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## **13th FYP development plan for renewable energy**

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### **Notice on the publication of the 13th Five Year Plan for the development of renewable energy by the National Development and Reform Commission**

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Development and Reform Commissions (Energy Administrations) of provinces, autonomous regions, direct-controlled municipalities, and Xinjiang Production and Construction Corps, local agency branches, relevant enterprises under the control of the central authorities, and renewable energy societies and associations :

In order to achieve the goal of getting 15% of primary energy consumption from non-fossil energy by 2020, to accelerate the establishment of a clean, low-carbon, safe, efficient and modern energy system, to promote the sustainable and healthy development of the renewable energy industry, in accordance with requirements from the "Renewable Energy Law", and on the basis of the "13th Five-Year Plan for National Economic and Social Development of the People's Republic of China" and the "13th Five-Year Plan for energy development", we have formulated the "13th Five Year Plan for the development of renewable energy". It is hereby issued to you; please implement accordingly。

Annex : 13th Five Year Plan for the development of renewable energy

National Development and Reform Commission

December 10, 2016

Annex

## **13th Five Year Plan for the development of renewable energy**

**(Version for public release)**

**National Development and Reform Commission**

**December 2016**

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### **Foreword**

Renewable energy is an important part of the energy supply system. Currently, the scale of global renewable energy development and utilization is continuously expanding, costs of utilization are rapidly declining, and the development of renewable energy has become a core element of promoting energy transitions and a key approach to addressing climate change in a large number of countries. It is also an important measure in China's promotion of a revolution in energy production and consumption, and in pushing forward an energy transition.

Over the "12th FYP" period, China's renewable energy development has been rapid, making important contributions to adjustments in China's energy structure. The "13th FYP" period is a decisive stage in building a moderately prosperous society, a period of comprehensive and deepened reform, and further is a critical period for implementing the "Four revolutions and one cooperation" energy development strategy proposed by general secretary Xi Jinping. In order to achieve the goal of getting 15% and 20% of primary energy consumption from non-fossil energy by 2020 and 2030, respectively, to accelerate the establishment of a clean, low-carbon, safe, efficient and modern energy system, to promote the sustainable and healthy development of the renewable energy industry, in accordance with requirements from the "Renewable Energy Law", and on the basis of the "13th Five-Year Plan for National Economic and Social Development of the People's Republic of China" and the "13th Five-Year Plan for energy development", the "13th Five Year Plan for the development of renewable energy" (hereinafter: "the plan") is formulated.

The plan includes hydro, wind, solar, biomass, geothermal and marine energy, and clarifies the guiding ideology, basic principles, development goals, key tasks, optimization of the allocation of resources, innovation and development methods, improvements to the industrial system and safeguard measures, of renewable energy development in China from 2016 to 2020. Is the main guide for China's renewable energy development over the "13th FYP" period.

## **1. Development status and outlook**

### **(i) International situation**

With ever increasing attention of the international community for guaranteeing energy security, protecting the environment, responding to climate change and other issues, there is already global consensus and concerted action on accelerating the development and utilization of renewable energy, with the following trends in international renewable energy development :

**First, renewable energy has become a major strategic element in achieving global energy transitions and climate change mitigation targets.** The basic trend of the global energy transition is to go from fossil energy systems to low-carbon energy systems, and ultimately entering a sustainable energy era, where renewables are the main energy source. To this end, many countries have energy transition strategies in which the development of renewable energy is the core content. Reports from the United Nations Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), and other organizations have all pointed out that renewable energy is an important measure in achieving goals for addressing climate change. More than 90% of the signatories of the United Nations "Paris Agreement" on climate change have set renewable energy development targets. The European Union, the United States, Japan, Britain and other developed countries are all using renewable energy development as an important measure in reducing greenhouse gas emissions.

**Second, renewable energy is already replacing an important share of energy consumption in some countries.** In recent years, Europe, the United States and other countries' newly installed capacity was more than 60% renewables each year. In 2015, newly installed capacity, globally, was more renewables than conventional energy for the first time, indicating that the global power system development is undergoing a structural change. Especially in Germany and other countries, renewable energy has gradually become the dominant source of energy, and has become an important component of these countries' energy transition and low-carbon development. In the United States, renewable energy accounts for an increasing share in total power generation year by year, and India, Brazil, South Africa and Saudi Arabia and other countries are also vigorously building renewable power generation projects.

**Third, the economics of renewable energy have significantly improved.** Together with the technological progress and expansion of the scale of application of renewable energy, the cost of renewable electricity generation has been significantly reduced. Wind power equipment and PV module prices have decreased by approximately 20% and 60% over the last five years. In some countries in South America, Africa and the

Middle East, the price bids in wind and PV power generation projects tenders were already competitive with traditional fossil electricity generation. In the US, prices in long-term purchase agreements for wind power are already on similar levels with fossil electricity generation. In Germany, newly added renewable electricity generation is already basically at grid parity with electricity from traditional energy sources. Renewable electricity generation subsidies continue to decline, and its economic competitiveness has significantly improved.

**Fourth, renewable energy has become a global strategic emerging industry.**

Many countries regard renewable energy as a strategic high ground in a new generation of energy technology and an important new area of economic development, and invest large sums of money in support of renewable energy technology R&D and industrial development. International competition in the renewable energy industry has intensified, and international trade disputes concerning related technology and products continue to increase. Renewable energy has become an important new area of international competition, and is a representative industry of a new generation of manufacturing technology for many countries.

**(ii) Domestic situation**

**1) Development status**

Over the "12th FYP" period, China's renewable energy industry began large-scale development, and entered into a development phase where it was an alternative for additional growth in a wide range of applications, and replacing existing stock in some fields.

**First, the role of renewable energy in promoting energy structure adjustment is continuously increasing.** In 2015, the consumption of commercialized renewable energy sources equaled 436 million tons of standard coal equivalent, accounting for 10.1% of total primary energy consumption; if non-commercialized renewable energy sources such as solar hot water heaters etc. are taken into account, the annual total renewable energy consumption amounted to 5 million tons of standard coal equivalent; when including the contribution of nuclear power, all non-fossil energy consumption accounted for 12% of total primary energy consumption, up 2.6 percentage points from 2010. By the end of 2015, China's installed capacity of hydropower was 320 GW, grid-connected installed capacity of wind power and PV was 129 GW and 43.18 GW, respectively. The surface area of solar hot water heaters exceeded 400 million square meters, a scale of application that is the largest worldwide. Total renewable electricity generation was capacity of 1,380 TWh, accounting for 25% of total electricity consumption, with non-hydro renewable electricity accounting for 5% of total

electricity consumption. Biomass energy continues to diversify; various types of biomass energy consumption are circa 35 million tons of standard coal equivalent.

**Second, the technological level of renewable energy equipment has significantly improved.** With the gradual growth of the scale of development and consumption, China has gradually gone from large user of renewable energy towards being a leading power in renewable energy technology industries. China already has mature capabilities in the design, construction and operation of large-scale hydropower, with domestically manufactured Francis type turbine generator units with a unit capacity of 800 MW put into operation, and having mastered the manufacturing technology for pumped storage equipment with 350 MW class units and 500 m hydraulic heads. The wind power industry concentration has significantly increased, with manufacturers of complete wind turbine sets having gradually reduced from more than 80 to more than 20 over the "12th FYP" period. The technological level of wind power has improved significantly, with production of key components basically localized, with operational testing done for large wind power equipment of 5-6 MW. Low-speed wind power has seen particular breakthroughs in technological development, and widespread application in central, eastern and southern regions. There have been substantial increases in capacity for technological innovation in solar cell technology, setting world records in conversion efficiency for crystalline silicon and other new solar cell technologies. A PV industry chain with international competitiveness has been established, having broken through poly-silicon production technology barriers, with poly-silicon production already accounting for about 40% of global output, whilst PV module production reached about 70% of global output. The technological progress and expansion of the scale of production have led PV module prices to fall by more than 60% over the "12th FYP" period, significantly improving the economics of PV power generation. Various types of biomass, geothermal, and marine energy, as well as supporting energy storage technologies have made great progress.

**Third, policy support for the development of renewable energy has gradually been perfected.** Over the "12th FYP" period, China has successively promulgated electricity pricing policies for PV power generation, waste incineration power generation, and offshore wind power, timely adjusted feed-in tariffs for onshore wind power and PV power generation based on technological advances and costs reductions, clarified the subsidy policy for distributed PV, announced a feed-in tariff for solar thermal power generation demonstration plants, and improved the grid connection management system for renewable power generation. In accordance with requirements in the "Renewable Energy Law", and linked with the development of the industry, the renewable electricity surcharge has been adjusted three times, expanding

the scale of financial support for renewable energy development, and improving the management processes for the collection and disbursement of funds。 A renewable energy standards system has been established and improved, product testing and certification capacities continues to increase, renewable energy equipment quality has steadily improved, and the development of various types of renewable energy development has been effectively promoted。

**Table 1. Renewable energy development indicators at the end of the "12th FYP" period**

Content	2010	"12th FYP" target	2015	Average annual growth rate (%)
<b>1. Electric power generation</b>				
1) Hydropower (MW)	216,060	290,000	319,540	8.1%
2) Grid-connected wind power (MW)	31,000	100,000	129,000	33.0%
3) PV power (MW)	800	21,000	43,180	122.0%
4) Various types of biomass power (MW)	5,500	13,000	10,300	13.4%
<b>2. Gas supply</b>				
Biogas (million m3)	14,000	22,000	19,000	6.3%
<b>3. Heat supply</b>				
1) Solar hot water heater (1000 m2)	168,000	400,000	440,000	21.2%
2) Geothermal and others (kt of standard coal eq./year)	4,600	15,000	4,600	0.0%
<b>4. Fuels</b>				
1) Biomass briquettes and pellets (kt)	0	10,000	8,000	
2) Bio-ethanol (kt)	1,800	4,000	2,100	3.1%
3) Biodiesel (kt)	500	1,000	800	9.9%
Total consumption (kt of standard coal eq./year)	286,000	478,000	512,480	12.4%

## **2) Situation and challenges**

With the accelerated pace of technological progress and industrialization of renewable energy, China already has an industrial base for large-scale development and

application of renewable energy, showing good development prospects, whilst also faced with obvious constraints in institutional mechanisms, mainly apparent in :

**First, the existing electric power operating mechanisms do not meet the needs of large-scale development of renewable energy.**

The conventional energy based electric power system can not yet fully meet the grid operation requirements for wind, PV, and other intermittent renewable electricity sources. The electric power market mechanisms and pricing mechanism are not perfect, the flexibility of the electric power system is not fully exploited, the technical management system for the coordinated development of renewable and other electric power supply has not yet established, there are still technical obstacles in the grid-connection of large scale renewable energy power generation, there are difficulties in the effective implementation of the guaranteed purchase of the full amount of renewable electricity generated, and there is serious curtailment of hydropower, wind and PV power.

**Second, renewable energy is relatively strongly dependent on policy support.**

At present, the costs for power generation from wind, solar, biomass etc is still relatively high compared to those for conventional fossil based electricity generation, subsidies per kWh are relatively high, and there is a relatively large deficit in funds for subsidies. There is still a need for a further reduction in the cost of electricity generation by promoting technological progress and establishing good market competition mechanisms. The overall dependency of renewable energy on policy support is relatively high, the impact from adjustments to policy are relatively strong, and the sustainable development of the renewable energy industry remains limited. Further, a national carbon emission market has not yet been established, the current energy pricing and taxation systems do not yet reflect the environmental costs of various types of energy, and a fair market competition environment for the development of renewable energy has not yet been established.

**Third, renewable energy is not yet being used effectively.**

Although the installed capacity of renewables, in particular that of modern renewables, has grown rapidly growth year after year, the responsibilities and obligations of different market players with respect to the the utilization of renewable energy are not clear, the efficiency of the utilization is not high, there is a clear issue of a strong focus on construction, and a weak focus on utilization, and there is an imbalance and lack of coordination between supply and demand, resulting in the potential for sustainable development of renewable energy not being fully realized, with renewable energy still accounting for a lower share of primary energy consumption when compared with advanced countries.

## **2. Guiding ideology and basic principles**

### **(i) Guiding ideology**

Fully implement the spirit of the 18th National Congress and the third, fourth, fifth and sixth plenary sessions of the 18th Central Committee of the Communist Party of China. Adhere to innovative, coordinated, green, open, and inclusive development concepts, follow the strategic direction of the "Four revolutions and one cooperation" energy development strategy, adhere to clean, low-carbon, safe and efficient development approaches, conform to the trend of the global energy transition, perfect the support policy system for the development of the renewable energy industry, comprehensively plan the coordinated development of various types of renewable energy, effectively alleviate the problem of hydropower, wind and PV curtailment, accelerate and promote distributed renewable energy applications, substantially increase the share of renewable energy in total energy production and consumption, accelerate the replacement of fossil fuels, accelerate technological progress and industrial upgrading in the scaled up development, promote optimized distribution, improved quality and increased efficiency of renewable energy, and accelerate the transformation of China's energy system to a clean, low-carbon model。

### **(ii) Basic principles**

**1) Adhere to target control, promote structural optimization。** Expansion of the scale of renewable energy utilization, and increasing the proportion of renewable energy in total energy consumption will be key binding targets for energy development for individual provinces/regions. Form consensus on the priority of renewable energy development and utilization in energy development, and actively promote the diversified development of various types of renewable energy。

**2) Adhere to market guidance, improve policy mechanisms。** Give full play to the decisive role of markets in the allocation of resources, encourage the allocation of resources in a competitive manner, accelerate cost reductions, implement mandatory market shares and a green certificate system for renewable electricity, gradually reduce subsidy levels for new and renewable power generation, implement a system for the guaranteed full purchase for renewable electricity generation, and improve the level of renewable electricity consumption。

**3) Adhere to leadership through innovation, promote transformation and upgrading。** Let accelerating technological progress and improving industrial innovation capacity guide the direction of the development of renewable energy. Through strict market access standards for renewable energy products, promote market entry for advanced technology, improve and upgrade the industrial chain, gradually establish a market with healthy competition, eliminate backward production

capacity, and continuously improve the economics and market competitiveness of renewable energy.

#### **4) Adhere to expansion of exchanges, promote international cooperation.**

Actively participate in international policy dialogue and technical exchanges, make full use of international and domestic markets and resources, attract global technology, capital, development experience and other superior resources, encourage enterprises to transform from pure equipment exporters or project investment into international integrated service providers, and actively participate in global energy governance and industrial resource integration.

### **3. Development goals**

A strategic target of achieving a share of non-fossil fuels in primary energy consumption of 15% by 2020, and 20% by 2030. Further promote renewable energy development and consumption, accelerate the replacement of fossil energy, and improve the economics of renewable energy. The main targets are as follows :

**1) Total renewable energy consumption target.** By 2020, annual consumption of all renewable energy sources will be 730 million tons of standard coal equivalent. Of this, consumption of commercialized renewable energy sources will be 580 million tons of standard coal equivalent.

**Table 2. Key 2020 targets for renewable energy development and utilization**

Content	Scale of utilization		Annual energy production		kt standard coal eq./year
	Value	Unit	Value	Unit	
<b>1. Electric power generation</b>	<b>675,000</b>		<b>1,904,500</b>		<b>561,880</b>
1) Hydropower (excluding pumped storage)	340,000		1,250,000		368,750
2) Grid-connected wind power	210,000		420,000		123,900
3) PV power	105,000		124,500		36,730
4) Solar thermal power	5,000		20,000		5,900
5) Biomass power	15,000	MW	90,000	GWh	26,600
<b>2. Bio-natural gas</b>			<b>8,000</b>	<b>million m3</b>	<b>9,600</b>
<b>3. Heat supply</b>					<b>151,000</b>

1) Solar hot water heater	800	million m2	96,000
2) Geothermal heat utilization	1,600	million m2	40,000
3) Biomass based heat supply			15,000
<b>4. Liquid biofuels</b>			<b>6,800</b>
1) Bio-ethanol	4,000	kt	3,800
2) Biodiesel	2,000	kt	3,000
<b>Total renewable energy</b>			<b>729,280</b>
<b>Total commercialized renewable energy</b>			<b>578,280</b>

**2) Renewable power generation target.** By 2020, installed capacity of all forms of renewable power generation will be 680 GW. Renewable power production will be 1,900 TWh, accounting for 27% of total power generation.

**3) Renewable energy heating and fuel consumption target.** By 2020, various types of renewable energy based heat supply and household fuel consumption will replace circa 150 million tons of standard coal equivalent.

**4) Renewable energy economics target.** By 2020, wind power prices will be competitive with local coal-fired power generation, PV power prices will be comparable with grid sales prices.

**5) Renewable energy grid operation and consumption target.** Combined with electricity market reform, by 2020, hydropower curtailments will be basically solved. Areas with high levels of curtailment of wind and solar power will all meet the minimum number of guaranteed purchase of full-load hours.

**6) Mechanism for binding renewable energy assessment target.** Establish a management system for the share of renewable energy in total primary energy consumption, and for the share of renewable power generation in total power consumption, for individual provinces (autonomous regions and municipalities). By 2020, individual power companies should significantly increase the ratio of non-hydro renewable power generating capacity versus coal-fired power generation capacity.

Note : Commercialized renewable energy includes electricity, natural gas and biofuels.

#### 4. Key tasks

Over the "13th FYP" period, through continuous improvement of policies to support renewable energy, innovate renewable energy development patterns and optimize the

development layout, accelerate renewable energy technology advances and cost reduction, further expand the scale of renewable energy, increase the share of renewable energy in total energy consumption, and promote upgrading and optimization of China's energy structure.

**(i) Actively and steadily develop hydropower**

Actively promote innovation of the principles of hydropower development, support development and conservation, pay equal attention to construction and management, constantly improve water resources assessment, accelerate feasibility studies for hydropower planning, co-ordinate the development of hydropower with electricity market development. With a focus on major rivers in the Southwest, actively and orderly promote the construction of large hydropower bases, rationally optimize and control development in small and medium-sized watersheds, ensure orderly construction and effective consumption of hydropower. Co-ordinate planning, rationally lay out, and accelerate the construction of pumped storage hydropower stations.

**1) Actively promote the construction of large hydropower bases.** Whilst ensuring environmental protection, proper resettlement of population displaced for hydropower projects, and co-ordination with electricity market development, continue construction on hydropower bases along the Jinsha River, Yalong River, Dadu River and elsewhere ; Adapt to the need for energy transition, optimize the development of the hydropower base in the upper reaches of the Yellow River. By 2020, basically complete the six large hydropower bases with a combined capacity of 100 GW in the upper reaches of the Yangtze River, the upper reaches of the Yellow River, Wujiang River, Nanpanjiang Red River, Yalong River, and Dadu River. Actively promote development of hydropower bases in the upper reaches of the Jinsha River and elsewhere, strive to build the southeastern Tibet base for the "West-to-East electricity transfer" project. Over the "13th FYP" period, 40 GW of conventional hydropower will be added to operational capacity, and 60 GW of new conventional hydropower projects will start construction. Accelerate the construction of controllable reservoirs with good dispatching performance such as Lianghekou in the Yalong River, Shuangjiangkou in the Dadu River, and other projects. Accelerate feasibility studies for Longtou reservoir in the middle reaches of the Jinsha River, and actively promote construction of the Longpan hydropower station. Improve the quality of hydropower and the benefits from its development. Co-ordinate planning of hydropower development and power grid construction, and accelerate the construction of complementary long-distance transmission projects. Improve the coordination mechanism for market consumption of

hydropower, promote optimal inter-regional allocation of hydropower resources, and strive to resolve hydropower curtailment.

**Table 3. Key conventional hydropower projects in the "13th FYP" period**

No.	River	Key construction projects	Projects to be accelerated or moved forward in planning
1	Jinsha River	Baihetan, Yebatan, Lawa, Batang, Jinsha	Changbo, Boluo, Gangtuo, Xulong, Benzilan, Longpan, Yinjiang, etc.
2	Yalong River	Yagen Stage 1, Mengdigou, Kala	Yagen Stage 2, Lenggu, etc.
3	Dadu River	Jinchuan, Badi, Yingliangbao, Zhentou dam Stage 2, Shaping Stage 1	Anning, Danba, etc.
4	Yellow River	Ma'erdang, Yangqu	Cihaxia, Ningmute, etc.
5	Other	Linzhi, Baima	Aqing, Zhongyu, Kanggong, Zhala, etc.

## **2) Transform concepts of, and optimally control, development in small and medium-sized watersheds.**

Create the conditions for building an 'ecological civilization', and plan as a whole the development and conservation tasks for the overall basin, including main stream and tributaries. In accordance with the principle that development of the main stream within the river basin is the priority, and that for the tributary conservation is the priority, strictly control development in small and medium-sized tributaries, and small and medium-sized hydropower stations, thus preserving essential watershed habitats, and maintaining the ecological health of the watershed. The western region, which is rich in hydropower resources and has a large development potential, shall focus on the development key rivers and major hydropower bases in large rivers, where hydropower resources are concentrated, and environmental impacts will be smaller, and strictly control the development of small and medium-sized hydropower projects ; Eastern and central regions, which have a relatively high degree of hydropower development, will in principle no longer develop small and medium hydropower. Sichuan and Yunnan provinces, where hydropower curtailment is severe, will have a moratorium on development of small hydropower and of medium-sized hydropower without dispatching control, over the "13th FYP" period. Developments under the 'hydropower for poverty alleviation' project are exempt from this moratorium. Strengthen and synthesize the management experience with cascading hydropower construction in small and medium-sized river basins. Carry out evaluation after hydropower development, and implement ecological restoration in small and medium-sized river basins.

According to local conditions, support the reasonable and appropriate development of small hydropower in areas that are remote, lack grid connections or have power

shortages. Priority areas for supporting development of small hydropower for poverty alleviation are the Tibet Autonomous Region, Sichuan, Yunnan, Qinghai, Gansu provinces and poverty-stricken areas with concentrations of ethnic minorities。 Over the "13th FYP" period, circa 5 GW of new small-scale hydropower will come into operation。

**3) Accelerate the development of pumped storage hydropower。** Speed up the construction of pumped storage power station, adhering to the principle of "comprehensive planning, rational layout", and considering the regional development of nuclear and renewable power, inter-regional power transmission, and power grid security and stability requirements。 Paying close attention to planned construction site conditions, accelerate the construction of a number of pumped storage hydro power

**Table 4. Key pumped storage hydropower construction projects in the "13th FYP" period**

Region	Province	Project name	Total installed capacity (MW)
Northeast China Power Grid	Liaoning	Qingyuan, Zhuanghe, Xingcheng	3,800
	Heilongjiang	Shangzhi, Wuchang	2,200
	Jilin	Jiaohe, Huadian	2,400
	Inner Mongolia (East)	Zhirui	1,200
East China Power Grid	Jiangsu	Jurong, Lianyungang	2,550
	Zhejiang	Ninghai, Jinyun, Pan'an, Qujiang	5,400
	Fujian	Xiamen, Zhouning, Yongtai, Yunxiao	5,600
	Anhui	Tongcheng, Ningguo	2,400
North China Power Grid	Hebei	Funing, Yixian, Shangyi	3,600
	Shandong	Laiwu, Weifang, Tai'an stage 2	3,800
	Shanxi	Yuanqu, Hunyuan	2,400
	Inner Mongolia (West)	Meidai, Wuhai	2,400
Central China Power Grid	Henan	Dayugou, Huayuangou, Baoquan Stage 2, Wuyue	4,800
	Jiangxi	Hongping Stage 2, Fengxin	2,400
	Hubei	Damushan, Shangjinshan	2,400
	Hunan	Anhua, Pingjiang	2,600
	Chongqing	Liziwan	1,200
Northwest China Power Grid	Xinjiang	Fukang, Hami Tianshan	2,400
	Shaanxi	Zhen'an	1,400
	Ningxia	Niushoushan	800
	Gansu	Changma	1,200
China Southern Power Grid	Guangdong	Xinhui	1,200
	Hainan	Sanya	600
Total			58,750

stations. These should be close to load centers, supported by remote power sources, and facilitate renewable power consumption。 Over the "13th FYP" period, construction

should start on circa 60 GW of pumped storage hydropower, with operational capacity reaching 40 GW。 Properly plan pumped storage hydro with ongoing adjustments, and comprehensive consideration of regional power system load peak and valleys, safe and stable operation requirements and site construction conditions. When planning for a number of regional sites for pumped storage hydropower has started, adjustments to plans have been made, and system requirements have been fully demonstrated, determine the preferred construction sites。 According to development needs, timely launch a new round of national planning for pumped storage hydropower。 Strengthen research on key technologies, and promote the construction of pumped storage demonstration projects using seawater。 Actively promote the diversification of investment in the construction of pumped storage hydropower plants, encourage private capital investment, and accelerate the establishment of a tendering mechanism for investments in pumped storage hydropower。 Further improve the operation management system for pumped storage power plants, improve the pumped storage power price formation mechanism, and accelerate the establishment of ancillary services markets for pumped storage power stations。 Perform exploratory research on new methods and mechanisms for the construction, operation and management of pumped storage integration with nuclear, wind, solar, and other new types of energy。

**4) Actively improve the operating management system for hydropower。** Research comprehensive management systems for cascaded hydropower reservoirs, and establish coordination mechanisms for plant operation。 Carry out comprehensive monitoring of basins, establish an integrated monitoring platform, and create a management system for real-time monitoring, inspection, information sharing, and supervision for the whole basin。 Research joint dispatching mechanisms for cascaded hydropower, consider 'comprehensive resources utilization' requirements, optimize hydropower station scheduling。 Formulate optimal scheduling operation procedures and technical standards for cascaded hydropower, and promote joint scheduling for cascaded hydropower in main river basins。 Explore formation of unified river basin companies, adhering to the 'modern enterprise system', for the major river basins. Gradually promote the establishment of a unified power price and operational management mechanism for the entire basin, and fully enable overall benefits from cascaded hydropower development。 Strengthen the role of pumped storage hydropower, and the mechanisms that result in its benefits. Deepen research into optimized joint operation and compensation mechanisms for pumped storage hydropower with other forms of renewable power generation. Implement integrated optimized scheduling within regional power grids, establish operational assessment mechanisms, ensuring fully utilizing the benefits of pumped storage hydropower。

**5) Promote hydropower development for poverty alleviation.** Implement the spirit of the Central Committee on development-oriented poverty reduction. Actively bring into play the advantages of local hydropower resources, whilst fully respecting wishes of local and immigrant populations, and with scientific planning. Accelerate the construction of major hydropower projects in poor areas, and better ensure that hydropower resource advantages are turned into economic advantages and poverty alleviation benefits。 Further perfect the resettlement policy for hydropower development, with smoother administrative systems for migration related tasks, strengthening the social management of the resettled population, and improve the resettlement quality。 Explore mechanisms that would result in returns from hydropower development being used for poverty alleviation in poor areas. Establish and improve mechanisms for public sharing of earnings from hydropower development and income distribution policies for income from resource development. The priority for earnings extracted from power generation is its use for development of the area surrounding the reservoir after its construction, and the population displaced by it. In poor areas, increase annual power generation targets, and increase the proportion of power generation available for the local population from hydropower projects in poor areas。 Research improvements in financial and taxation policy for hydropower development, and explore using returns on assets for poverty alleviation, so that energy resources development generates more local and public benefits。

**(ii) Comprehensive and coordinated promotion of wind power development**

Adhere to the principles of comprehensive planning, simultaneous development of concentrated and distributed forms, as well as onshore and offshore forms, and effective utilization of wind power generated. Strictly co-ordinate development and construction with consumption markets, and strive for consumption of wind power in markets in close proximity to wind farms. Actively support development of dispersed wind energy resources in central and eastern regions. Orderly promote large-scale wind power base construction, provided that a consumption market and/or availability of long-distance transmission capacity is ensured. Actively and steadily develop offshore wind power, and improve the industrial service system。 By the end of 2020, total installed capacity of grid-connected wind power is guaranteed to reach 210 GW or more。

**1) Accelerate the development of wind power in central, eastern and southern regions.** Strengthen wind energy resource surveying in central, eastern and southern regions. Improve low speed wind turbine technology and micro-siting. Do a good job in environmental protection, soil and water conservation and vegetation restoration.

Comprehensively promote the development and utilization of wind energy resources in the central, eastern and southern regions。 Combined with power grid construction and upgrading of rural power grids, improve technological standards and grid connection services for distributed wind power. Promote decentralized wind power construction, whilst considering local availability of resources, land, and conditions for transport, construction and installation, in accordance with the local conditions, and aiming for consumption of the wind power close to the source of generation 。 By 2020, installed capacity of onshore wind power in the central, eastern and southern regions will reach 70 GW. Installed capacity will be 5 GW or more in the provinces of Jiangsu, Henan, Hubei, Hunan, Sichuan, Guizhou, and other provinces。

**2) Orderly construction of large-scale wind power bases in the "Three Norths" region。** On the basis of fully tapping the capacity for wind power consumption in local markets, and with the help of UHV inter-provincial transmission cables already in place or firmly planned in the "Three Norths" region, in accordance with the principle of "complementarity of different power sources and coordinated operation", coordinated planning of wind, PV, hydro, thermal and other types of power generation, and on the premise that a consumption market has been guaranteed, maximize the delivery of renewable energy, expand the deployment of wind power, and promote wind power consumption。 On the basis of solving existing problems of wind power curtailment, and considering changing trends in power supply and demand, gradually expand wind power development in the "Three Norths" region, and promote large-scale development and efficient utilization of wind power in the "Three Norths" region。 By 2020, installed capacity of wind power in the "Three Norths" region is guaranteed to reach 135 GW or more. Of this, circa 35 GW of the newly installed capacity will generate power to be consumed locally。 In addition, 40 GW of wind power capacity (including existing stock of projects) will utilize inter-provincial or inter-regional transmission cables to connect to remote consumption markets。

**3) Actively and steadily push forward the development of offshore wind power。** Carry out offshore wind resources surveying and evaluation, and improve the offshore wind power development plan of coastal provinces (autonomous regions and municipalities) 。 Accelerate the construction of offshore wind power projects that have started construction, and actively promote earlier start of construction of planned offshore wind power projects. Encourage coastal provinces (autonomous regions and municipalities) and major development enterprises to build offshore wind power demonstration projects, and stimulate industrialization of offshore wind power。 Improve the policies managing the development and construction of offshore wind power, enhance coordination between departments, standardize and streamline project

approval procedures, and improve offshore wind power pricing policies. Improve the industry system for supporting services for offshore wind power. Strengthen offshore wind power technology standards, norms, equipment testing and certification, and data monitoring. Ensure formation of capacities covering the entire industrial chain of equipment manufacturing and development and construction. By 2020, have 10 GW of offshore wind power projects under construction, and ensure the completion of 5 GW of offshore wind power capacity.

**4) Effectively improve the capacity for consumption of wind power.** Strengthen grid planning and construction; targeted reinforcement and capacity expansion of important sections of long-distance transport cables, wind power collection and transformer substations; improve the main grid structure; reduce problems of wind power curtailment due to shortfalls in long-distance transmission or transformer substation capacity. Fully utilize the power systems peaking potential, improve the operating flexibility of conventional coal-fired and city-heating units, encourage technological upgrading to enhance the peaking capacity of coal-fired units, resolve the operational conflict between CHP and wind power generation in the winter heating period. Combined with the power system reform, cancel or reduce planned coal-fired power generation capacity, promote participate in peaking capacity of gas-fired and coal-fired power plants. Optimize the management of operation and dispatching of wind power; establish an ancillary services market, strengthen the construction of a system for demand side management and demand response, improve wind power prediction accuracy and increase the intensity of assessments, leave sufficient room for wind power in power generation plans, make reasonable arrangements for the start-up and power generation plan for conventional power generation, let wind power participate in power balancing and combined start-up; encourage wind power and other renewable energy generators to participate in market support services and real-time price competition, etc., and gradually increase the capacity of the system to absorb wind power.

### **(iii) Promote the use and diversification of solar energy**

In accordance with the principle of "technological advances, cost reductions, expand the market, improve the system", promote large-scale application of photo-voltaic power generation and cost reductions, promote the industrialization of solar thermal power, and continue to promote the use of solar thermal applications in urban and rural areas. By the end of 2020, guarantee the national installed capacity of grid connected solar power generation to be at 110 GW or more.

**1) Comprehensively promote distributed PV and "PV +" comprehensive resource utilization projects.** Continue to support industrialization and promotion of rooftop PV systems in areas with high power consumption, such as completed industrial parks and economic development zones with the right circumstances ; Actively encourage the construction of PV power plant projects, in accordance with the principle of local consumption, in and around cities and industrial parks in Central and Eastern regions, where power demand is large and where the industrial and commercial base is good ; Combined with comprehensive utilization of land, relying on agriculture, aquaculture, and forestry, according to local conditions, innovate all kinds of "PV+" comprehensive utilization business models, and promote the organic integration of PV and other industries ; Innovate distributed PV utilization models; in areas with the right conditions in central and eastern regions etc., carry out "1 kW PV for everyone" demonstration projects, and construct PV towns and PV villages。

**2) Orderly advance construction of large-scale PV power stations .** Under the premise of an effective solution to PV curtailment, orderly advance the construction of PV power stations in areas in the central and western regions, where there are good resources, where there is access to the power grid, and where the capacity to absorb the electricity produced is good。 In central and eastern regions, in combination with environmental management and land re-use requirements, actively support implementation of the PV "Leader" plan, promote advanced PV technology and product applications, and accelerate the process of survival of the fittest in market competition and the rapid decline in PV electricity prices。 In areas rich in hydropower resources, use the balancing capacity of hydropower in demonstration projects for complementary hydro and PV generation or joint delivery to remote markets。

**3) In accordance with local conditions, promote demonstration projects for solar thermal power generation .** In accordance with the overall planning, and step by step implementation of ideas, actively promote the development of the solar thermal power generation industry。 The first development phase of solar thermal power generation will primarily be based on demonstration. Through construction of a first batch of solar thermal demonstration projects, promote technological progress and scaling-up, spur localization of equipment manufacturing, and gradually cultivate the formation of integrated industrial capabilities。 In accordance with the development principle of demonstrating first and expansion after, timely summarize demonstration project construction experiences, expand the market size for solar thermal power, promote the construction of solar thermal power bases in areas in western regions where resource, consumption market and ecological conditions allow, give full play to the role of solar thermal in flexible power generation, and realize complementary operation with wind

and PV。 Attempt demonstration of solar thermal aided coal-fired power generation。 Improve the technological level of solar thermal power equipment and system design capabilities, enhance system integration capabilities and supporting industry capacities, form a domestic system of indigenous solar thermal power technology and manufacturing industry 。 By 2020, strive to build 5 GW of solar thermal power generation projects。

#### **4) Vigorously promote diversified development of solar thermal utilization.**

Continue to expand the widespread use of solar thermal applications in urban and rural areas, actively promote solar heating and refrigeration technology development, achieve large-scale use of solar hot water, heating, and refrigeration systems, promote complementary application of solar energy and other energy sources。 Continue to popularize solar hot water systems in residential buildings in cities as well as in the vast rural areas. By 2020, total surface area of installed solar water heating systems will be 450 million square meters。 Speed up the use of solar heating and refrigeration systems in construction industry, and expand the scale of application of solar thermal technology in industrial and agricultural fields of production。 By 2020, solar thermal collector area will be 800 million square meters。

**5) Actively promote the PV for poverty alleviation program.** Make full use of the widely distributed solar energy resources, focusing on villages included in the "National Poor Registration System" with early stage pilots and good solar resource conditions. For the purpose of poverty reduction through income from assets, and advancement of the entire village, construct household PV systems or village-level large-scale PV power plants, and guarantee an increase in income of more than 3,000 yuan per household per year, for 2.8 million "National Poor Registration System" households, who lack the ability to work (including persons with disabilities) ; Other poor areas with good solar resources may, in accordance with poverty alleviation requirements, and in accordance with local conditions, promote PV projects for poverty alleviation。

#### **(iv) Accelerate the development of biomass energy**

Following the notions of 'according to local conditions', coordination of supply and demand, comprehensive utilization, and improved efficiency, establish and improve systems for collection of resources, processing, and distributed production with local consumption, accelerate the pace of industrialization of bio-natural gas, biomass heat supply, and other non-electricity generation uses, and increase benefits and efficiency of biomass energy utilization。

**1) Accelerate bio-natural gas demonstration and industrialization** 。 Selecting large counties rich in organic waste resources from crop production and animal

husbandry, with the county as a unit, establish an industrial system, carry out construction of bio-natural gas demonstration counties, and promote the progress of bio-natural gas technology and modernization of engineering and construction。 Establish raw material collection safeguards and systems for the use of biogas slurry as organic fertilizer. Establish a transmission and distribution system for bio-natural gas, and create diversified consumption by connecting it to conventional natural gas pipeline networks, use as vehicle fuel, for power generation, and as industrial boiler fuel, etc。 By 2020, annual production of bio-natural gas will be 8 billion cubic meters, and 160 bio-natural gas demonstration counties will have been constructed。

**2) Actively develop biomass-based heating。** Link heat demand with heat supply retrofitting of operational pure power biopower generation projects, increase the efficiency of biomass energy use, actively promote biomass cogeneration for city and industrial park heating, and form more than 20 counties and cities that have biomass cogeneration as the primary form of district heating。 Accelerate the development of heat supply with technologically mature compacted biomass fuels, promote the application of large-scale, advanced, low-emission compacted biomass fuel boilers of 20 tons of steam/h (14 MW) and above, achieve pollutant emission levels comparable to natural gas-fired boilers, and promote their application in industrial heat supply and district heating in the Yangtze River Delta, the Pearl River Delta, Beijing - Tianjin - Hebei - Shandong, and other areas. For the provision of clean and renewable energy for industrial production, schools, hospitals, hotels, office buildings and other public and commercial facilities, create a group of districts where clean biomass heat accounts for a dominant proportion heat supply。 By 2020, the utilization of compacted biomass fuels will reach 30 million ton。

**3) Steadily develop biomass power generation。** Under the premise of doing a good job in site selection and implementation of environmental protection measures, combined with the new urbanization process, focusing on prefecture-level cities and a selection of counties with sufficient resources, steadily develop urban waste incineration power generation. By 2020, the installed capacity of power generation from municipal solid waste incineration will reach 7.5 GW。 According to biomass resource conditions, orderly develop power generation through direct combustion of crop and forestry residues and biogas power generation. By 2020, installed generation capacity of biomass power from crop and forestry residues will reach 7 GW; biogas power generation will reach 500 MW。 By 2020, the total installed capacity of biomass power will reach 15 GW; the annual generation will exceed 90 TWh。

**4) Promote industrialization of liquid biofuels。** Steadily expand fuel ethanol production and consumption。 Based on domestic technological capacity, actively

introduce, digest, and absorb advanced foreign experience, and vigorously develop cellulosic ethanol. Combined with the consumption of tainted and heavy metal polluted grain, control the development of the total volume of fuel ethanol from grain. According to resource conditions, appropriately develop fuel ethanol projects using cassava, sweet sorghum, and other crops. Upgrade biodiesel projects, improve product quality, and meet fuel quality requirements for transport fuels. Accelerate the technological innovation for poly-generation of liquid bio-fuels and other products from woody biomass, micro-algae and other non-grain raw materials. Promote applied demonstration for the industrialization of the refinery of high-grade fuel oils from biomass, and bio-based aviation fuel. By 2020, the annual consumption of liquid biofuels will exceed 600 million ton.

#### **5) Improve the policy system for promotion of biomass energy development.**

Strengthen the comprehensive utilization of waste products, protecting the natural environment. Create policy for the prioritization of the use bio-natural gas and liquid biofuels, establish a mechanism for non-discriminatory and barrier-free feed-in into the pipeline network, and research the establishment of a compulsory quota mechanism. Improve pricing, taxation and other preferential policies for the support of the development of biomass energy, research the introduction of a bio-natural gas product subsidy policy, and accelerate the pace of development of the bio-natural gas industry.

#### **(v) Accelerate the development and utilization of geothermal energy**

Adhering to the "clean, efficient and sustainable" principle, and in accordance with the overall requirements of "advanced technology, environment-friendly, economically viable", accelerate the development and utilization of geothermal energy, strengthen management of the whole process, with innovative development and utilization models, and comprehensively promote the rational and efficient use of geothermal energy resources.

**1) Actively promote the use of geothermal heat.** Strengthen links between geothermal energy development and utilization planning with overall city planning, include geothermal heating in urban infrastructure construction, provide policy support for the development and utilization of geothermal energy for land use, electricity consumption, taxation, pricing, etc. In Beijing-Tianjin-Hebei-Shandong-Henan and adjacent areas, where centralized district heating is implemented and where there are rich geothermal resources, under the premise of strict control on over-exploitation of groundwater resources, vigorously promote the construction of major projects for deep geothermal heating. Increase promotion efforts for development and utilization of the shallow geothermal energy, actively promote technological progress, and further

standardize administrative management. Integrated promotion of shallow geothermal energy major projects, focusing on the economically developed areas, with high demand for cooling in summers in the Yangtze River Economic Zone, in particular in urban agglomerations in southern Jiangsu, Chongqing, Shanghai, Wuhan and other regions 。

**2) Orderly promotion of geothermal power generation。** Whilst giving integrated consideration to geological conditions, resource potential and application methods, construct several new high-temperature geothermal power generation projects of circa 10 MW each along the Qinghai-Tibet Railway, in Tibet, western Sichuan and other regions with distributed high-temperature geothermal resources, and carry out technology upgrades of Yangbajing Geothermal Power Station in Tibet。 In coastal areas, oil fields, and other areas with rich medium and low-temperature geothermal resources in the eastern region, in accordance with local conditions, develop small and medium-scale distributed medium and low-temperature geothermal power generation projects。 Support key technology research and demonstration projects of deep-level, high-temperature, hot dry rock power generation systems, on the Qinghai-Tibet Plateau and adjacent areas, and in Beijing-Tianjin-Tangshan and other economically developed areas。

**3) Increase geothermal resource potential surveying and evaluation。** By 2020, finish a basic survey of the national geothermal energy resources and distribution characteristics. Focusing on major urban agglomerations and central towns in the North China region and along the lower reaches of the Yangtze River, carry out shallow geothermal energy resources assessment. In the Songliao Basin, the Huaihe Basin, Jiangnan Basin, the Central Ordos Basin etc., that have prospects for future development and have poorly surveyed typical conduction type geothermal resources, carry out surveying work on medium depth geothermal resources. On the Qinghai-Tibet Plateau and adjacent areas, the southeast coast, Hebei province etc., which have typical high temperature geothermal systems, carry out surveys of deep geothermal resources。 Establish a national geothermal resources data and information service system, improve the geothermal energy basic information database, and carry out monitoring of geothermal energy exploration, development and utilization。

#### **(vi) Promote technological demonstration of marine energy power generation**

Combining the national distribution of marine energy resources and local location advantages, with proper coordination of planning of development and utilization of coastal and island resources, according to local conditions, carry out the development and utilization of marine energy, so that China's marine energy technology and industry may progress towards internationally advanced levels。 Build an improved public

support service platform for the development and utilization of marine energy. Construct marine energy demonstration bases, initially in the four key areas of Shandong, Zhejiang, Guangdong, Hainan and elsewhere。 Strengthen the technological research and development for comprehensive utilization of marine energy; focus on supporting demonstration projects with wave energy of a scale of circa 100 kW each, and tidal energy projects with a scale of circa 1 MW each, and launch research and development on small-scale, modular marine energy supply systems. Strive for breakthroughs in bottlenecks regarding efficient conversion, efficient energy storage, and high reliability designs, forming a number of marine energy comprehensive utilization equipment products suitable for widespread application。 On islands or reefs, develop demonstration projects for independent power systems using marine energy ; In Zhejiang, Fujian and other areas, start construction of tidal power stations of a scale of circa 10 MW, laying a foundation for the large-scale development of marine energy resources。

#### **(vii) Promote technological demonstration of energy storage technology**

In line with the National Strategic Energy Action Plan, promote energy storage technology demonstration within the field of renewable energy, and achieve energy storage industry breakthroughs in market size, areas of application and core technology。

##### **1) Carry out demonstration of energy storage in renewable energy fields.**

Combined with the development and construction of renewable energy power generation, distributed energy, and new energy micro-grid projects, carry out comprehensive demonstration of energy storage technology, and through the integrated and complementary use of various types of energy storage technology with wind power, solar energy and other intermittent forms of renewable energy systems, improve the stability and grid-friendliness of renewable energy systems and 。 Focus on exploring energy storage technology types and development models that suit renewable energy development, explore management systems, incentive policies and business models for the construction of energy storage facilities。

##### **2) Improve the economics of energy storage technologies in renewable energy fields。**

Cultivate a stable renewable energy storage market through demonstration projects, focusing on enhancing the energy storage system security, stability, reliability and applicability; gradually improve energy storage technology standards, testing and certification and grid connection specifications. Through downstream application, drive upstream product technology innovation and cost reduction, and promote the

realization of commercial application of energy storage technology in the field of renewable energy.

### **(viii) Strengthen international cooperation in renewable energy industries**

Combined with economic globalization and international energy transition trends, give full play to the comparative advantage of China's renewable energy industries, closely integrated with the "One belt, one road" initiative, promote comprehensive internationalization of renewable energy industry chains, enhance the international competitiveness of China's renewable energy industries, and actively participate in and promote global energy transitions.

**1) Strengthen dialogue; construct an international cooperation and exchange services platform.** Continue to strengthen policy dialogue and technical cooperation with key international organizations and countries, and fully grasp the international renewable energy development trends. Integrated with existing multi- and bilateral cooperation mechanisms, establish international cooperation services and capacity-building platform for renewable energy industries. Provide comprehensive information and integration services including policy exchange, planning follow-up, technology exchange, financing interaction, risk warning, brand building, experience sharing. Effectively support the internationalization of China's renewable energy industries.

#### **2) Rational arrangement; participate in global renewable energy markets.**

Closely integrated with national development planning and construction needs of countries along the "One Belt, One Road", consolidate and deepen traditional markets, cultivate and open up new markets, launch a number of landmark cooperation projects when the time is ready, promote consulting, design, contracting, equipment, developers and other enterprises in the field of renewable energy to internationalize together, and create a good environment in which Chinese enterprises complement and collaborate in their international development.

**3) Enhance the level; participate in international standard systems.** Support enterprises and related institutions to actively participate in the drafting or revision of international standards, in leading fields guide the drafting or revision of a number of international standards, and enhance the technological level of China's renewable energy industries. Increase exchanges and efforts at mutual recognition of technical standards with the main renewable energy markets, actively utilize multilateral mechanisms for mutual recognition, deeply participate in the formulation, implementation and evaluation of conformity assessment standards and planning in the IEC System for Certification to Standards Relating to Equipment for Use in Renewable

Energy Applications (IECRE), and enhance China's influence in international certification, recognition, testing and other areas。

**4) Fully utilize advantages; promote the development of global energy transistions。** Give full play to the support conditions of China's various foreign aid cooperation mechanisms, share our experience in policy planning and technology development in the field of renewable energy applications. Provide capacity building, policy planning and other assistance and support to countries participating in the global energy transition, in particular to economically and technologically relatively backward developing countries 。

## **5. Optimizing resource allocation**

Make full use of transmission lines that are planned, under construction and already built, and on the basis of scientifically demonstrated peak regulating capacity by the exporting grid and consumptive capacity for renewable electricity in the receiving grid, increase the proportion of renewable electricity in the total amount of electricity in inter-regional transmission as much as is possible。 Combined with air pollution control measures, promote the coordinated development of renewable energy in the Beijing-Tianjin-Hebei region and surrounding areas, and orderly promote the inter-provincial consumption of renewable energy。 Bring into play the regulation capacity of hydropower, solar thermal and other forms of renewable energy, and promote the complementary and joint inter-provincial transmission of hydropower, wind, PV, solar thermal power generation and other forms of renewable energy。

### **(i) Orderly promotion of construction of large-scale renewable energy bases**

With the help of inter-provincial UHV transmission lines for which construction has already been completed, accelerate the construction of supporting renewable energy projects in Hami, Xinjiang and Ningdong, Ningxia and other areas, and ensure that all renewable energy projects are grid-connected by 2020。 In unison with progress on transmission lines under construction, orderly promote the construction of renewable energy projects in Jiuquan, Gansu; Inner Mongolia; Shanxi; Zhundong, Xinjiang and other areas, effectively expand the scale of consumption, and increase the proportion of renewable electricity in total inter-provincial electricity exports to a maximum 。

**Table 5. Long-distance transmission lines for renewable energy; existing, under construction and planned**  
**Table 6. Joint development of renewable energy in Beijing, Tianjin, Hebei and surrounding areas**

- Transmission lines already constructed : Hami - Zhengzhou  $\pm$  800 kV DC, Ningxia - Shandong  $\pm$  660 kV DC, Northeast - North China 500 kV DC project, etc.
- Zhangjiakou renewable energy demonstration area : Thoroughly implement the concept of "low carbon Olympics", implement the Zhangjiakou renewable energy demonstration area plan, promote the construction and utilization of wind power, solar energy, geothermal energy and other renewable energies in Zhangjiakou.
- Transmission lines planned or under construction : Xinling - Shandong 1000 kV AC, Xinling - Jiangsu  $\pm$  800 kV DC, West Inner Mongolia - South Tianjin 1000 kV AC, Shanghai Miao - Shandong  $\pm$  800 kV DC, Shanxi - Jiangsu  $\pm$  800 kV DC, Ningdong - Zhejiang  $\pm$  800 kV DC, Jiuquan - Hunan  $\pm$  800 kV DC, Jarud - Shandong  $\pm$  800 kV DC, etc.
- Chengde wind power base phase three : Timely advance the construction of Chengde wind power base phase three, and coordinate with consumption in the Beijing - Tianjin - Hebei region.
- Wulanchabu wind power base : Plan construction according to market demand, actively promote the capacity for consumption within the North China power grid region.
- Chifeng wind power base : Plan construction according to market demand, actively promote the capacity for consumption within the North China power grid region.

**(ii) Strengthen the coordinated development of renewable energy in the Beijing-Tianjin-Hebei and surrounding area**

Implement the relevant requirements from the "Air Pollution Control Plan of Action", and in combination with the "Green Olympics" and "Beijing-Tianjin-Hebei integration" development strategy, actively promote the construction of renewable energy bases in Zhangjiakou and Chengde, Hebei province, and other areas. Perform feasibility studies and timely promote the planning and construction of renewable energy bases in Wulanchabu and Chifeng, Inner Mongolia province, and other areas. Strengthen the planning and construction of supporting transmission lines, improve the capacity to consume new and renewable energy Beijing-Tianjin-Hebei regional grid, promote widespread adoption of clean renewable energy based district heating, achieve electrification with clean energy sources, and significantly increase the proportion of renewable energy in energy consumption in the Beijing-Tianjin-Hebei region.

**(iii) Carry out demonstration of complementary hydro, wind and PV bases**

Utilize the complementary characteristics of hydro, wind and PV power generation. On the premise of not increasing hydropower curtailment, in hydropower resource-rich areas in the southwest, northwest and elsewhere, utilizing the capacity for flexible output of, and inter-provincial export transmission lines in place for hydropower stations, construct supporting wind and PV power generation projects, and promote the construction of demonstration projects for the complementary generation of hydro, wind and PV power. Focus on promoting construction of Liangshan hydro and wind power complementary power generation base, the Yalong river hydro, wind and PV power complementary power generation base, and the Jinsha river hydro, wind and PV

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**Table 7. Hydro, wind and PV power complementary power generation demonstration bases**

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--- Sichuan Province Liangshan wind power base : consumption within Sichuan Province.

--- Yalong River hydro and wind complementary power generation base : achieve joint dispatch of hydro, wind and PV and inter-provincial consumption through the Jinping - Jianguo and other UHV DC transmission lines.

--- Jinsha River hydro and wind complementary power generation base : achieve joint dispatch of hydro, wind and PV and inter-provincial consumption through the Xiluodu - Zhejiang UHV DC, Xiangjiaba - Shanghai UHV DC, Xiluodu - Guangdong DC and other transmission lines.

--- Guizhou Wujiang River and Beipan River hydro and wind complementary power generation base : consumption within Guizhou Province.

--- Qinghai Province Hainan prefecture hydro and wind complementary power generation base : considering the situation in receiving consumption markets, promote demonstration programs for combined inter-provincial dispatch of hydro, wind, PV, and solar thermal power.

power complementary power generation base in Sichuan province, the cooperative operation of hydro and wind power in the Wujiang and Beipan rivers in Guizhou province, and the hydro, wind and PV power complementary power generation base in Hainan prefecture in Qinghai province, and other renewable energy bases.

**(iv) Plan for demonstration of wind, PV, and solar thermal comprehensive new energy bases**

In areas with rich wind and solar energy resources, comprehensively consider the complementary capacity for power output regulation of wind, PV, solar thermal and pumped storage hydro resources in the exporting region, research and plan new inter-provincial delivery transmission lines, comprehensively consider both resources in the exporting region and market situation in the receiving region, give full play to the role for power regulation in the receiving region, and achieve optimal configuration of high-quality new energy resources in more extensive markets 。 Research and explore programs for the inter-regional export of electricity with majority shares of renewable energy from Alxa League in Inner Mongolia, Haixi prefecture in Qinghai, and Jinchang and Wuwei in Gansu province, and other regions.

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**Table 8. Wind, PV, and solar thermal comprehensive new energy bases**

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--- Alxa League, Inner Mongolia : Promote research on combined operation mechanisms of wind, PV, solar thermal and pumped storage hydro. Whilst considering the electricity market situation in the receiving region, timely explore joint inter-provincial export demonstration programs.

--- Haixi Prefecture, Qinghai : Promote research on combined operation mechanisms of wind, PV, solar thermal and pumped storage hydro. Whilst considering the electricity market situation in the receiving region, timely explore joint inter-provincial export demonstration programs.

## 6. Innovation and development methods

Combined with the electricity market formation and electric power system reform, select appropriate geographic areas for demonstration of various types of renewable energy, explore integrated technology applications, industrialization pathways and business models for renewable energy, and lay a solid foundation for accelerating the use of renewable energy and replacing fossil energy consumption。

### (i) Renewable energy district heating demonstration projects

In accordance with the principles of "prioritized utilization, cost-effectiveness, complementary diversification, comprehensive integration", carry out large-scale demonstration of renewable energy based district heating。 In the process of urban planning and construction, link district-level energy planning and urban development planning, adopt the concept of prioritized development of renewable energy, and let renewable energy based district heating be an important part of district-level energy planning。 Promote renewable heat supply in construction and industry, start projects to replace fuels with biomass in cities, and accelerate the replacement of fossil fuels with various types of renewable energy sources in the field of district heating。

Comprehensively plan the construction and renovation of the heat supply infrastructure, strengthen the construction and renovation of supporting electricity grids, optimize the design of district heating networks, and establish a heat supply system with cascaded and complementary utilization of renewable and conventional energy sources。 By 2020, various types of renewable energy-based district heating and household fuel use will in total replace 150 million tons of standard coal equivalent of fossil energy sources。

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**Table 9. Renewable energy district heating demonstration projects**

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--- Solar district heating。 On the basis of continued promotion of building-integrated solar energy, accelerate the application of various types of medium and high temperature solar thermal technologies in industry, to meet the demand for hot water, heating, steam, refrigeration and other types of heating/cooling needs。 In appropriate areas, promote heat supply projects using inter-seasonal solar thermal storage。

--- Biomass district heating。 Measured to local conditions, promote the comprehensive development of biomass energy use based on agricultural and forestry residues, municipal solid waste and other biomass sources. Encourage the retrofitting of small coal-fired district heating boilers for the use biomass-pellet fuels within cities, increase the share of biomass-based cogeneration of heat and power, improve the efficiency of the utilization of biomass, to replace the consumption of fossil fuels in cities。

--- Geothermal district heating。 Encourage the establishment of district heating systems with geothermal energy as the main energy source in geothermal resource-rich areas, to meet a variety of heating needs。

--- Clean power district heating。 In northern regions, which are rich in wind energy resources, have large heat demand, and where there is a surplus of power supply, promote large-scale clean electricity based district heating projects, with the goal of replacing small coal-fired boilers. Whilst meeting the strong heating needs of these areas, expand the proportion of local clean electricity consumption, and reduce the consumption of coal。

## **(ii) Regional energy transition demonstration projects**

With the goal of promoting new energy applications and significantly increasing the share of new energy in total energy consumption, and on the basis of continued good work on green energy demonstration counties, new energy demonstration cities, etc., support regions with good resource conditions, which have a groundwork of administrative management, large development potential, and a clear role in demonstration. At the level of provinces, cities, counties or parks, develop regional 'comprehensive utilization' energy transition demonstration projects, promote innovation in various aspects of new energy such as technological integration, fields of application and institutional mechanisms, and explore energy technology applications and new systems for comprehensive management with majority shares of renewable energy. In the "Three Norths" area, carry out tests with local consumption, develop energy-intensive industry in support of renewable energy, and explore the production of hydrogen on the basis of wind power, direct industrial power supply, and other development and utilization models for new renewable energy sources. By 2020, strive to take a leading position in having high shares of renewables in energy consumption increases or total consumption in a number of fields such as industry, construction, transportation and other areas.

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**Table 10. Regional energy transition demonstration projects**

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--- Energy transition demonstration provinces (regions)。 Support renewable energy resource-rich provinces (regions) in the northwest, southwest and elsewhere, with planning strategic objectives in energy transitions, exploring coordinated operation mechanisms for local consumption, inter-provincial trading of renewable energy and complementary generation of wind, PV, and hydropower, and with the construction of energy transition demonstration provinces (regions)。 By 2020, renewable energy will account for more than 30% of total energy consumption in the demonstration provinces (regions)。 Support provinces with average or relatively poor renewable energy resources but concentrated energy use in central and eastern regions, giving full play to inter-grid transmission capacity and regional peak regulation capacity, with exploring the implementation of demand-side management and other integrated optimized scheduling modes, and with increasing the share of renewable energy in total energy consumption. Over the "13th FYP" period, utilizing market mechanisms to consume renewable energy from outside the region, strive to exceed 30% of renewable energy in total energy consumption in the demonstration provinces, and to exceed 50% of renewable energy in energy consumption increases。

--- Energy transition demonstration cities。 On the basis of continuing to thoroughly carry out work on creating new energy demonstration cities, guide active cities in creating energy transition model cities。 With a focus on distributed energy and renewable energy based district heating, demonstration cities should improve relevant policy measures, establish and improve the management of statistics and monitoring systems, strive to fulfill energy consumption increases mostly with renewable energy supply, accelerate the replacement of fossil energy consumption with new energy sources, improve the share of new energy consumption in urban energy consumption, and promote transformation of the urban energy structure。 Renewable energy will account for more than 50% of total city-wide energy consumption in the demonstration cities。

--- Rural energy transition demonstration counties (districts)。 Support the construction of rural energy transition demonstration counties (districts) in provinces with large agricultural sectors and large populations。 Accelerate the process of equalization of urban and rural electricity services etc., to achieve universal coverage of a stable and reliable power supply 。 Promote various kinds of biomass-based centralized gas supply, centralized anaerobic digestion-based gas supply, and pelletized fuel based heating projects in rural and urban applications 。 Utilize barren mountain slopes, agricultural greenhouses or facilities etc., for the construction of "PV+" projects, and measured to local conditions, promote the application of PV and wind power generation in agricultural production, such as irrigation pumps etc.。 Support demonstration counties (districts) in building new rural renewable energy development and utilization cooperatives, and accelerate the realization of cleaner, higher quality, industrialized and modernized rural energy。

--- High renewable energy penetration demonstration zones。 In pilot regions with rich renewable energy resources and innovative institutional mechanisms, in accordance with local conditions, support the creation of clean and renewable energy demonstration zones with higher shares of renewable energy, to fulfill various energy needs such as electricity, heating, cooling, gas supply etc., and achieve integration of production and consumption systems of different new energy technologies as well as of new and conventional energy sources。 Renewable energy will account for more than 80% of total energy consumption in the demonstration zones。

### **(iii) New energy micro-grid demonstration projects**

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**Table 11. New energy micro-grid demonstration projects**

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--- Grid-connected microgrids。 In areas with relatively high demand and good resource conditions, encourage the construction of grid-connected micro-grids with majority shares of renewable energy supply and complementary energy sources such as natural gas etc., to achieve dynamic balancing of local heating, cooling, and electricity demand, as well as flexible interaction with the greater power grid 。

--- Stand-alone microgrids。 In remote areas, areas with weak grid infrastructure, or island sites, establish independent micro-grids with majority shares of power supply from wind, PV, and hydro, and with energy storage, natural gas, and diesel for back-up。

To explore the establishment of a local power system with high shares of intermittent renewables and integrated energy storage, explore new business models and formats for electricity services, promote more dynamic market-driven innovation and development, and ultimately form a more complete technological system and administrative institutions for new energy micro-grids. Adhering to the principles of "in accordance with local conditions, complementary diversification, technological advancement, innovative mechanisms", promote the construction of micro-grid demonstration projects with majority shares of renewable energy, distributed, and diversified, complementary sources of power supply 。

## **7. Improving the industrial system**

Gradually improve the renewable energy industry system, adhere to scientific and technological innovation as the basic driving force for promoting the sustained and healthy development of the renewable energy industry, continuously improve the efficiency of renewable energy utilization, improve the quality of renewable energy products, reduce the construction and operation costs of renewable energy projects, and enhance the overall technical and economic competitiveness of renewable energy 。

### **(i) Strengthen the surveying of renewable energy resources**

On the basis of a need for adjustments to the energy structure, investigate and evaluate the amounts of renewable energy resources in key areas, and timely start post-development evaluation of a rivers' hydropower resources。 Completely finish the hydropower resource survey in Tibet, and organize the publication of the results of the hydropower resource survey in Sichuan。 Increase resource assessments of offshore wind resources, and of low wind speed sites with complex terrain conditions in central, eastern, and southern regions。 Increase surveying of distributed photovoltaic resources in central and eastern regions, and of solar thermal resources in western and northern regions。 Strengthen the surveying of resources for geothermal, biomass, marine, and other new types of renewable energy。 Timely publish resource survey

results for various types of renewable energy, to guide and optimize the distribution of project investment.

**(ii) Accelerate and promote technological innovation of renewable energy technologies**

Promote capacity-building for indigenous innovation in the renewable energy industry, promote technological progress, improve the efficiency, performance and reliability of renewable energy equipment, and enhance international competitiveness. Construct comprehensive technological research and development platforms for renewable energy, establish public research and development labs for advanced technologies, promote increased (domestic) localization of the whole industry chain, including raw materials, processing and production technologies and installation, and accelerate mastering the capacities for technological research and development and equipment manufacturing of key technologies. Give full play to the role of corporate R&D, increase capital investment, promote upgrading of industrial technology, and accelerate the rapid decline in production costs of wind, solar, and other sources for renewable electricity generation.

**(iii) Establish a quality supervision and management system for renewable energy**

Carry out comprehensive quality assessments of the main engineering and related equipment of renewable power generation plants, and regularly publish reports on the quality of renewable power generation plants construction and operational safety. Strengthen the acquisition and monitoring of operational data of renewable power generation plants, and establish transparent and open quality supervision and management, as well as an early warning mechanism for safety shortcomings, that covers the entire process of design, production and operation. Establish a renewable energy industry accident notification mechanism, and timely publish notifications of major accidents and common accident prevention measures. Establish 'survival of the fittest' market mechanisms through a combination of government regulation and industry self-regulation; construct a fair, just and open tendering market environment and a negative behavior blacklist system for renewable energy development and construction.

**(iv) Improve the technical level of renewable energy operational management**

Actively promote the level of and technological upgrading for automated management in renewable energy projects, and improve their capacity for power generation and adaptability to the power grid. Gradually improve specialized services for construction, maintenance and repair, operation and other aspects, strengthen after-market services, and establish a more comprehensive industrial services and technical

support system。 Vigorously promote technological research on the grid connection and consumption of wind, PV, and other new energy sources, focus on promoting electricity storage, flexible DC transmission and other high-tech demonstration applications, promote energy structure adjustment, strengthen construction of peaking capacity, fully utilize peaking potential, and improve power system flexibility。 Improve the power grid structure, optimize power scheduling, strengthen the planning and construction of inter-regional export transmission lines for renewable energy and increase their utilization, gradually establish new electric power operating mechanisms that integrate large-scale renewable energy into the electric power system, and achieve deep integration of renewable and existing energy systems。

**(v) Improve renewable energy standards, testing and certification systems**

Strengthen the coordinated development of renewable energy standard systems, and form a renewable energy standard system that covers aspects including resource surveying, project planning, project design, equipment manufacturing, testing and certification, construction, grid connection, operation and maintenance etc.。 Encourage relevant scientific research institutions and enterprises to actively participate in the preparation and revision of standards related to renewable energy, and promote the convergence of domestic and international standard systems。 Support capacity-building of testing organizations, strengthen construction of a equipment testing and certification platform, and reasonably distribute renewable power generation equipment testing centers。 Enhance the professional level of certification bodies, accelerate the construction of a credit system for the renewable energy industry, and regulate the market order of renewable power generation equipment。 Promote the international mutual recognition of certification results, providing support for China's renewable energy equipment companies to participate in global markets。

**(vi) Enhance the level of information management for renewable energy**

Construct a public industry services platform, fully implement renewable energy industry information management, establish and improve a national information management platform for renewable electricity generation projects, monitor and publish comprehensive, systematic, timely and accurate information on renewable power generation project construction and operation, and thus provide support for renewable energy industry management and policy making。 Make full use of big data, "Internet+" and other advanced concepts, technologies and resources; construct a project life cycle information management system, construct a renewable power generation demonstration system, testing system and data center, so as to provide a full range of data and information monitoring services to industry。

## **8. Safeguard measures**

In order to implement the main renewable energy development tasks and achieve renewable energy development goals, the following safeguard measures are adopted :

### **(i) Establishment of a target-oriented administrative management system for renewable energy development and utilization**

To implement requirements from the "Renewable Energy Law", and in accordance with targets from this renewable energy development plan, determine a target share of renewable energy in total primary energy consumption for each administrative area to be achieved during the planning period, as well as a target share for renewable energy in total electricity consumption. Pay close attention to and research power grid operation mechanisms and technical support programs that benefit large-scale renewable energy grid-connection, and establish energy development assessment systems oriented on renewable energy utilization indicators. Improve coordination mechanisms between national and provincial levels, and break down implementation into annual components. Monitor, and timely publish and assess, the development and utilization of renewable energy at the level of provinces (autonomous regions, municipalities), power grid companies and power generation enterprises, to serve as basic indicators of the energy transition as well as important measures in promoting the revolution in energy production and consumption. Local governments at all levels shall, in accordance with requirements in national planning, develop a local renewable energy development plan, and incorporate main objectives and responsibilities into local economic and social development planning.

### **(ii) Implementation of a system for the guaranteed full purchase of renewable electricity**

In accordance with overall progress of the power system reform, implement the system for the guaranteed full purchase of renewable energy, and in accordance with the requirements laid out in the "Measures for the guaranteed full purchase of renewable electricity", strictly implement the number of guaranteed purchased annual full-load hours for wind and PV power generation as clarified by the central government. Increase the pace of reform and innovation, promote demonstration of electricity market system reform adapted to the specific characteristics of renewable energy, gradually establish new power system operating mechanisms and price formation mechanisms, and actively explore multi-part electricity pricing mechanisms. Establish coal-fired power flexibility and peaking compensation mechanisms, establish an auxiliary services market, encourage market actors to provide auxiliary services, establish a flexible electricity market mechanism, and achieve deep integration with conventional energy systems.

### **(iii) Establishment of a green certificate trading scheme for renewable energy**

On the basis of non-fossil energy consumption share targets and renewable energy development and utilization objectives, establish of a unified national renewable energy green certificate trading mechanism, and further improve renewable electricity subsidy mechanisms。 Through the establishment of non-hydro renewable energy quota for firms with coal-fired power generation units and for electricity providers, require market actors to purchase green certificates to fulfill their renewable energy quota obligations. Through market-based transactions of green certificates, compensate the environmental and social benefits of new and renewable energy, and gradually transition from the current subsidy model based on price differences to a new mechanism that combines fixed subsidies with a green certificate income.

Simultaneously, link with carbon trading markets, and reduce the subsidy intensity from the renewable electricity fund, to ultimately create the conditions for the cancellation of subsidies from these funds。

### **(iv) Strengthening renewable energy supervision**

Implement the relevant requirements of the State Council on transformed functioning, streamlining of administration and decentralization, ensuring the simultaneous delegation of power and responsibility to lower administrative levels, and the simultaneous strengthening of regulation and supervision。 Strengthen the guiding role of planning, annual work programmes, departmental regulatory and standardization documents, and national standards, give full play to the role of supervision by industry regulation departments and self-regulation by industry associations, to create an efficiently operating administrative management system with good laws and regulations, and close supervision。 Improve the industry information monitoring system, perfect the industrial risk early warning and prevention systems and emergency response mechanisms, and improve assessment and penalty mechanisms。 Carry out cascaded joint operation and comprehensive monitoring of river basins with hydropower, further improve information management for renewable energy projects, establish information management system that cover the entire industry chain, and implement a reporting system for major quality problems and accidents。 Regularly carry out 'special supervision' on renewable energy consumption, the collection and payment of subsidy funds, project construction progress and engineering quality, project grid-connection etc。

## **9. Investment estimates and environmental & social impact analysis**

### **(i) Investment**

By 2020, additional installed capacity of hydropower will be circa 60 GW, requiring investment of circa 500 billion RMB. Additional installed capacity of wind power will be circa 80 GW, requiring investment of circa 700 billion RMB. Additional installations of the various types of solar power will require investment of circa 1 trillion yuan. When adding investment required for various other types of renewable energy including biomass power, solar hot water heaters, biogas, and geothermal energy, the total renewable energy investment required over the "13th FYP" period is circa 2.5 trillion yuan.

## **(ii) Environmental & social impact analysis**

Renewable energy development and utilization can replace a large amount of fossil energy consumption, reduce greenhouse gas and pollutant emissions, significantly increase new job creation, and as such plays an important and positive role in environmental and social development.

Hydropower, wind power, solar power and solar thermal do not emit pollutants or greenhouse gases in the energy production process, and can also significantly reduce the consumption of various types of fossil fuels, and simultaneously reduce ecological damage from coal mining and water resource consumption from coal-fired power generation. The use of agricultural and forestry industry residues biomass does not increase carbon dioxide emissions when the entire life cycle from growth to final use is regarded, and the emissions of sulfur dioxide, nitrogen oxides, soot and other pollutants from biomass power generation are far less than from coal-fired power generation. In 2020, the national consumption of renewable energy will be equivalent to 730 million tons of standard coal, of which 580 million tons of standard coal eq. will be commercialized renewable energy. Such an annual use of renewable energy is equivalent to reducing carbon dioxide emissions by circa 1.4 billion ton, reducing sulfur dioxide emissions by circa 10 million tons, reducing nitrogen oxide emissions by circa 4.3 million tons, reducing soot emissions by circa 5.8 million tons, and annual water consumption reduction of about 3.8 billion cubic meter, yielding significant environmental benefits.

The renewable energy industry involves a wide range of fields, can effectively drive the development of related industries, and can significantly increase new job creation. It can also play an important role in achieving poverty reduction, have a positive impact on macroeconomic development, and is an even more important driving force for transforming the mode of economic development. In 2020, the number of people employed in the renewable energy sector will exceed 13 million, of which more than 3 million new jobs will be created over the 13th Five-Year Plan period.