

# Renewable energy: key factor of China's energy revolution

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**Abstract.** To realize the sustainable development of China's energy industry, it is necessary to speed up the transformation of energy development mode and deepen the reform of the energy system in an all-round way so as to establish a clean, low-carbon, safe and efficient modern energy system. This paper analysed the opportunities and challenges in energy sectors to promote the energy mix update in China. Fossil energy, especially coal, has brought great progress to the world as well as a great deal of negative effects. In recent years, China's greenhouse gas emissions continued to grow rapidly, and has become the world's largest greenhouse gas emitter. To deal with the challenge, the Chinese government has promised that renewable energy will account for 15% of total energy consumption in 2020 and 20% in 2030. This goal requires China to add 800 to 1000 GW of wind, solar and other clean energy.

## 1. Introduction

Renewable energy is energy form that can naturally be replenished on a human timescale, including sunlight, wind, rain, tides, waves, and geothermal heat. Reported by the Renewable Energy Policy Network for the 21st Century( REN21) in 2016, renewables contributed 19.2% to humans' global energy consumption and 23.7% to their generation of electricity in 2014 and 2015, respectively. Renewables attracted investment of more than US\$286 billion in 2015 and China, EU and the United States are the main player in wind, hydro, solar and biofuels investment.

China's energy mix development is confronted with complicated domestic and international condition.<sup>[1, 2]</sup> Global response to climate change calls low carbon development and provides a great opportunity for China's energy revolution. However, China's energy consumption is still in the stage of inefficient, extensive, high emission and high pollution, and the old development mode and institutional obstacles have become a major challenge for China to achieve energy reform.<sup>[3]</sup> In order to realize the sustainable development of China's energy resources, it is necessary to speed up the transformation of energy development mode and deepen the reform of the energy system in an all-round way so as to establish a clean, low-carbon, safe and efficient modern energy system. Therefore, promoting the energy revolution is an effective way to solve the problems of energy shortage, environmental pollution and global climate change, and clean energy should become an important factor of China's energy revolution.

"13th Five-Year plan" of China proposed a number of indicators for the energy mix to 2020: non fossil increased to more than 15% in total energy consumption, natural gas to reach 10%, coal reduced to below 58%, and coal for power generation accounted for the proportion of coal consumption increased to more than 55%. This means that clean energy will play a more important role in the future. Based on the review of the development of clean energy industry in China, this paper will analyze the opportunities and challenges in energy sectors to promote the energy mix update.

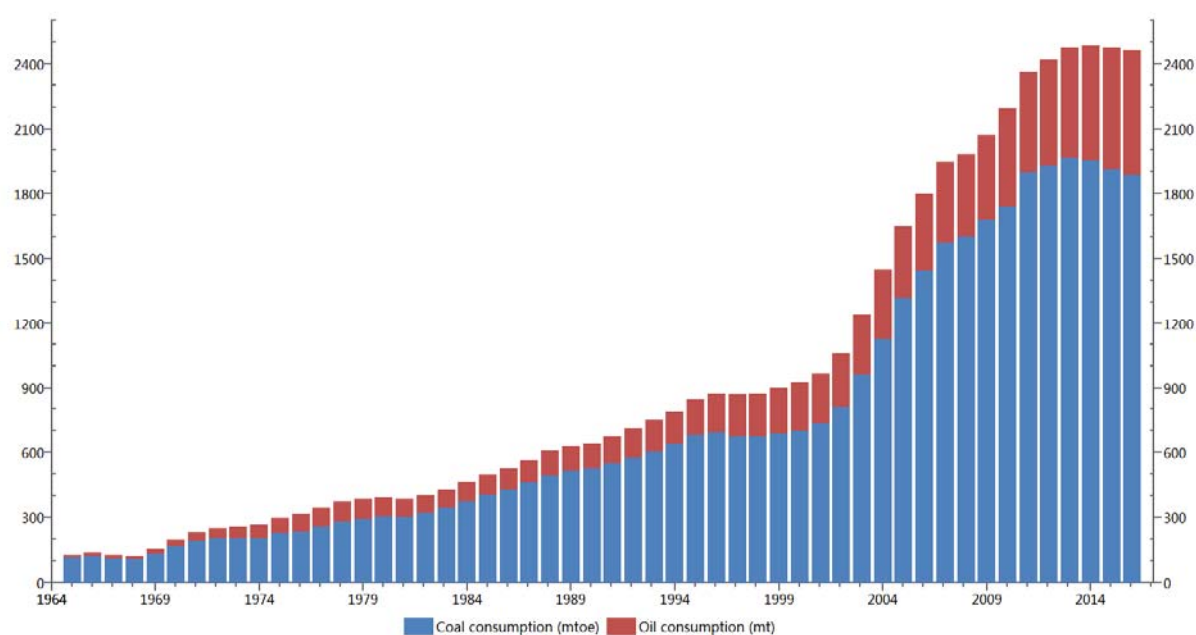
## 2. Fossil fuels in China's energy mix



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Fossil energy, especially coal, has brought great progress to the world as well as a great deal of negative effects. The environmental problems such as haze in China and India, oil pollution in the Gulf of Mexico and finally the climate change. To meet the growing demand for energy, especially the demand for clean energy, governments around the world face the energy security issues. IPCC (Intergovernmental Panel on Climate Change) reported in the fifth assessment report in September 2013 that the climate is undergoing significant change globally, and most likely is due to the cumulative emissions of carbon dioxide since the industrial revolution, thus breaking the balance of the natural carbon cycle.

China's energy consumption growth since 2000 exceeded expectations (Fig.1). In 2015 China's total energy consumption reached 4.3 billion tons of standard coal, and is the world's largest energy consumer. For long term energy mix in China is at low-quality, high-carbon stage, and compared with developed countries which are generally already in oil, gas and renewable energy era, coal has dominated China's total energy consumption and growth. In 2015, the proportion of coal in primary energy consumption was as high as 64%, much higher than the level of developed countries. The large-scale development and utilization of coal has had a serious impact on the ecological environment such as water pollution, land and atmosphere pollution.

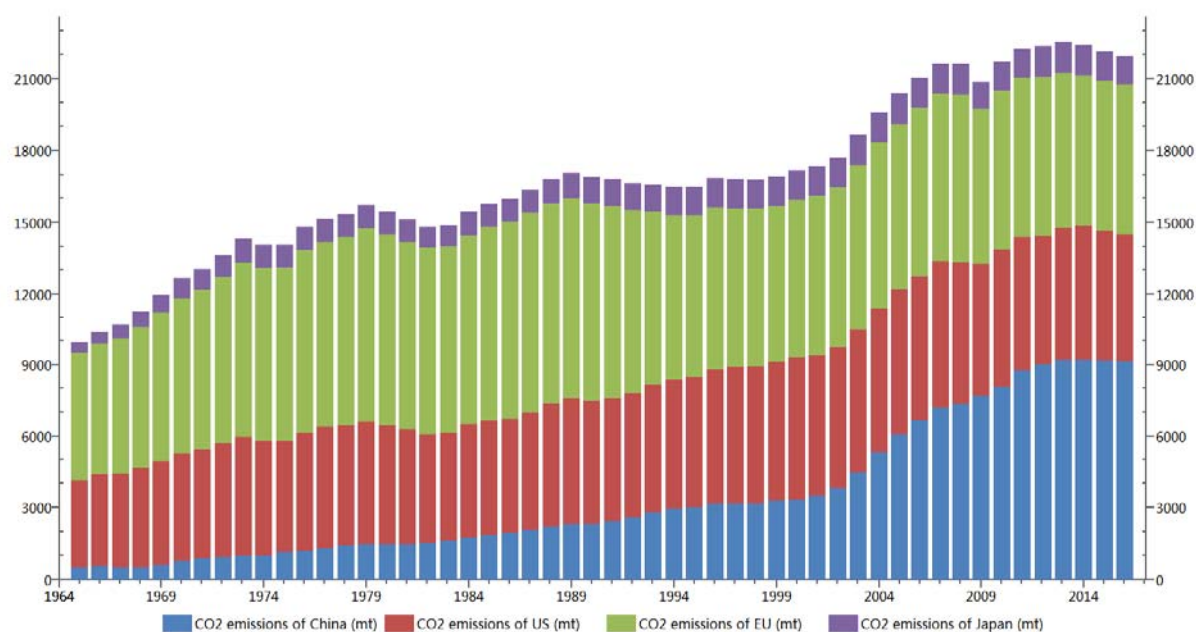


**Fig.1** China's coal and oil consumption since 1964

The latest research shows that China's geological resources and recoverable resources of natural gas, including conventional natural gas, shale gas, coalbed methane and gas hydrate, amounted to 342 trillion cubic meters and 76 trillion cubic meters (by isothermal value conversion, equivalent to 100 billion tons of standard coal). Even if the consumption level than the current doubled each year to 400 billion cubic meters, China's natural gas resources are still available for more than 200 years. From the resource composition point of view, China's geological resources and recoverable resources of conventional natural gas were 68 trillion cubic meters and 40 trillion cubic meters; Shale gas geological resources and recoverable resources were 134.42 trillion cubic meters and 25.08 trillion cubic meters; coalbed methane geological resources and recoverable resources were 36.81 trillion cubic meters and 10.87 trillion cubic meters (Depth of 1500 meters); gas hydrate geological resources of about 102.35 trillion cubic meters, mainly in the South China Sea and the East China Sea, Qinghai-Tibet Plateau permafrost zone and other regions. After nearly 20 years of unremitting efforts, China's

gas hydrate resources exploration has made a major breakthrough. It is supposed that China will realize the commercial development of gas hydrate before 2030.

In recent years, China's greenhouse gas emissions continued to grow rapidly, and has become the world's largest greenhouse gas emitter (Fig. 2). In 1988, China's coal consumption exceeded the United States and in 2007 China's energy consumption exceeded the United States. China's CO<sub>2</sub> emissions in 2009 is more than the United States, becoming the world's largest CO<sub>2</sub> emitter. In 2011, China's energy consumption was comparable to that of the United States, but because of China's coal-based energy structure, greenhouse gas emissions were nearly 80% higher than in the United States.

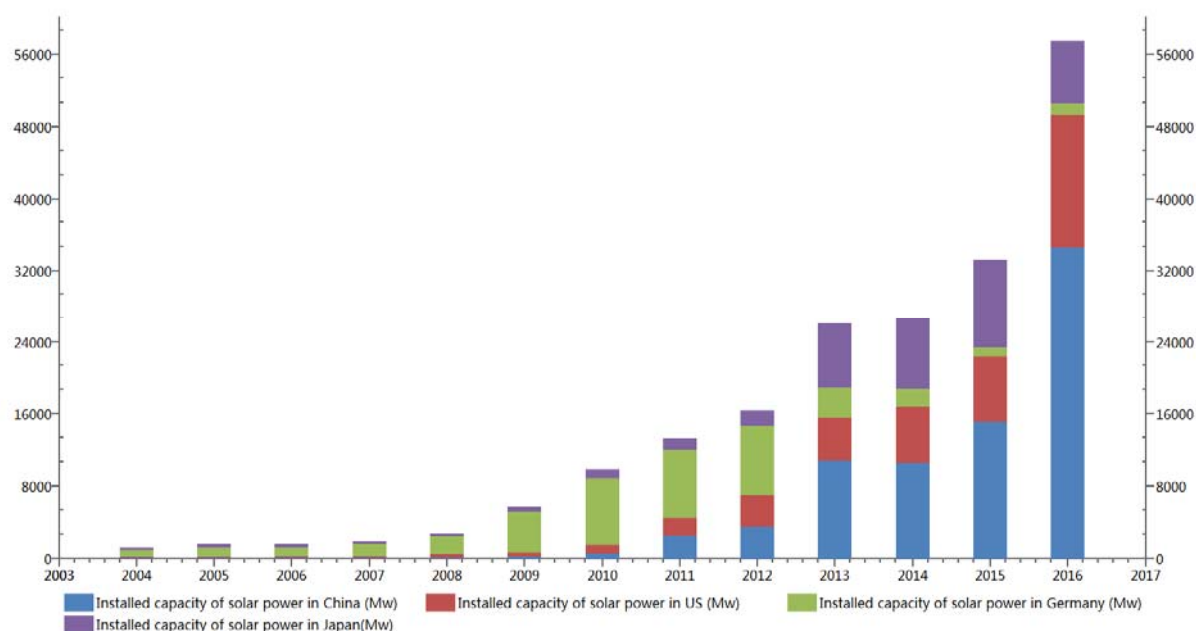


**Fig.2** CO<sub>2</sub> emission of China, US, EU and Japan

### 3. Renewable energy in China's energy mix

China's renewable energy development during the second "Five-Year" period has made remarkable achievements. Compared with 2010, hydropower, wind power, solar power installed capacity increased by 1.4 times, 4 times and 168 times, respectively. As of the end of 2015, installed capacity of non-fossil energy power generation is about 510 million kilowatts, accounting for 35% of total installed capacity. Renewable energy utilization increased from 290 million tons of standard coal in 2010 to nearly 500 million tons in 2015, effectively supported the clean and low carbon development in China.<sup>[4]</sup>

The Chinese government has promised that renewable energy will account for 15% of total energy consumption in 2020 and 20% in 2030. This goal requires China to add 800 to 1000 GW of wind, solar and other clean energy, equivalent to the current US total power capacity. Among them, the solar power generation is China's strategic industry. China's solar power generation increased by 100 times in past five years, and planned installed capacity of 100 million kilowatts by 2020. As of the end of 2016, China's solar power installed capacity is 34.54 million kilowatts, accounting for more than 1/3 of the global installed capacity (Fig.3).



**Fig.3** Installed capacity of solar power (Mw) in China, US, Germany and Japan

Over the past nine years, clean energy investments in Asia and Oceania have continued to grow uninterrupted. In 2016, Asia attracted more clean energy investment than other regions. Investment in Asia grew 16% to \$101 billion, or 42% of the world's total. Regional investment, including Europe, the Middle East and Africa, fell 22% to \$ 87.6 billion. <sup>[5]</sup>

In 2016, although the global investment in clean energy industry fell 11%, China is still surpassing the United States, and get back to the top of clean energy financing leader in G20 countries. The global investment in the clean energy industry in 2016 declined by 11% to \$ 269 billion. While China has once again become the center of clean energy financing in the downtrend, attracting up to \$ 65.1 billion investment, taken more than 30% of G20's total clean energy investment. China's investment in solar energy in 2016 reached \$ 31.2 billion and wind energy reached \$ 27.2 billion, while investment in other renewable energy is \$ 6.3 billion.

#### 4. Conclusion

According to their own conditions, the United States, Germany and other developed countries proposed a series of strategic objectives of energy transformation to deal with global climate change. The G20 summit in June 2015 suggested that global carbon emissions would be reduced by 40% to 70% by 2050, and that the world would achieve complete decarbonization by 2100. The EU proposed by 2050 renewable energy would account for 75% of the terminal energy consumption, and 80% - 95% reduction in greenhouse gas emissions compared to levels in 1990. Germany proposed a 50% drop in energy consumption by 2050 compared to 1990 and a 60% increase in renewable energy consumption. The world's major economies all are adjusting their long-term energy strategy to accelerate the development of clean energy to improve the efficiency of energy resources allocation, to encourage investment in clean energy. <sup>[6, 7]</sup>

Cultivate clean energy market is of great importance for sustainable development. Compared with the traditional energy industry, clean energy industry needs higher R&D investment. In the "13th Five Year" period, the solar energy industry's contribution to China's economic output will exceed one trillion RMB, and may provide about 700 million jobs. It is worth mentioning that the solar energy industry is likely to bring more innovative investment and financing model for China. In the future, the

PV industry's better economic benefits will attract more social capital, and PV industry will bring multiple benefits for the community.

From the data of 2016, China's renewable energy production capacity has been far more than the United States and Germany, and in it the hydroelectric power accounted for more than half of the renewable power generation. In recent years the practice shows that hydroelectric power generation may have a negative impact on the ecological environment of the local waters. Therefore, China will focus on the development of solar photovoltaic and wind power generation in the future.

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