Research on the Optimization of Energy Structure in Jiangsu Province

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Abstract: Jiangsu Province is a major economic province in China. Coal and oil account for more than 90% among all energy consumption in Jiangsu, and the proportion of natural gas and renewable energy is very low. The energy production is obviously insufficient, which cannot meet the energy demand. The balance between energy supply and demand in Jiangsu is also a problem needing attention. Studying the optimization of energy structure in Jiangsu is of great practical significance for the construction of sustainable economic development in Jiangsu.

1. Introduction

Energy is a material guarantee for the development of the national economy. Energy consumption in China has grown rapidly since the 21st century, and China has become the largest energy consumer in the world since 2009. According to the BP World Energy Statistical Yearbook 2018, the world's proven oil reserves are only available for 50 years, coal is only available for 100 years, and natural gas is only available for 50 years. The total energy consumption in China is 4358.19 million tons of standard coal, and the total energy production is 3460.37 million tons of standard coal in 2016 [1]. With the continuous development of economy, insufficient energy reserves, unreasonable energy structure, low energy efficiency, and environmental pollution have become serious problems.

The total energy consumption of Jiangsu Province in 2016 is 349 million tons of standard coal, accounting for 7.13% of the total consumption in China. However, energy resources such as coal in Jiangsu Province are very scarce. The proven reserves are 4.78 billion tons, which is a small proportion in China. The primary energy production of Jiangsu Province was only 24.71 million tons in 2016, accounting for less than 10% of the total primary energy consumption, and more than 90% of primary energy needs to be imported from other provinces or countries [2].

Jiangsu Province is also a major economic province in China. China's GDP was 74059.8 billion RMB in 2016, and the GDP of Jiangsu Province reached 7738.8 billion RMB, more than 10% of the national economic output value [1]. However, with the continuous development of Jiangsu's economy, the energy consumption structure poses a great threat to the ecological environment. The carbon emissions in China were 11.02 million tons in 2016, and the carbon emissions in Jiangsu Province were 570,100 tons [2]. The growth rate of carbon emissions in Jiangsu Province was higher than the national level. Unreasonable energy consumption structure, low energy utilization efficiency, and high energy consumption per unit of GDP are the largest challenges of Jiangsu's sustainable development. Studying the optimization of energy structure in Jiangsu Province is of great practical significance for
the construction of a pleasant ecological environment and sustainable economic development in Jiangsu.

2. Analysis of the energy structure in Jiangsu Province

2.1 Structure of energy consumption in Jiangsu Province

The energy structure is divided into energy consumption structure and energy production structure [3]. The total energy consumption of Jiangsu Province was 349 million tons standard coal in 2016, which is 11.5% higher than 2012. The total energy consumption increased by 2.75% annually from 2013 to 2016, which was 4.9% lower than the average annual growth rate from 2009 to 2012.

| Energy consumption     | 2016  | 2015  | 2014  | 2013  | 2012  | 2011  | 2010  | 2009  |
|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Coal consumption       | 28048.1| 27209.1| 26912.6| 27946.1| 27762.0| 27762.0| 23100.4| 21003.0|
| Standard coal          | 20034.7| 19435.4| 19223.6| 19961.8| 19830.4| 19546.1| 16500.6| 15002.4|
| Coke consumption       | 3840.2 | 3588.6| 3408.6| 3190.6| 3170.1| 3151.4| 2663.4| 2211.2|
| Standard coal          | 3730.3 | 3485.9| 3311.1| 3099.3| 3079.4| 3061.3| 2587.2| 2157.6|
| Crude oil consumption  | 4092.1 | 3823.2| 3511.4| 3394.7| 2947.9| 2981.0| 2998.5| 2661.4|
| Standard coal          | 5845.8 | 5461.8| 5016.3| 4849.7| 4258.7| 4283.7| 3820.1|      |
| Gasoline consumption   | 1012.3 | 1003.8| 974.6 | 891.4 | 935.0 | 827.3 | 749.8 | 585.6 |
| Standard coal          | 1489.5 | 1477.1| 1434.1| 1311.6| 1275.7| 1217.4| 1103.3| 861.7 |
| Kerosene consumption   | 90.5   | 84.8  | 82.7  | 63.7  | 53.1  | 44.7  | 35.6  | 21.1  |
| Standard coal          | 133.2  | 124.8 | 121.7 | 93.8  | 78.1  | 65.8  | 52.5  | 31.1  |
| Diesel consumption     | 821.3  | 819.3 | 814.1 | 752.2 | 803.5 | 759.4 | 727.9 | 655.8 |
| Standard coal          | 1196.7 | 1193.9| 1186.1| 1096.1| 1170.8| 1106.5| 1060.7| 955.6 |
| Fuel oil consumption   | 151.6  | 143.7 | 151.7 | 182.7 | 158.3 | 151.1 | 157.7 | 217.1 |
| Standard coal          | 216.5  | 205.3 | 216.8 | 261.1 | 226.2 | 215.9 | 225.3 | 310.1 |
| Natural gas consumption (100 million cubic meters) | 172.7 | 165.1 | 127.7 | 124.4 | 113.1 | 93.7  | 71.5  | 63.4  |
| Natural gas consumption (100 million cubic meters) | 2297.3 | 2194.7| 1698.4| 1655.4| 1540.7| 1246.7| 951.8 | 843.6 |

From the perspective of various types of traditional energy consumption, coal is the major energy consumption in Jiangsu Province, which accounted for more than 50% of total energy consumption in 2016, and natural gas consumption accounted for less than 10%, as shown in Figure 1. From the trend of traditional energy consumption over the years, the overall consumption of coal has been declining year by year from 2008 to 2016. The proportion of coal consumption was 64.68% in 2008, and it only accounted for 57.33% in 2016, a decrease of 7.35%, as shown in Figure 2. In contrast, the consumption of clean energy such as natural gas has increased year by year. The natural gas consumption of Jiangsu Province increased from 6.31 billion cubic meters to 17.27 billion cubic meters from 2008 to 2016, and the proportion also increased from 3.67% to 6.57%, as shown in Figure 3. Due to the further popularization of natural gas in cities and towns, the proportion of coal in terminal energy consumption is slowly decreasing, and the proportion of natural gas and electricity consumption is increasing. Energy consumption structure is gradually showing a trend of low carbonization [4].
2.2 Structure of energy production in Jiangsu Province

The growth rate of traditional energy production in Jiangsu Province such as coal has dropped significantly recently. The primary energy production of Jiangsu Province was 24 million tons of standard coal in 2016, which is 10.2% lower than 2012, as shown in Figure 4. The primary energy production decreased by 2.7% annually from 2013 to 2016, and the growth rate dropped by 5.2% from the average annual growth rate from 2009 to 2012. The proportion of raw coal production in total energy production of Jiangsu Province was 40.9% in 2016, which decreased by 16.5% compared with 2012. The proportion of crude oil production was 9.6%, which decreased by 0.5% compared with 2012. However, the proportion of natural gas production was 0.7%, which increased by 0.4% compared with 2012. The proportion of primary power production was 36%, which increased by 12.4% compared with 2012[2].
The new energy industry in Jiangsu Province has developed rapidly recent years. Jiangsu's power generation installed capacity was 100 million kilowatts in 2016, which increased by 34.7% compared with 2012. The average annual increasing rate is 7.7% from 2013 to 2016. However, the installed capacity of new energy power generation was 12.32 million kilowatts in 2016, which increased by 282.1% compared with 2012. The average annual increasing rate is 40.7% from 2013 to 2016[4][5].

The new energy power generation capacity in 2016 was 22.6 billion kWh, with an increase of 168.7% over 2012. The new energy power generation increased by 28% annually from 2013 to 2016. The proportion of new energy power generation to total power generation is 4.8%, which is 2.8% higher than 2012, as shown in Figure 5. The continuous decline of traditional energy production and the continuous increase of clean energy indicate that the energy production structure continues to be optimized in Jiangsu Province [6].

2.3 Analysis of the energy structure in Jiangsu Province

Figure 4 Energy production structure of Jiangsu Province

Figure 5 The proportion of new energy power generation in Jiangsu Province
The energy consumption of Jiangsu Province has been higher than that of energy production from 2007 to 2015, and the energy consumption has increased sharply. The amount of energy imported from other provinces has increased year by year. The gap has increased from 188.48 million tons to 278.91 million tons of standard coal.

3. **Comparative study of international energy industry**

In order to further understand the energy structure of Jiangsu Province, we compared the energy economy of Jiangsu Province with the international energy and economic conditions.

3.1 **United States**

The United States attaches great importance to achieve its own energy independence. The energy self-sufficiency rate in the United States has been increasing in recent years. In 2013, the US energy self-sufficiency rate reached 84%. Oil accounts for the largest proportion of the energy consumption structure [8]. Therefore, the US government has continuously increased its oil production. And, energy self-sufficiency is realized through the development of alternative energy sources and energy efficiency.

The United States is one of the first countries to develop new energy industry. The shale gas is a kind of energy source with good economic benefits in unconventional oil and gas. Its exploration and development began in the United States as early as in 1920, the Energy Department of US officially launched the eastern shale gas project in 1976. With the gradual maturity of mining technology, the rapid development of shale gas industry was opened by the 1980s, and the US shale gas production increased rapidly.

3.2 **Japan**

Japan is a major energy importer in the world. Energy consumption is basically dependent on imports, and external dependence on coal, oil and natural gas has reached 99.7%, 97.7% and 96.6% respectively. The energy consumption structure of Japan in 2012 was that, coal accounted for 24.8%, oil accounted for 46.5%, natural gas accounted for 23.3%, and nuclear power accounted for 1%. However, Japan’s nuclear power accounted for 15.1% in 2010. The Fukushima nuclear accident in 2011 led to a significant drop in Japan’s nuclear power to 1%[4].

In order to reduce the import of energy, Japan has proposed the "New Sunshine Plan" to research the development and utilization of solar energy, geothermal energy, hydrogen energy, wind energy, ocean energy and biomass energy. This plan not only promotes Japan's energy diversification, but also meets the requirements of the Kyoto Protocol, reducing energy consumption and greenhouse gas emissions. Under Japan's energy diversification policy, Japan's energy supply structure has undergone major changes, renewable energy accounted for 12.9% in 2014. And Japan is the country with the highest energy efficiency in the world.

4. **Policy Suggestions on the Optimization of Energy Structure in Jiangsu Province**

4.1 **Strengthening energy exploration**

According to the above analysis, the excessive dependence on foreign countries and cities will affect energy security of Jiangsu Province. Energy shortage is a common phenomenon throughout China and the world, and no country can meet the energy consumption of Jiangsu Province. So Jiangsu Province needs to increase the energy exploration, increase energy input, and ensure the safety of energy supply. However, while increasing the intensity of traditional energy exploration in the own province, the enterprises in Jiangsu can push the strategy of walking out and establish their own production bases in energy-rich areas.

4.2 **Developing new energy industry and establishing industrial agglomeration**
The core of new energy development is to establish a complete set of energy industry system and development mechanism. The development of new energy industry is a dynamic process, including research of new energy technologies, product manufacturing, and product after-sales maintenance. The industrial development chain is the fundamental driving force for the development of the industry. Jiangsu Province can develop wind power and solar energy industry with its unique geographical location advantages, and supplemented by new energy industry supporting facilities, such as establishing a new energy industry base, and achieving cooperation between different enterprises in the industrial chain. The government gives policy supports, cultivates and develops new energy markets through special funds and tax policies, to establish industrial agglomeration.

4.3 Adjusting related policies
The renewable energy industry should be dominated by market demand. However, compared with traditional energy source, the development and production of renewable energy is high-involvement in the early stage of construction, and the investment recovery period is long. It requires government encouragement, support and participation. Governments must reasonably grasp the timing and methods of their intervention and quitting. Government should understand on the role that should play in industrial development. Excessive use of administrative power to support industrial development will not only cause unfair e market, but also lead to uncompetitive products hitting the market, which causes waste of resources and decline of industry. The government should rationally carry out macroeconomic regulation starting from various aspects of industrial structure policy, competition policy, subsidy policy and anti-monopoly law, to create an open, orderly and fair competitive environment for renewable energy, and promote innovation in the R&D and management systems of renewable energy industry and optimize the energy structure.

5. Conclusions
The above data shows that, firstly, with the rapid development of economy, the energy demand in Jiangsu Province continues to grow rapidly. The energy consumption structure is unreasonable, coal and oil account for more than 90% among all energy consumption, and the proportion of natural gas and renewable energy is too low. The irrational energy structure has brought various problems to the environment in Jiangsu Province, which has seriously hindered the sustainable development of Jiangsu Province. Secondly, the energy production is obviously insufficient, which cannot meet the energy demand. The gap depends mainly on the import of other countries and provinces. The excessive dependence on foreign countries will not only affect energy security, but also be detrimental to the economic development of the province. Therefore, the balance between energy supply and demand in Jiangsu Province is a problem needing attention.

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