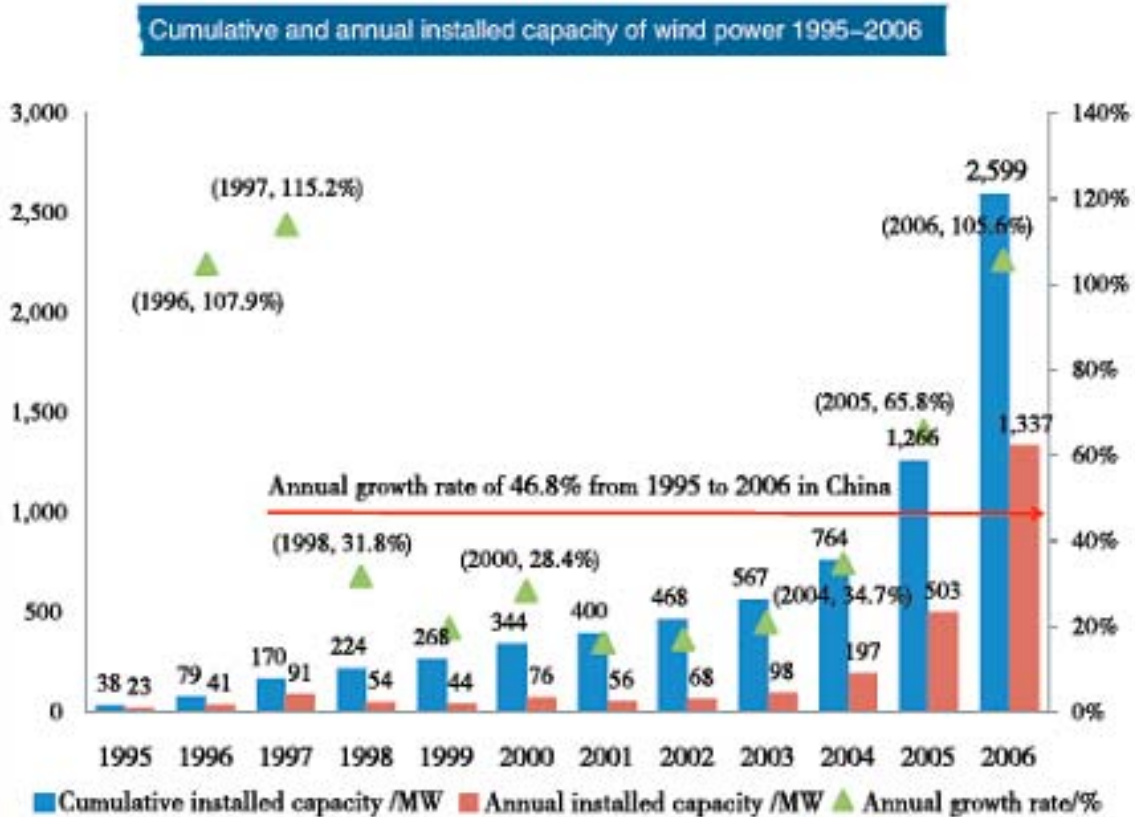
Year	Production		Annual	Total installations		Annual
	10 <sup>4</sup> m <sup>2</sup>	MW/h		10 <sup>4</sup> m <sup>2</sup>	MW/h	
2001	820	5740	28	3200	2240	23
2002	1000	7000	22	4000	28000	25
2003	1200	8400	20	5000	35000	25
2004	1350	9450	12.5	6200	434000	24
2005	1800	10500	11.1	7700	539000	24
2006	2000	12600	20	10000	70000	30

## **1.2 Wind power**

### **1.2.1 Rich wind resources**

China's wind energy resources are very rich and have great potential for development. Since 2004, according an NDRC plan for preparing large wind farm projects, the China Meteorological Administration has implemented three nation-wide wind resource assessments. Based on historical data sets between 1971 and 2000 obtained from 2386 weather stations across the country, wind energy resources in China were assessed according to the NDRC's "National Wind Resource Assessment Technical Requirements". The results of these assessments indicate that China's total onshore wind energy capacity measured at 10m height above the ground is theoretically as great as 430GW, with the technically feasible potential capacity at around 380GW in 200,000km<sup>2</sup> of land. In addition, China has a long coast line with 5~20m deep sea water. Using similar assessment methods to estimate the potential capacity of this area, China's 10m

above ground wind energy potential could be as much as 700GW off shore.



### Cumulative and annual installed capacity of wind power (1996-2006)

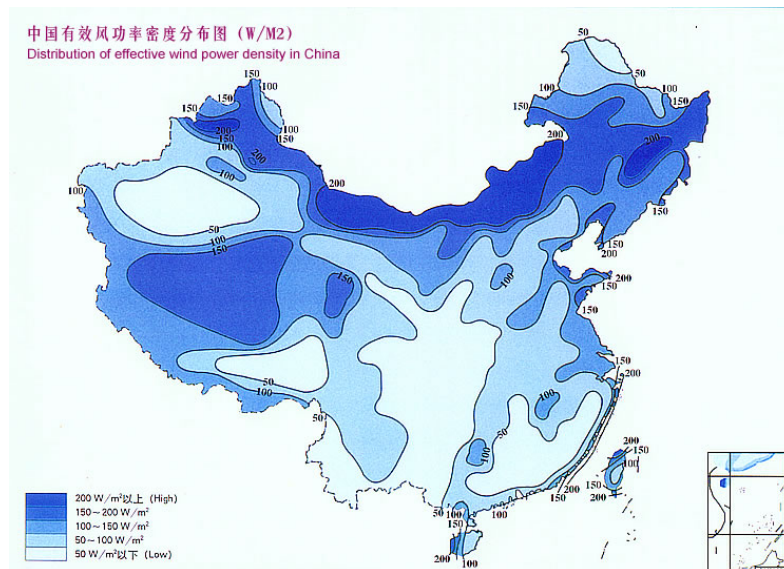
#### 1.2.2 Wind energy resource distributions

The wind-rich areas in China are concentrated mainly on the southeastern coastal line and nearby islands as well as throughout north China. In addition, there are several wind energy-rich locations at inland and near offshore areas. China’s four “wind belts” are:

- 1) Coast line and near-coast islands: the 10km wide coastal line belt along the east coast of Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Guangxi and Hainan provinces has an annual wind power density over 200W/m<sup>2</sup> and wind power density line parallel to the coast line.
- 2) Northern China wind energy rich belt: 200km belt along the Northeastern three provinces of Liaoning, Jilin and Heilongjiang, Hebei, Inner Mongolia, Gansu, Ningxia

and Xinjiang with over 200-300W/m<sup>2</sup> wind power density. Its wind power density reaches a maximum of 500W/m<sup>2</sup> in such areas as Alatawa region and Dabancheng in Xinjiang, Huitengxili and Huiliangteng in Inner Mongolia, and Weichang in Hebei's Chengde.

- 3) Inland wind energy rich areas: The wind power density is generally no more than 100W/m<sup>2</sup> in inland areas, but there are some wind resource rich areas due to landforms of lakes and special geographic characteristics.
- 4) Offshore areas with wind potential: along the eastern coastal areas with 5-20m deep area belt, it is estimated that 700GW wind energy potential can be utilized based on the assessment of wind resources at 10m height. In addition, these offshore wind areas are close to the major power load centers. As technologies for more cost effective wind farms develop further, the potential offshore wind power capacity will become a vital and sustainable power source.

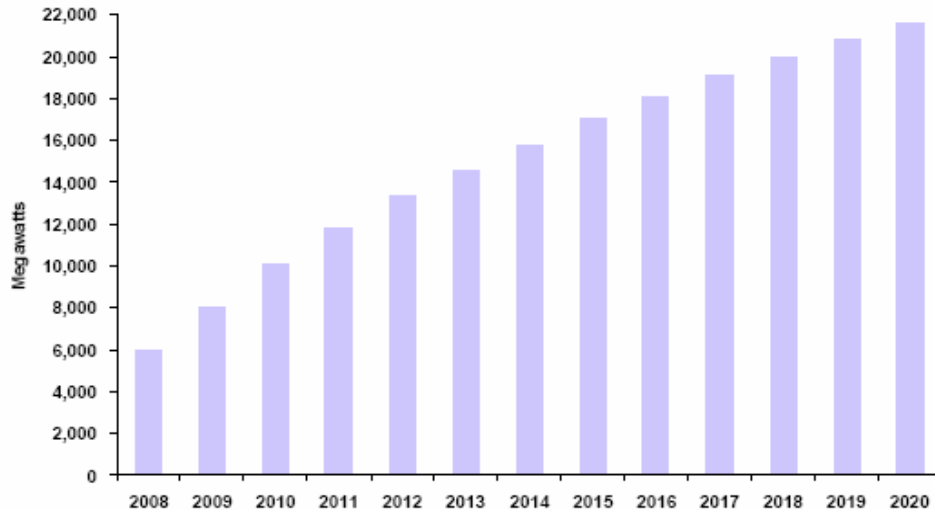


**Distribution of effective wind power density in China**

### 1.2.3 Wind power installations

During 2006, mainland China had 2443 newly installed wind turbine systems with total capacity of 4.332 GW. By the end of 2006, a total of 3307 wind turbine systems had been

installed at 100 wind farms. In 15 provinces, and with a total installed capacity of 2.6GW. the 2006 accumulated wind turbine installations increased 106% from the 1.26GW of capacity in 2005. The estimated grid-connected wind power generation in 2006 was as much as 5.1 billion kilowatts. For China’s wind power installation growth since 1986.



### Wind power installation in China

The market share of wind turbine producers in 2006 is: local manufactures took 45% of the market among which Xinjiang Goldwind was largest contributor, accounting for 33% of the new capacity. Around 80% of the new wind power installations used locally made equipment.

The pattern of installed wind power capacity by province remained relatively unchanged in 2006, but some differences in development became apparent. Installations in Inner Mongolia exceeded 500MW, accounting for 1/5 of the local installations nationwide, followed by Hebei, Jilin, Liaoning, Guangdong and Xinjiang provinces with installed capacity more than 200MW each. The number of provinces with installations over 100MW grew from 7 in 2005 to 11 in 2006, with Heilongjiang, Shandong, Gansu and Jiangsu provinces adding to the list.

## Provincial wind power installations in 2008

(Sorted by capacity, Unit kW)

	<b>Province/Municipality</b>	<b>2007total</b>	<b>2008 newly added</b>	<b>2008 total</b>
1	Inner Mongolia	1 563 191	2 172 250	3 735 440
2	Liaoning	515 310	734 450	1 249 760
3	Hebei	491 450	619 250	1 110 700
4	Jilin	612 260	457 200	1 069 460
5	Heilongjiang	408 250	428 050	836 300
6	Jiangsu	293 750	354 500	648 250
7	Gansu	338 300	298 650	636 950
8	Xinjiang	299 310	277 500	576 810
9	Shandong	350 200	222 100	572 300
10	Ningxia	355 200	38 000	393 200
11	Guangdong	287 390	79 500	366 890
12	Fujian	237 750	46 000	283 750
13	Zhejiang	47 350	147 280	194 630
14	Shannxi	5 000	122 500	127 500
15	Yunnan	0	78 750	78 750
16	Beijing	49 500	15 000	64 500
17	Hainan	8 700	49 500	58 200
18	Henan	3 000	47 250	50 250
19	Jiangxi	0	42 000	42 000
20	Shanghai	24 400	15 000	39 400
21	Hubei	13 600	0	13 600
22	Chongqing	0	1 700	1 700

23	Hunan	1 650	0	1 650
24	Hong Kong	800	0	800
	National sum	5 906 360	6 246 430	12 152 790

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### Accumulated capacity of wind power in the world

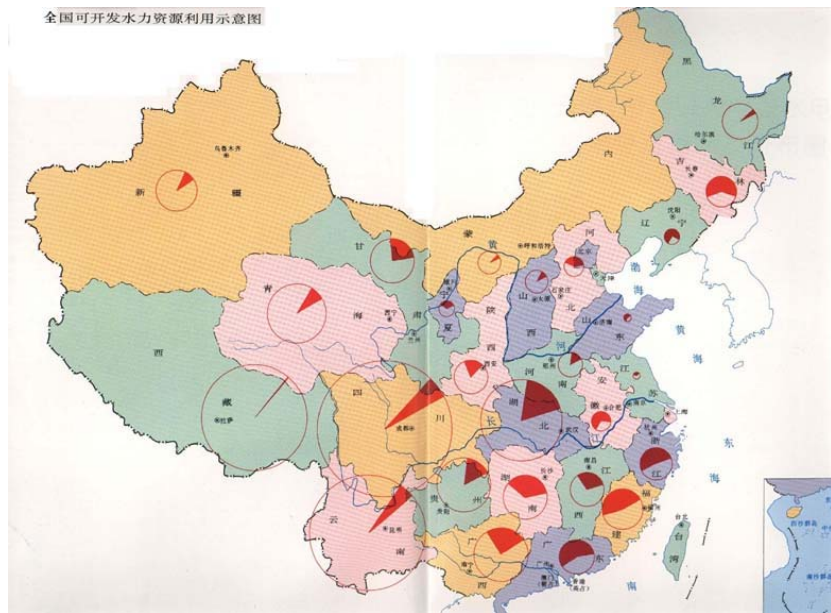
Country	Year							
	2001	2002	2003	2004	2005	2006	2007	2008
World	2390	3110	3930	4760	5910	7420	9382	12079
Europe	1730	2320	2860	3440	4050	4810	5653	6495
U.S.	425	465	635	675	915	1158	1682	2517
India	163	187	248	360	534	627	785	965
Japan	31	46	68	93	108	149	153	188
China	40	47	57	76	126	260	603	1227

### 1.3 Hydropower

Hydropower is one of the most important renewable energy resources in China. According to the results of 2003 National Hydropower Resource Assessment, China's total potential capacity of technically exploitable hydropower is 540GW, with an annual power generation potential of 2470 TWh. The total potential capacity of economically feasible hydropower is 400GW, with annual power generation potential of 1750 TWh. These hydropower resources are distributed mainly in the nation's western regions, with 70% of the total located in Southwest China and mainly concentrated in 9 resource rich rivers. Approximately 60% of the total economically feasible hydropower is characterized by technically exploitable features and sound power transport potential.

As of the end of 2006, the total installed capacity of hydropower in China had reached

129 GW, or 19% of total electricity generating capacity, with an annual power generation of 390 TWh. Small hydropower systems comprise 40 GW of this capacity, with an annual power generation of 140TWh supplying half of the territory, one third of all the countries and one fourth of the total population with power. Nationwide 653 hydropower primary rural electrification projects have been established, and 400 counties established with initial rural hydropower stations and 400 more electrification projects with main power supply dependent on small hydropower are under construction. China's hydropower exploitation, design, construction, installation and equipment manufacturing levels have reached international standards and have formed a complete industry system.

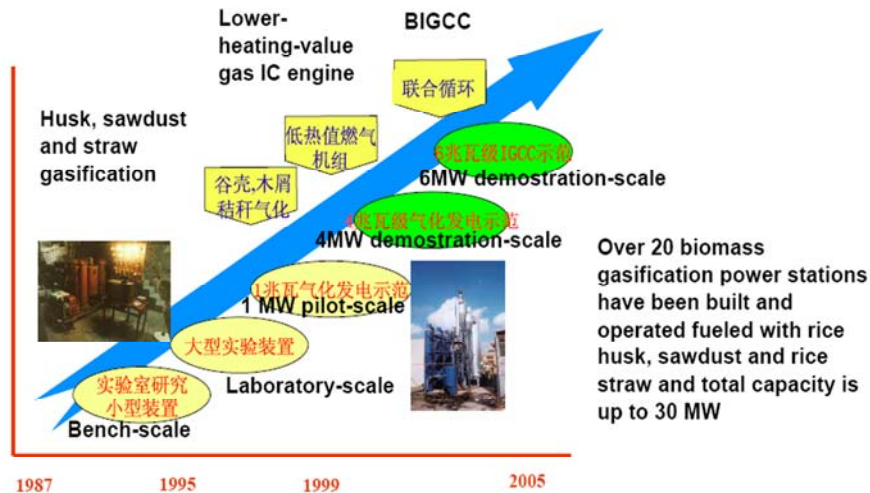


**China water resource distribution**

#### **1.4 Biomass energy**

Also China is rich of the biomass. Each year the cornstalk yield is more than 1.6 billion tons , 1.4billion tons of the animal dung, 20.6 billion tons of industrial organic waste water and residue, 0.11 billion tons of urban rubbish, 1.54 million tons of biogasse(2.5 million tons used to produce the paper), as well as the abundant of aquatic life and oil-bearing crops. Biomass power generation capacity is small in China, about 2000 MW

in 2005, down from 2300 MW in 2004, partly because of the high costs and difficulties of transporting biomass feedstocks to central locations, and the need for better combustion technology. The main feedstocks are deteriorated (rotted) grain.



### Technology progress and power generation scale of the Biomass Gasification Power Generation

Household-scale biogas for rural home lighting and cooking is a wide-spread application in China. About 17 million households have household-scale biogas digesters. Total biogas production was 8 billion m<sup>3</sup> in 2005, including about 1500 industrial scale biogas installations. A typical household-scale digester, sized 6-8 m<sup>3</sup>, produces 300 m<sup>3</sup> of biogas per year and costs 1500-2000 RMB (\$200-250), depending on the province. Because digesters are a simple technology, there is no need for advanced expertise, and they can be supplied by local small companies. Farmers, after receiving training, can build the digesters themselves. A new government program, started in 2002, provides 1 billion RMB annually as subsidies to farmers who build their own digester. The subsidy is 800 RMB per digester. Some estimate that more than 1 million biogas digesters are being produced each year.

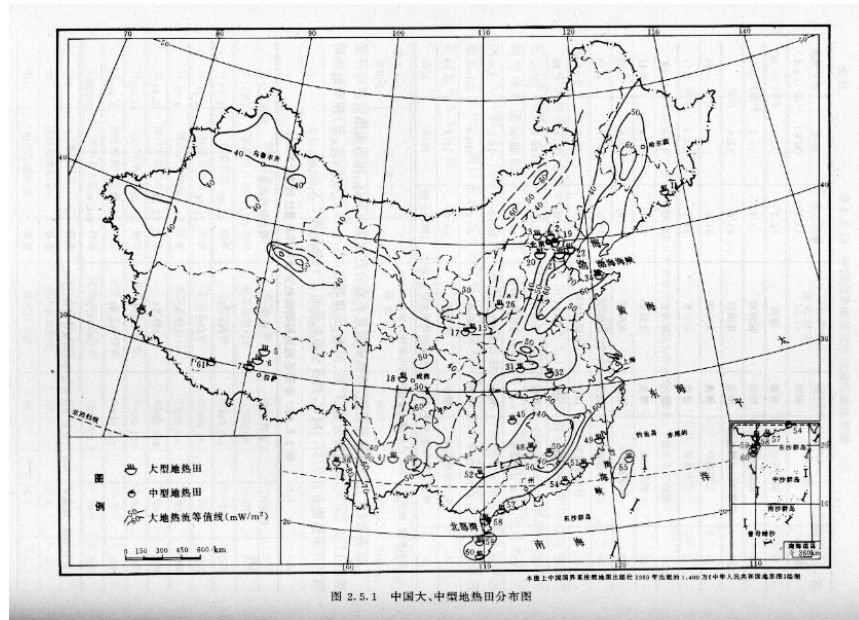
## Potential of available biomass resources

(100 million tce)

	2006	2010	2020	2030	Remarks
Agriculture residues	0.69	0.88	1.43	2.34	Practical amount will reach 500 millions tons
Forestry residues	0.63	0.71	0.91	1.16	Computed with 2.5% growth annually
Animal dung	1.07	1.21	1.55	1.98	Computed with 2.5% growth annually
Industrial organic wastes	0.39	0.44	0.57	0.73	Computed with 2.5% growth annually
Municipal Solid Wastes	0.025	0.03	0.07	0.15	Computed with 10% used and 8% growth annually
Energy crops	-	0.04	0.25	0.34	Exploitation ratio of backup farmlands and winter-free farm lands will reach 10%, 50% and 80% by 2010, 2020 and 2030, respectively
Energy forest	-	0.05	0.82	1.32	Exploitation ratio of backup woodlands and existing energy forests will reach 3%, 50% and 80% by 2010, 2020 and 2030, respectively
<b>Total</b>	<b>2.8</b>	<b>3.4</b>	<b>5.6</b>	<b>8.0</b>	

### 1.5 Geothermal energy

The application of geothermal energy in China has a long history. From the 70's last century, the research and development of geothermal in the world has been greatly advanced, and the Chinese geologists have finished the fundamental work for geothermal prospecting. The application technology is much behind in china. With the fast growing of national economy, the public, as well as the government recognizes the importance of clean and renewable energy, large scale development of geothermal energy is on the gate in China.



## Large and medium scale Geothermal energy distribution map of China

Obviously in the year of 2020, China will realize and surpass the current development goal of renewable energy. It can be forecasted that the installation capacity of renewable energy could reach 400GW (three times than 135GW in 2006), under the facilitation of the hydropower, biomass power and solar power. Under the stimulus of the current goal and policy, one third of Chinese family will use solar heaters, as for other renewable energies as the biogas and solar thermal power system will get definite development and increasement.

## 2. Executive summary

Renewable energy resources are abundant in China: two thirds of China's territory enjoys rich solar energy, total solar radiation per unit area of over 500GJ/m<sup>2</sup> that is around 1.7 trillion tce equivalent solar energy absorbed by the earth's surface. Potential national wind power capacity is 3200 GW, with immediately exploitable potential wind capacity estimated at 1000 GW. Based on the experiences of such advanced wind power users as Germany, Spain and Denmark, China's long term wind power capacity may even surpass 3000 GW. The estimated technically exploitable capacity of ocean energy is 400-500GW. Future reserves of geothermal energy are estimated at 135.5 billion tce, and proven

reserves are already at 3.16 billion tce. Existing biomass resources including straw, forest residues, organic MSW, and industrial organic wastes can provide 700 million tce worth of energy and this number could be doubled by improving breeding and extending energy crops. Thus, China has a significant renewable energy resource base and the technological potential to scale-up renewable energy development, thereby ensuring energy supply security for social and economic development in the future.

## **II Leading R&D institutions and national agencies**

### **2.1 Government Agencies**

#### **National Development and Reform Commission (NDRC)**

General Overview: National Development and Reform Commission (NDRC) is a comprehensive economic management commission which is in charge of formulating the National Economic Development Plan, Five Year plan and National Long-Term Program as well as approving large-scale projects. The NDRC is a macroeconomic management agency under the Chinese State Council, which has broad administrative and planning control over the Chinese economy. The NDRC's functions are to study and formulate policies for economic and social development, maintain the balance of economic development, and to guide restructuring of China's economic system.

Since 2005, the NDRC has Promulgate the related law and regulations to speed up the development of the renewable energies, as *the Development Guiding Catalogs of Renewable Energy Industry, The Eleventh-five-year Renewable Energy Development Planning, Mid-Long term Development Plan for Renewable Energy* and others. All these regulations has greatly speed up the development of the renewable energies in China.

#### **National Energy Administration (NEA)**

National Energy Administration (NEA) is responsible for formulating and implementing energy development plans and industrial policies; promoting institutional reform in the energy sector; administering energy sectors including coal, oil, natural gas, power (including nuclear power), new and renewable energy and etc.; taking charge of energy conservation, comprehensive utilization of resources in the energy sector; guiding scientific and technological advancement; organizing and coordinating key energy-related demonstration projects and promoting the deployment of new products, new technologies and new equipments; approving, reviewing, or examining fixed asset investment projects of the energy sector within national plans and the scale of annual plans in accordance with the authority stipulated by the State Council;

In accordance with relevant regulations of the State Council, The NEA is under the administration of the NDRC.

### **Chinese Ministry of Science and Technology (MOST)**

MOST is a ministry of the government of China which coordinates science and technology activities in the country. MOST takes the lead in drawing up S&T development plans and policies, drafting related laws, regulations and department rules, and guaranteeing the implementation; responsible for drafting the National Basic Research Program, the National High-tech R&D Program and the S&T Enabling Program etc.

The Energy Division of Industry and Technology Department is in charge of regulating and organizing significant science and technology projects concerning renewable energy technology.

### **Chinese Ministry of Housing and Urban-Rural Development**

Ministry of Housing and Urban-Rural Development provides housing and regulates the state construction activities in the country. Its Department of S&T and Energy Saving on Buildings mainly formulate policies and development programs for energy-saving of buildings and organize implementation accordingly.

Ministry of Housing and Urban-Rural Development and the Ministry of Finance jointly promulgated *“Implementing Opinion Concerning Speeding Up the Promotion of the Utilization of Solar Energy PV Power in Buildings”*, *“Interim Measures for the Administration of Government Subsidies of Building Uses of Solar Energy Photovoltaic Power”*, *Implementation Plan on Speeding-up the Utilization of the Renewable Energy Building in Rural Area* and *the Urban Demonstration Implementation Plan of Renewable Energy Building*. Although these regulations issued not for a long time, it has already made a great impact on society. It attracts more attention and the renewable energy investment will increase significantly.

### **Chinese Ministry of Finance**

MOF is a ministry of the government of China which formulates and implements strategies, policies and guidelines, medium-and-long-term development plan and reform programs of public finance and taxation; Preparing the draft annual budget of the central government. In 2008 and 2009 the MOF and other ministries jointly promulgated “*Implementing Opinion Concerning Speeding Up the Promotion of the Utilization of Solar Energy PV Power in Buildings*”, “*Interim Measures for the Administration of Government Subsidies of Building Uses of Solar Energy Photovoltaic Power*”, *Implementation Plan on Speeding-up the Utilization of the Renewable Energy Building in Rural Area and the Urban Demonstration Implementation Plan of Renewable Energy Building*. All these regulations have greatly speeded up the utilization of renewable energy.

### **Chinese Academy of Sciences (CAS)**

**Chinese Academy of Sciences (CAS)** is the national academy for the natural sciences with headquartered in Beijing, which institutes all over the China. It has also created hundreds of commercial enterprises with Lenovo being one of the most famous legacies. The Chinese Academy of Sciences has six sections: Mathematics and Physics, Chemistry, Life Sciences and Medicine, Earth Sciences, Information Technical Sciences, and Technological Sciences.

### **CAS Institutes on Renewable Energies**

#### **☞ Guangzhou Institute of Energy Conversion**

Guangzhou Institute of Energy Conversion(GIEC), Chinese Academy of Sciences(CAS), was founded in 1978, which mainly engages in the research field of clean energy engineering, Presently, the institute is subdivided into 8 research groups: solar, clean energy, biomass, solid wastes, industrial energy conservation, geothermal energy & heat pump, water & air treatment, and heat chilling. Among all theses research field, GIEC have set the biomass as its priority, the main research fields include biomass bio-chemical conversion technologies, biomass-based chemical production technologies, waste treatment and utilization technologies. The researches focus on biodiesel, fuel ethanol and gasification.

### ☞ **The Institute of Engineering Thermophysics**

The Institute of Engineering Thermophysics was founded in 1980, which engages in the research in the fields of energy, power and environment, including such disciplines as engineering thermodynamics, aerothermodynamics in turbo machinery, combustion and heat and mass transfer.

### ☞ **Institute of Electrical Engineering**

IEE is a national scientific research organization and initiated many leading basic researches in advanced energy & electricity technologies, modern electrical drive technologies, applied superconducting technologies, biomedical engineering and micro-nano fabrication technology, developed several high-strategic technologies.

IEE is also a leading institute in solar PV power system and solar thermal utilization system.

## **2.2 Association and Societies**

Types of the association and societies formed in China locates in different provinces and cities and played more and more important role in speeding up the development of renewable energy. Among it, the Chinese Renewable Energy Society, Chinese Rural Energy Industrial Association, Chinese Wind Energy Association and other provincial level societies and associations as Gansu Rural Energy Association bring together industry, science and politics in workshop, conference on renewable energy and provide advices to governments in policy making and sustainable development.

### **Introduction of Chinese Wind Energy Association**

Founded in 1981, CWEA plays as an intermediate in the field of wind energy, as a bridge between the government and the enterprises. Organize the conference, forum and exhibition on wind energy, also in charge of the journal *Chinese Wind Energy*.

## **2.3 Research institutes**

For the Energy Research Institutes:

- ☞ Guangzhou Energy Research Institute of Chinese Academy of Sciences
- ☞ Gansu Natural Energy Research Institute
- ☞ Energy Research Institute of Shandong Academy of Science
- ☞ Liaoning Energy Research Institute
- ☞ Zhejiang Energy Research Institute

Especially for the solar energy research institutes:

- ☞ Gansu Natural Energy Research Institute
- ☞ Solar Energy Research Institutes of Xi'an Jiaotong University
- ☞ Wind Energy Research Institutes of Shenyang Industry University
- ☞ Solar Energy Research Institutes of Shanghai Jiaotong University

Especially for the wind energy research institutes:

- ☞ Xiangjiang Wind Energy Research Institute
- ☞ Wind Energy Research Institute of Shenyang Industry University

### **Introduction of Gansu Natural Energy Research Institute**

Among all these research institutes, **Gansu Natural Energy Research Institute (GNERI)** is the first institute involved in the research and development of solar energy technologies. For the solar photovoltaic and solar thermal technologies are their primary focus. Gradually, the research focus has spread to Integration of Solar Power Generation and Solar powered Building Structures, solar thermal/photovoltaic power generation systems, thin-film PV cells and other new types of PV cells, buildings integrated with solar energy, low-cost and low-pollution production technology of high-purity silicon materials, the industrial application of solar thermal technology and so on. In recent years, GNERI also focus on the research of wind energy, biomass energy, solar water treatment and other energy-saving technologies. About the information in detail please see following:

**Gansu Natural Energy Research Institute (GNERI)** is mainly engaged in the studies and application of new and renewable energy, and solar energy technique, domestic and foreign technical cooperation and training, technical consultation and exchange, new product research and development on solar energy, technology promotion and transfer on solar energy in particular. At present, GNERI has already become one of the leading national research agencies; its academic level has been powerful to national advanced ranks and also well-known over the world. It is one of the main founding member units of the China South-South Cooperation Network, one of the “International Science and Technology Cooperation Base” granted by the Ministry of Science and Technology of People’s Republic of China and an Associated Institution of United Nations University within the overall framework of the UNU Environment and Sustainable Development Program, as well as one of UNIDO’ s agencies for technology promotion and transfer.

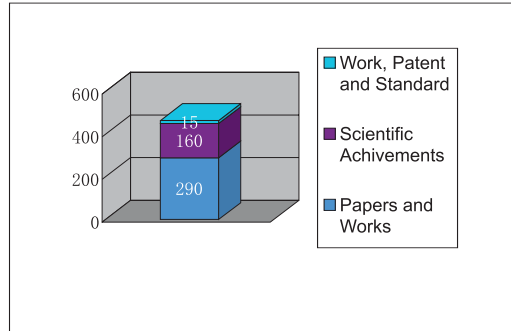
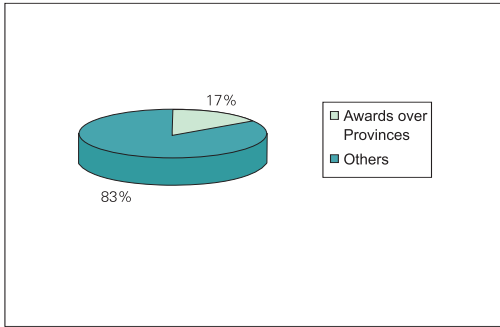


**Solar and other energy-saving technologies in the Building:**

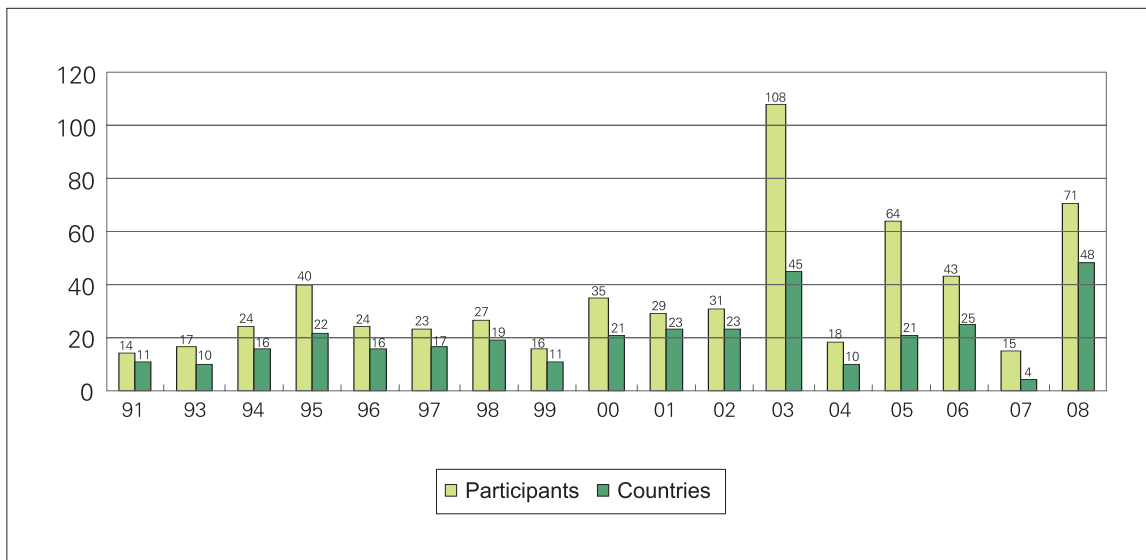
- Solar PV technology;
- Passive solar building technology;
- Solar water heating and circulating system;
- “Solar Wall” technology;
- Geothermal heat-pump system;
- Other energy-saving technologies;

**New office building of ISEC-UNIDO**

**R&D Achievements :** Since 1978, there are more than 130 scientific research achievements have been gained, of which 26 items obtained the award of national or provincial level. For example, *The Passive Solar Heating Technology for Building* won the unique national award of Advanced Science and Technology in the solar building field, 15 monographs and comprehensive tool books have been published. Besides, more than 290 papers have been published on domestic and international publications or international seminars.



**National and international trainings:** Under the support of Chinese governments at different levels, 70 domestic training workshops have been held by GNERI, with more than 10 thousand participants attended solar water heater, solar cooker, solar building, solar photovoltaic technique, energy saving and coal or firewood saving stove workshops. Furthermore, by the support of Chinese Ministry of Commerce, Ministry of Science and Technology, Ministry of Foreign Affairs, UN and relevant international organizations, GNERI has held “International Solar Energy Application Technological Training Workshop” over 28 times, and trained more than 800 solar energy talents for 104 countries in the five continents from 1991 to 2008.



**International Training Workshops (1991-2008)**  
 (Total: over 800 participants from 104 countries)

**International conferences and forums:** International conferences and forums are not only the way to spread technology and friendship, but also plays an active role in improving and strengthening the relationship between China and the other countries, developing countries in particular. GNERI has sponsored and hosted 12 international academic conferences or forums on solar energy and other renewable energies, together with the UN systems and other international organizations, concerned commissions and ministries of the Chinese Government, institutes as well as universities.



**Evaluation, Testing, Inspection and Consultancy** GNERI provides evaluation, testing, inspection and consultancy services for governments, enterprises, institutes and individuals. Up till now, GNERI has hired 12 senior consultants and 81 senior experts from China as well as from other countries, so as to provide good, reliable and extensive services. At the same time, experts and researchers from ISEC-UNIDO/GNERI has been invited by universities, associations, institutes and journal at home and abroad for evaluation, inspection and consultancy services

**Solar Energy Demonstration Center:** With the support from the Ministry of Science and Technology, Ministry of Commerce of PRC and Gansu Provincial Government, GNERI has successfully carried out the two phases of UNDP projects on solar energy utilization, set up the “Solar Energy Heating and Cooling Technology Experiment and Demonstration Center” in the outskirts of Lanzhou city, which is the biggest one in Asia covering 80 thousand sq meters. The center is equipped with the advanced testing

instruments for photovoltaic and solar heating technique, and can serve as an excellent platform for the research and experiment of applied technology, the research and development of high-technology product, the national and international technology cooperation and exchange, and the personnel training. Through 30 years' hard work, GNERI has grown from a recipient of technology assistance unit into a successful technology provider and an international agency under UNIDO. In Dec 2007, GNERI got the award of the "*Foreign bases of international cooperation*" by the Ministry of Science and Technology of People's Republic of China.



## 2.4 Famous Enterprises

### Solar PV market development

The Chinese solar PV sector is developing into a specialized, scaled-up and internationalized producer in the global solar market. Wuxi Suntech was ranked as the world's 8<sup>th</sup> largest solar cell producer with 82MW annual capacity in 2005. After going public in December 2005, it had material supply contracts worth US\$ 6 billion and purchased Japan's MSK in 2006. The landmark event demonstrated that the Chinese solar PV sector can compete in the international market. The Jingling Group produced 1126 tons mono-crystal direct-pulling silicon ingots in 2005 and has become the world largest supplier of this product. Several MW capacity ingot and cell producers emerged in 2006,

making the Chinese silicon sector even more specialized, scaled-up and international. These internationally advanced enterprises are building their capacity for a healthy and mature Chinese PV industry. At the same time, this industrial development had trained and excellent group of entrepreneurs and technical teams in the solar industry, which in turn promotes Chinese solar technology development.

#### Top 10 global PV producers (2008)

Ranking in 2008	Manufacturer	Country of Origin	Annual production (MW)
1	Q-Cells	Germany	574.2
2	First Solar	USA	503
3	Suntech	China	497.5
4	Sharp	Japan	473
5	Kyocera	Japan	290
6	Tianwei Yingli	China	281.5
7	JA Solar	China	277
8	Motech	China	272
9	Sun Power	USA	237
10	SANYO	Japan	215

#### Monosilicon ingot production in China, 2005-2007(ton)

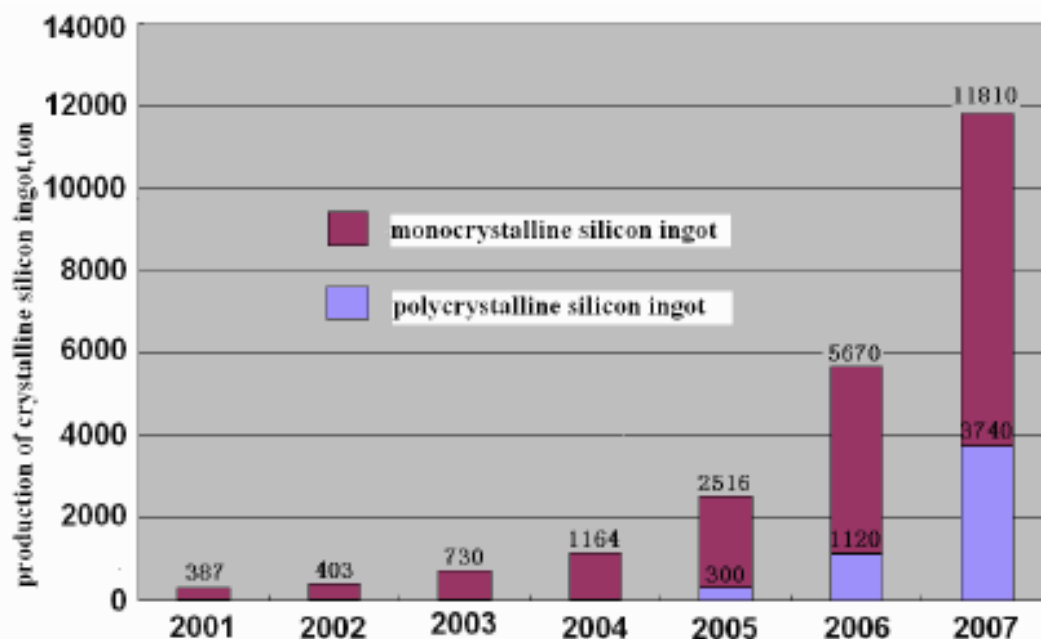
	Manufacturer	2005	2006	2007
		Output	Output	Output
1	Ningjin Jinglong	1126	1250	1500
2	Zhejiang renesola Co. Ltd	300	750	1100
3	Jinzhou Xinri Silicon material Co. Ltd	400	750	900
4	Yangzhong Huantai	-	350	900
5	Changzhou Trina Solar Co. Ltd	-	300	680
6	Yanzhou Shunda Group	100	250	500

7	Shanghai COMTEC Ltd	-	30	450
8	Changzhou Eging Photovoltaic technology Co. Ltd	80	200	300
9	Jiangyin Hairun	-	40	200
10	Beijing Langfang	-	100	150
11	Zhejiang Jiashan	-	-	120
12	Inner Mongolia Huhehaote	-	-	100
13	Zhejiang Kaihua	-	70	100
14	Shanghai wafer work PROP	-	30	80
15	Shanghai Songjiang	-	30	70
16	Xinjiang Sunoasis Co. Ltd	-	-	60
17	Huzhong Xinyuangtai	-	-	50
18	Shanghai Jiujing	-	20	50
19	Tianjin Huano	-	20	40
	Others	210	360	710
	<b>Total</b>	<b>2216</b>	<b>4550</b>	<b>8070</b>

### Polysilicon ingot production in China, 2006-2007(ton)

Company	2005	2006	2007		
	Output	Output	Furnaces	Capacity	Output
LDK solar Co. Ltd	—	450	150	4000	2300
Tianwei Yingli New Energy Resources Co. Ltd	260	550	40	2000	1200
Changzhou Trina solar Co. Ltd	—	—	25	700	120
Jingong P-D Shaoxing solar energy technology Co. Ltd	—	80	8	132	80
Zhejiang Sino-Italian Photovoltaic Co. Ltd	40	40	4	90	40
Total	300	1,120	227	6,922	3,740

**Production of solar grade silicon ingot in China, 2001-2007(ton)**



### **Solar thermal market development**

China's SWH installations make up 60.6% of the world total capacity. 75.8% of the new SWHs in 2006 were installed in China, making China the world's biggest consumer of SWHs. However because of its huge population, China's per capita SWH installation rates in 2004, 2005 and 2006 were only 48m<sup>2</sup>, 57m<sup>2</sup> and 69m<sup>2</sup> per thousand people respectively. This is higher than the global average (38m<sup>2</sup>/thousand people in 2004), but far lower than the international best practice.

China is currently a period of rapid economic and social development, and as a result people's demand for bathing water is growing tremendously. The solar water heater sector will keep growing in the expanding market in large Chinese cities due to the following trends: ever-rising prices of conventional energy products, greatly increased demand for hot water, improved environmental awareness among the public, upgraded SWH products and development of building-integrated solar thermal technologies.

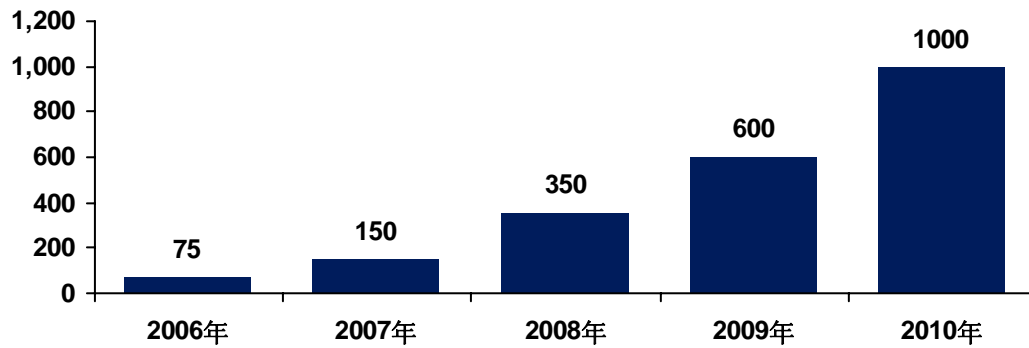
### 1988~2008 SWH yearly production and installation

Year	Total production		Annual Growth (%)	Installation		Annual Growth (%)
	10 <sup>4</sup> m <sup>2</sup>	MW <sub>th</sub>		10 <sup>4</sup> m <sup>2</sup>	MW <sub>th</sub>	
1998	350	2450	-	1500	10500	-
1999	500	3500	43	2000	14000	33
2000	640	4480	28	2600	18200	30
2001	820	5740	28	3200	22400	23
2002	1000	7000	22	4000	28000	25
2003	1200	8400	20	5000	35000	25
2004	1350	9450	12.5	6200	43400	24
2005	1500	10500	11.1	7500	52500	21
2006	1800	12600	20	9000	63000	20
2007	2300	16100	30	10800	75600	19.4~20
2008	2800	19600	22	12850	89950	19

### Introduction of Trina Solar in Changzhou, China

Trina Solar Limited (TSL) is an internationally recognized manufacturer of mono and multicrystalline photovoltaic (PV) modules and has a long history as a solar PV pioneer since it was founded in 1997 as a system installation company in China. The high-quality PV modules provide clean and reliable solar electric power to on-grid and off-grid residential, commercial, industrial and utility scale applications around the world. Trina Solar produces and commercializes a wide variety of photovoltaic (PV) modules, both monocrystalline and multicrystalline, with power outputs ranging from 165W to 230W so as to sell and market its products in number of European countries, such as Germany, Spain, Italy, Netherland, France, and Belgium, where government incentives have accelerated the adoption of solar power. Trina Solar also targets in emerging PV markets such as France, the United States, South Korea, India, Australia, China and Mongolia. Trina Solar sells its products to distributors, wholesalers and PV system integrators

around the globe.



**Yearly Production Capacity (MW)**

The listing in the New York Stock Exchange (NYSE) in December 2006 and the subsequent follow-on stock offering in June 2007 and convertible bond in July 2008 have allowed Trina Solar to successfully execute its expansion plans, guarantee a rapid increase of production capacity and ensure procurement of raw materials. At the same time, the listing in the NYSE and support of international investors has allowed the company to attract talent from around the world. Today, Trina Solar has a team with employees from over a dozen nations with significant PV industry experience, who contribute each day to the success of the company.

### **Windpower market development**

So far there are 70 off-grid wind power system producers in China, including 35 companies affiliated with universities and institutes, 23 specialized manufacturers and 12 component providers(for batteries, blades and converters, etc.). In 2006, China produced 30,000 wind generators with single system capacity under 30KW, an increase of 34.4% from 2005, within which the 200W, 300W and 500W systems accounted for 72.5% of the total annual production.

**Cumulative market share of Domestic and Chinese-Foreign Joint Venture Owned Manufacturers by end of 2008**

<b>Manufacturer</b>	<b>Capacity (KW)</b>	<b>Percentage of domestic and Chinese –Foreign joint venture owned manufacturers</b>	<b>Percentage of Cumulative Total capacity</b>
Goldwind	2629050	35.02%	21.63%
Sinovel	2157000	28.74%	17.75%
DEC	1290000	17.19%	10.61%
Windey	330250	4.40%	2.72%
CASC-Acciona	250500	3.34%	2.06%
Sewind	201250	2.68%	1.66%
Mingyang	175500	2.34%	1.44%
XEMC	12800	1.71%	1.05%
New Unite	82500	1.10%	0.68%
BEIZHONG	60000	0.80%	0.49%
OTHERS	202170	2.69%	1.66%
Total	7506220	100.00%	61.76%

**Introduction of Goldwind Science & Technology Co., Ltd.**

Goldwind Science & Technology Co., Ltd. specializes in R&D, product development and the manufacturing of large-sized wind turbines. According to the report of the Goldwind in 2007, the company has been holding 25.25% market share in China's wind power market, ranking top amongst other suppliers. By the end of 2008, Goldwind's total capacity of wind turbines reached 2889MW, saving 14.445 million tons of standard coal and reducing carbon dioxide emissions of 5,760,700 tons, 173,300 tons of sulfur dioxide, and 86,700 tons of nitrogen dioxide. This is equivalent to recycling 3,147,900 cubic meters of forest to create substantial environmental benefits.

Also Goldwind has carried out part of the Beijing Olympic Projects—Guanting Wind Farm, which has supplied power to grid up to 80 Million KW per hour, with availability 95.41%. Furthermore, Goldwind also accomplished the Marine Wind Power Project, the China's first marine wind power generator on Bohai Sea. The project equipment

consisted of Gold wind's permanent-magnetic direct-drive generator unit(1.5MW), which is the first wind power project in the world to supply power to marine oil field.

## 2.5 Media

For the formal published journal on renewable energy in China, there is more than 40 types, however, all the journals at present are published in Chinese. Among these, the famous are *Solar Energy* issued and published by the Chinese Renewable Energy Society, *Energy of China* by Energy Research Institute of National Development and Reform Commission, *Renewable Energy Resources* by Liaoning Provincial Energy Research Institute, *China New Energy* by Guangzhou Energy Institute of Chinese Academy of Sciences, *Energy Research & Utilization* by Jiangsu Provincial Energy Research Society, *Acta Energiae Solaris Sinica* by the Chinese Renewable Energy Society, *Geothermal Energy* by Tianjin University and *Small Hydro Power* by Bureau of Rural Hydropower and Electrification Development, Ministry of Water Resources.

The new policy and the technology development trend etc are contained in these journals. Except that types of the websites have showed more and more advantages. Such as some website about the energy and renewable energies: <http://www.china5e.com/>, [www.newenergy.org.cn](http://www.newenergy.org.cn) etc and some about the solar energy: [www.cn-solar.net](http://www.cn-solar.net), [www.21tyn.com](http://www.21tyn.com) also some about wind energy: [www.cnwee.com](http://www.cnwee.com), <http://www.cnwp.org.cn>. Etc.

### **III Policies**

#### **3.1 Renewable Energy Law**

##### **3.1.1 Background of RE Law**

The Chinese Government has tried to adopt energy investment policies which include developing renewable energy and other new energy sources. However, China's energy legislation process is relatively slow. This is a common issue and China's renewable energy legislation is no exception. As China's energy legislation is carried out. Some similar laws (Electricity Law, Resource Saving Law, Building Law, Prevention of Large Gas Pollutants Law, etc) involved measures to promote the development of renewable energy. But all in all, before the Renewable Energy Law came out, renewable energy's development came mainly through state-level regulatory development, such as the State Planning Commission's (now the NDRC) New Energy Basic Infrastructure Project Management Rules (1997), the Management Measures on Straw Combustion and Comprehensive Utilization(2003) by the State Environmental Protection Agency(SEPA).

Following the Chinese economy's rapid development, a gap between energy supply and demand has emerged. The energy problem grows more serious every day and traditional pattern of energy exploitation and utilization are causing daily deterioration of China's environmental problems. Given these increasingly serious issues, speeding up the development of renewable energy has already become the Chinese governments' major strategic energy choice. In order to promote the development and utilization of renewable energy and deal with the barriers standing in the way of realizing this goal, the 2003 the tenth session of the Standing Committee, National People's Congress took development of the RE Law into the schedule for the year 2003 legislation, and was passed on February 28,2005 and put into effective on January 1, 2006

##### **3.1.2 Systems established in the RE law**

- Establishing national targets
- Grid connection priorities

- Classifying tariffs for Renewable Power
- Sharing cost at national level
- Renewable energy special fund
- Policy on favorable credit and Favorable tax treatment

### **3.1.3 Major tasks for regulations' formulation**

- National General Targets
- National RE plan
- Grid-connection pricing mechanism
- Cost-sharing measures
- Concrete economic incentives
- Financing backup measures in rural regions
- Renewable Energy Development Special Fund
- Guided Catalog for the Renewable Energy Industry Development
- Technical criteria—Solar integrating building
- Technology criteria—RE resource investigation and assessment
- Technology criteria—RE grid connection and other national standards
- Make clarification for hydro power how to be applicable for the RE law

### **3.1.4 The five regulations of the RE Law**

Based on the countries' experience in this area, the state has a clear responsibility to promote the development of renewable energy, extra costs incurred by the development and utilization of renewable energy must be shared by all consumers. Otherwise large-scale adoption of renewable energy will not be possible. The government's main responsibility lies in building, regulating and standardizing the market for renewable energy, thereby using the market structure to enable and encourage mainstream development and utilization of renewable sources in the market. In this vein, the Chinese Government had put forth five major regulations in the RE Law: the Renewable Energy Target Policy, Feed-in Law, Categorized Pricing, Cost Sharing and Special Fund Mechanisms.

- (1) **Renewable Energy Target Policy.** To define the national target for renewable energy development and to identify phased development goals, as well as clarifying

which fields or sectors will be supported, encouraged, constrained or designated for investment. The accelerated development of China's renewable energy industry should be promoted by a combination of government encouragement and market guidance.

- (2) **Feed-in Law.** As a condition for energy sale network's monopoly operating and licensed operating, the enforcement of the feed-in law will ensure the development of the renewable energy industry's basic system. This law will reduce transaction costs, shorten renewable energy projects' market entry lifecycle, and increase credit for project financing, thereby contributing to overall development of the renewable energy industry.
- (3) **Categorized Pricing Mechanism.** To categorize the price of the power generated according to various costs of different renewable energy technologies and to develop and publicize the reasonable fixed electricity price or bidding price.
- (4) **Cost Sharing Mechanism.** To ensure fairness in policy and laws, and to ensure that citizens fulfill their obligations and the state fulfills its responsibility, the extra cost of renewable energy should be shared equitable among different regions. The cost-sharing mechanism effectively resolves the problem of unfair cost burdens between regions and businesses, thereby promoting the large-scale development and utilization of renewable energy.
- (5) **Special Fund Mechanism.** The cost sharing mechanism described above will resolve most problems with the extra cost of renewable energy. Further cost-related bottlenecks in the development and utilization of renewable energy will need to be solved through special channels, necessitating the establishment of a Renewable Energy Special Fund to support such fields the cost sharing mechanism cannot cover, such as financial support for renewable energy research and development.

### **3.2 Strategic Plans and Development Targets**

At present, the Chinese Government is in the processes of formulating its *Medium and Long-term Energy Development Strategy and Plan to 2020*. This work will set forth the basic principles, strategic targets, and relevant guarantee measures for renewable energy

in China up until 2020. The basic principles of the energy strategy and plan as relates to renewable energy are as follows:

1. Support the harmonious development of society, the economy, and the environment, with priority on the development of renewable energy technologies that are closely related to the realization of achieving China's goal of a basic level of comfort for all citizens. These technologies include mainly PV, small hydropower and other renewable energy technologies, which can resolve the basic needs for electricity in rural areas. This principle also calls for improvement in the quality of energy used by rural residents, which can be achieved through biomass energy technologies, particularly biogas technology, which can promote the development of ecological agriculture and organic food products.
2. Stress should be put on the development of small-scale hydropower, solar water heaters, geothermal heating and other renewable energy technologies that are already competitive on the market. The share of renewable energy in overall energy consumption should be raised as rapidly as possible, so as to make a strong contribution to the adjustment of China's energy consumption mix.
3. The commercialisation of new and developing renewable energy technologies should be promoted actively. In particular, wind power and biomass power generation, for which resources are vast and commercialisation prospects good and which both can play a very important role in improving the structure of China's energy mix in the future, should be promoted through adoption of necessary measures to stimulate market demand, technical progress, and growth of manufacturing capability.

Long-term technical progress should be integrated with short-term development and utilization. Renewable energy technologies that have both a market at present and great potential for the future should be actively developed. PV technology should be developed so as to serve in speeding up the realization of rural electrification in the short term and to accumulate technical results for large-scale grid-connected PV in the future.

Ethanol gasoline and bio-diesel technologies should be developed through pilots and demonstration projects in the short-term to establish the necessary basis for future development; and strategies and technologies for long-term development should be pursued, so as to realize large-scale use and the supplementing of China's insufficient petroleum supply.

### **3.3 Other renewable energy policy and regulations**

In March of 2009, the Ministry of Finance and Ministry of Housing and Urban-Rural co-promulgated *“Implementing Opinion Concerning Speeding Up the Promotion of the Utilization of Solar Energy PV Power in Buildings”* and Ministry of Finance promulgated *“Interim Measures for the Administration of Government Subsidies of Building Uses of Solar Energy Photovoltaic Power”* According to the subsidies provision, the bench mark of subsidy is 20 yuan per kilowatt and after subsidy support, the cost of electricity generating will be approach to 1 yuan per kilowatt hour. The subsidy would be set aside for upper 50KW project, whereas, the normal installation capacity of family PV system is 3 to 4 kilowatt. Hence, the subsidy programme is not fit to family use. Besides, *the Implementing Opinion* and *the Interim Measures* both are not in involved in *“Network Feed-in subsidy”*. The intent of government is procuring experiences of policy implement and promulgating more resultful measures consequently. Anyhow, these two implement promulgation have profound meanings to Chinese solar PV development.

In July 2009, the Ministry of Finance and the Ministry of Housing and Urban-Rural Development jointly promulgated *Implementation Plan on Speeding-up the Utilization of the Renewable Energy Building in Rural Area* and *the Urban Demonstration Implementation Plan of Renewable Energy Building*. The first implementation plan has clearly showed the subsidy standard: 60 Yuan/m<sup>2</sup> for the Ground-source Heat Pump technology, 15 Yuan/m<sup>2</sup> for the integration between the building and solar thermal technologies, for the stand-alone solar bathroom and solar houses the subsidy will account for 60%. The second implementation plan shows that the central government will provide 50 million to 80 million Yuan as subsidy fund.

#### **IV Institutional infrastructure and incentives available for the promotion and utilization of renewable energy in the country**

Renewable energy is a source with tremendous potential. China has taken it as strategic goal to greatly develop and promote it and has announced serials of laws and regulations. Among them, the renewable law has played important role and since that the renewable energy market expanded rapidly.

Some systems and policies established in renewable energy law as: System on establishing national targets; System on grid connection priorities; System on classifying tariffs for RE electricity; System on sharing cost at national level; System on renewable energy special fund; Policy on favorable credit and favorable tax treatment.

And at the same time, it also includes many implementation regulations to promote the renewable energy as: Make the decision for hydro power how to be applicable for the RE Law; Study and establish the technology criteria for renewable energy resource investigation; Study and establish national middle and long-term target of the total volume for the development and utilization of renewable energy. In second paragraph, the related departments of the State Council with the local people's government of province, municipality and the municipality directly under the Central Government develop the local renewable energy development middle and long-term target; Develop the national plan for the development and utilization of renewable energy. The Energy Authority of the local people's government of province, municipality and the municipality directly under the Central Government is responsible for the local plan of the development and utilization of renewable energy; Study and establish the Guide Lines for the Renewable Energy Industry Development; Study and establish the technology standards on renewable energy power grid connection and other national standards on renewable energy technology and product which need uniform requirement in the national level; Study and establish the economic technology policies and technical criteria on integrating building with the solar utilization system; Study and establish the concrete methods for providing financial supports to the related renewable energy utilization projects in rural regions; Study and establish the grid connecting electricity

price for the renewable energy power generating projects; Study and establish the concrete method for the national cost sharing to the grid connecting electricity payments for the renewable energy power generating projects; Study and establish the management method for the Renewable Energy Development Special Fund; Study and establish the concrete methods on interest subsidy from finance and favorable revenue for renewable energy.

All these measures has given the confidence and hopes to the renewable energy industry, the objectives and targets set up to the renewable energy: To increase the proportion of RE in total energy consumption; to resolve the problem of lack of electricity in rural areas; to promote the development of renewable energy industries and by 2010 to raise the share in total primary energy consumption

Here specially list some incentive policies for PV in China in the Renewable Energy Law  
For Grid-connected PV:

Article 14 — Grid enterprises shall enter into grid connection agreement with renewable power generation enterprises that have legally obtained administrative license or for which filing has been made, and buy the grid-connected power produced with renewable energy within the coverage of their power grid, and provide grid-connection service for the generation of power with renewable energy.

Article 19 — Grid power price of renewable energy power generation projects shall be determined by the price authorities of the State Council in the principle of being beneficial to the development and utilization of renewable energy and being economic and reasonable, where timely adjustment shall be made on the basis of the development of technology for the development and utilization of renewable energy. The price for grid-connected power shall be publicized.

Article 20 — The excess between the expenses that power grid enterprises purchase renewable power on the basis of the price determined in Article 19 hereof and the expenses incurred in the purchase of average power price generated with conventional energy shall be shared in the selling price. Price authorities of the State Council shall prepare specific methods.

For Off-grid PV:

Article 15 — The Government supports the construction of independent renewable power systems in areas not covered by the power grid to provide power service for local production and living.

Article 22 — For the selling price of power generated from independent renewable energy power system invested or subsidized by the Government, classified selling price of the same area shall be adopted, and the excess between its reasonable operation, management expenses and the selling price shall be shared on the basis of the method as specified in Article 20 hereof.

«Renewable Energy Law» and the « Implementation Rules» (N0.7, 2006 NDRC)

Article 14 — Fully purchasing the grid-connected power produced by RE;

Article 19 — Feed-in tariff should be set to cover reasonable cost plus reasonable profits;

Article 20 — The excess cost between PV feed-in tariff and the tariff of conventional power will be shared by whole grid in China.

## **V Financial institutions supporting RE projects**

In China, the renewable projects mainly funded and managed through the national or provincial projects. As we have mentioned that the National Development and Reform Commission, National Energy Administration, Ministry of Science and Technology, Ministry of Housing and Urban-Rural Development, Ministry of Finance and the departments in provincial levels. Such as the *Sino-Japan International Cooperation Project*, “*Wind Power Irrigation Project*” in desert is funded by the Chinese Ministry of Science and Technology and co-funded by the Japanese Government and implemented by the Gansu Natural Energy Research Institute, Kyushu University, Tsinghua University.

## **VI Scope for utilizing renewable energy in the country**

On 18 March 2008, China Development and Reform Commission has issued the *11<sup>th</sup> Five-Year Plan for Renewable Energy Development*, on the base of the *Mid-Long Term*

*Development Plan for Renewable Energy.* The plan puts forward the main task, guideline, development goal, focused field, measurements and stimulus policies.

ITEMS	UTILIZATION	ANNUAL YIELD	Tce Ton/year
I. power generation	205.88 million watts	710.6 billion W/h	248.24 million
1. hydropower	190 million watts	665 billion W/h	232.75 million
2. in-grid wind power	10 million watts	21 billion W/h	7.35 million
3. small standalone wind power		80 million W/h	30 thousand
4. solar PV	0.3 million watts	540 million W/h	190 thousand
5. biomass power generation	5.5 million watts	24 billion W/h	7.92 million
☞ agriculture and forestry power generation	4 million watts	16 billion W/h	5.28 million
☞ biogas power generation	1 million watts	5 billion W/h	1.65 million
☞ garbage power generation	0.5 million watts	3 billion W/h	990 thousand
II. Biogas		19 billion m <sup>3</sup>	13.65 million
☞ Household produced	40 million households	15 billion m <sup>3</sup>	10.86 million
☞ Large animal farm		1 billion m <sup>3</sup>	500 thousand
☞ Waster organic water produced		3 billion m <sup>3</sup>	2.29 million
III. Heat supply			31.3 million
☞ Solar water heater	150 million m <sup>3</sup>		27 million
☞ Solar cooker	100 million sets		300 thousand
☞ Geothermal		100 million GJ	4 million
For heat	30 million m <sup>3</sup>		
For hot water	600 thousand households		
IV. Fuel			3.8 million
☞ Biofuel	100 million tons		500 thousand
☞ Fuel Ethanol	300 million tons		3 million
☞ Biodiesel	0.2 million tons		300 thousand
<b>Total</b>			300 million tons

The strategy for renewable energy development in the Government's energy plan calls for making use, by 2020, of most of the available resources for small-scale hydropower, solar thermal (i.e. solar water heaters), geothermal, and other renewable energies that are already competitive on the market. It further calls for actively promoting the

commercialization and development of related manufacturing capacity for wind power, biomass power generation, and solar energy-based power generation, so as to basically realize full commercialization and large-scale application by 2020.

Specific targets for renewable energy, as indicated in the Government's energy strategy and plan, include the following: By 2010, the installed capacity of small-scale hydropower, wind power, biomass power, geothermal power, and power generated by solar energy will total about 60 GW and account for about 10% of China's total installed power generation capacity. Of this, small-scale hydropower will account for 50 GW; wind power will account for 4 GW; biomass power generation will account for 6 GW; and power generated by solar energy will account for 450 MW. By 2020, the installed capacity for power generated by renewable energy will reach about 121 GW, accounting for about 12% of China's total installed power generation capacity. Of this, small-scale hydropower will account for 80 GW; wind power will account for 20 GW; biomass generated power will account for 20 GW; and power generated by solar energy will account for 1 GW. At the same time, great emphasis will be put on technologies using renewable energy to supply heat and on liquid biofuels, etc., so that the target of providing, by 2020, 200 million additional tons annually of standard coal equivalent (tce) of renewable energy of all types in the energy mix. This amounts to an additional 8,000 PJ, which would bring China's annual use of renewable energy up to 20,000 PJ and up to a 17% share in China's projected energy consumption in 2020.

## **VII Indigenously developed RETS**

### 1) Solar technologies

#### a. crystalline silicon solar cell technology

Crystalline silicon cell is still the mainstream of solar cell development. The key Chinese technologies should include: manufacturing cheap solar silicon materials, super thin cutting technologies and bonding equipment development, and new generation crystalline silicon cells.

#### b. Thin film cell technology

There are two major types of thin film solar cell technologies, i.e. silicon and non-silicon cells. China will focus R&D on manufacturing equipment and master equipment, and on developing new thin film cell technology.

#### c. Solar power utilization technology

Several critical technologies for expanding the market may include: desert solar station technology, high voltage and low voltage grid-connected solar generation systems and system stabilizing technologies and equipment.

### 2) Wind power technology

#### a. Off-grid wind generator system

Targeted users of off-grid standalone wind power systems are farmers in remote areas without networked power supply. As rural living standards improve and the number of electrical appliances used in rural households increases, required capacity for a single wind turbine unit has increased. The 50W system are no longer produced and the market for 100W and 150W systems is dwindling; instead, annual production for 200W, 500W and 1000W wind generator systems is increasing, allowing these larger models to account for 80% of annual output.

#### b. Grid-connected wind farms

In 2004, the NDRC started a “Wind power Concession Program”, which aims to reduce the on-grid wind power tariff by building large capacity wind farms and achieving scale cost effectiveness. Investors and developers are selected for wind power concession projects through a competitive bidding process in order to improve domestic manufacturing capacity and reduce costs and tariffs.

### 3) Biomass technology

#### a. Direct combustion technologies

Direct combustion technologies basically consist of biomass stove burning, biomass boiler burning, waste incineration and dense biomass fuel pellet combustion. Motivated by the implementation of the “Building a New Socialist Countryside” program and benefiting from the rising prices of crude oil and coal, the biomass fuel molding industry is gradually regaining its growth.

#### b. Power generation technologies

Small scale biomass power generation through combustion has been successfully commercialized. A number of sugar refinery factories in south China generate power from bagasse. There are 380 small power generation facilities in Guangdong and Guangxi Provinces with installed capacity amounting to 800MW.

#### c. Biomass pyrolysis technology

Biomass pyrolysis technology is similar to coal processing technology. It makes gas, charcoal, wood tar and wood vinegar products from straw, branches and leaves, grass, sawdust, husks and seeds through air-isolated pyrolysis.

#### 4) Geothermal technology

Geothermal direct utilization requires lower temperature of underground hot water so that middle and low temperature geothermal resources can be utilized for heating, greenhouse planting, bathing and medical treatment.

Geothermal heat pump is one of important geothermal direct utilization technologies. It is widely applied as a distributed heat source. The heat pump can use widely available low temperature geothermal sources or reuse discharged geothermal waste water at 30~40°C to provide service. Due to energy resource shortages, heat pump technology is receiving more and more attention and has been applied at office buildings, hotels and residential buildings, with over 10% annual growth.

## **VIII Case study on utilization of RETs**

a. Sino-Japan International Cooperation Project, “Wind Power Irrigation Project” in desert.

Under the fund support by NEDO of Japan, Gansu Natural Energy Research Institute cooperated with Kyushu University, Tsinghua University set up an experiment and demonstration project of irrigation by using wind generators in desert area. The project improved and upgraded original performance of wind generators, and plays a significant role of popularization.



b. Sino-US Micro-CDM Project in Gansu Province

ISEC-UNIDO/GNERI was chosen to be the cooperation partner by American Council on Renewable Energy (ACORE) to jointly develop a model programmatic or “Micro” CDM framework system in Gansu Province; Micro-CDM Project is only a first step in creating a functioning system for Micro-CDM and that, though they will be able to make considerable progress based on the support of the US-China Legal Cooperation Fund, ultimately it will be necessary to broaden support from a wide range of sources. And the project will be implemented from 2010.

## **IX Development Target of Renewable Energy in 2020**

### **Overall Target:**

- Largely develop renewable energy, increase the ratio of renewable energy in the national energy construction.
- Expedite the technology process, develop internationally advanced renewable energy technologies
- Promote the change of energy construction in countryside, gradually realize the high quality fuel utilization in country.
- Power supply with renewable energy to remote areas, solve the electricity supply problems in those areas.

### **Quantity target:**

- 2020, the exploited renewable energy resource accounts for 15% of the primary energy consume.
- The installed electricity capacity of renewable energy reaches 120 million KW, the generated electricity reaches 400 million KWh, accounts for about 8% of total generated electricity at that time.
- Reduce 8000 thousand tons of SO<sub>2</sub> emission and 1100 million tons of CO<sub>2</sub> per year (large-scale hydroelectricity included), reduce 20 million hectares disafforestation area.

## **X Barriers faced in transferring RETs**

The potential of the renewable energy still not been familiar with the populations, therefore, there are barriers and obstacles alongside the development of the future:

6.1 Shortage of the fund and incomplete of the supporting policies and absent of the basic knowledge.

Renewable energy is an innovative energy form and is on the primary stage of its development. It needs strong support from the governments in all levels. However, currently in China the industrial policy and management measurements are unsound. Although the Chinese Renewable Energy Law has been adopted and implemented, the encouraging mechanism has not formed.

The cost of the operation and maintaining of the renewable energy system is low, however, compare with the traditional energy, the primary input fund is much higher, even have much more risks, and investor would not like to enter into the field.

The main objective of current is energy-saving and energy-developing at the same time; the policymaker has bias to energy-saving technology for the short of the knowledge on the renewable energy.

6.2 The market is immature, investors have no will to enter, short of funds

The fund is the basic condition on the development of renewable energy. Although the operation and mountainous cost is relatively lower, compare with the traditional energy, the primary fund is huge, even in the application the technology cost is higher. Further more the market is immature.

6.2.1 Cost

The renewable energy market in China is still too small compare to the traditional energy market, which has direct relationship with the high cost of the renewable energy. For instance, the cost to generate the electricity, for the wind power is twice than the coal

power and solar power is ten times. Although in the past 10 years the cost has decreased, still higher than the traditional one. The market competition is still weak.

### 6.2.2 Supply and demand

For the supply, the new policy has greatly promoted the technology innovation and the new technology is easier to be accepted by the market. For the demand, the tax incentive and the idea of the green energy make it easier to enter into the market, even to obtain the confidence of the customers. More and more users means that it is possible for it to wildly promoted, as a result, to lower down the cost. However in China, because of the people are familiar with the traditional energy and it is cheaper. Supply and demand channel is immature and the high cost, it is difficult to apply and promote.

## **XI Strategies and future development of renewable energy**

In September 2007, Deputy Director-General CHEN Deming of Chinese National Development and Reform Commission announce that the Chinese Government will further speed up the development of renewable energy and 2,000 billion RMB (265 billion US dollars) will be put into the field of renewable energy. The renewable energy development plan made by Chinese Government shows that China has step out a magnificent step on the realizing the goal of developing renewable energy. In 1990s, Chinese has carried out the related renewable energy policies and have got rich achievements, strengthen the confidence of the governments in all levels and the entrepreneur's.

China is the first developing country which made the development of renewable energy as its basic nation policy to greatly speed up the innovation of renewable energy. Currently, the renewable energy of China is in a step of quick development. The cost of the manufacture is decreasing gradually. For the renewable energy field, the suit policy, technology innovation and human resource updating is essential element.

### **FUTURE DEVELOPMENT TARGETS**

	2006 actual	2010 target	2020 target
Hydro power	130 GW	190 GW	300 GW
Wind power	2.6 GW	5 GW	30 GW
Biomass power	2 GW	5 GW	30 GW
Solar PV	0.08 GW	0.3 GW	1.8 GW
Solar hot water	100 million m <sup>2</sup>	150 million m <sup>2</sup> -	300 million m <sup>2</sup>
Ethanol	1 million tons	2 million tons	10 million tons
Biodiesel	0.05 million tons	0.2 million tons-	2 million tons
Biomass pellets	~ 0	1 million tons	50 million tons
Biogas and biomass gassification	8 billion m <sup>3</sup> /year	19 billion m <sup>3</sup> /year	44 billion m <sup>3</sup> /year
Share of total primary energy (including large hydropower)	8%	10%	15%

## **XII Conclusion**

There are urgent demands for developing renewable energy in China and it is the inevitable trend for China to develop renewable energy. Research on renewable energy will promote the development various subjects and the technology advancement. We are sure that renewable energy will become the rising pillar industry. At present, China has been the biggest PV Manufacture country. In China, the financial budget at new energies and renewable energies in 2009 has increased to about 10 Billion RMB, about 6 Billion RMB higher than the last year. Furthermore, the Chinese government launched *Solar Roofs Plan* and *Golden Sun Demonstration Project* to promote the development of renewable energy industry, energy saving and environment friendly projects. The Hexi Corridor in Western China has been the World Wind Power Base. The input and investment into renewable energy increased drastically, and the renewable enrg manufacturing industry had achieved a positive international impact and attracted

widespread interest from global society. All these shows that the renewable energy will play more and more important role in the future.

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