Tianjin Energy Development Dilemma and Way Out

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Abstract. This study will start from different aspects of the energy revolution under the background of energy development in Tianjin City. According to the situation of energy development in Tianjin, Tianjin's energy supply and demand situation is studied. From the current situation of energy supply and demand, we understand the bottlenecks and challenges of energy development in Tianjin. We focus on the bottlenecks and challenges of energy development in Tianjin from three aspects of environmental protection, energy supply reliability and market mechanism. Finally, the implementation path of Tianjin energy production and consumption was studied. According to the current energy situation of Tianjin, the implementation path of Tianjin energy structure reform was proposed from the supply side and the consumption side respectively.

1. Introduction

With the increasing demand for energy in industrial production and residential life and the growing contradiction between environmental issues and energy development, the energy issue has become a hot topic in academic circles and industry in recent years. It is very necessary and urgent for Tianjin to further increase its efforts and comprehensively carry out the development strategy of “replacement by electricity and coal instead of electric energy”. It is of practical and urgent significance to solve the problems of energy security, environmental pollution and climate change and realize the goal of ecological civilization construction. As a pioneering demonstration area of national ecological civilization, Tianjin is very urgent and important to build a new pattern of Tianjin energy.

2. Status of energy supply and demand in Tianjin

2.1. Energy supply situation

Tianjin is located in the central part of the Bohai Sea. With a relatively shortage of coal resources, lack of water resources, limited environmental protection space, and tight land resources, it is difficult to meet economic development by its own resources. It is an energy-input city.

The current industrial and civil coal in Tianjin relies on supply from other provinces. At present, the local gas source in Tianjin mainly comes from the Dagang oil and gas field and the Bohai oil and gas field. In 2015, the city's power generation installed capacity reached 13.24 million kilowatts, an increase of 21% over 2010.
2.2. Status of energy consumption
As far as Tianjin is concerned, it is still an industrialized city. Industrial energy consumption accounts for about 70% of the total energy consumption. The proportion of the tertiary industry is difficult to increase significantly. Far below the current 81% and 68% levels in Beijing and Shanghai. At the same time, the average annual growth rate of GDP during the “Twelfth Five-Year Plan” period was 12.4%, higher than the national average growth rate of 4.5 percentage points over the same period, but still depended on the strong support of industry. The rigid demand for energy consumption is large, and the total amount of energy consumption is under great pressure.

2.3. Tianjin Energy Development Plan
The "Thirteenth Five-Year Plan" period is a key stage for the in-depth implementation of the Beijing-Tianjin-Hebei coordinated development strategy and the comprehensive construction of beautiful Tianjin. The "Outline" determines the direction of Tianjin's urban energy development [1]. Strengthen urban refined management and promote the development of low carbon cycle. The Tianjin Development and Reform Commission issued the “Thirteenth Five-Year Plan for Renewable Energy Development in Tianjin” to continuously increase the utilization of renewable energy. It is planned to achieve an annual replacement of 3.2 million tons of standard coal by 2020 [2].

3. Tianjin energy development dilemma

3.1. Energy conservation and environmental protection issues
Air pollutants in China mainly include sulfur dioxide, particulate matter, heavy metals and nitrogen oxides. For the whole year of 2016, Tianjin's comprehensive index of ambient air quality was 6.65.

![Figure 1. The concentration of six major air pollutants in Tianjin's environment in recent years](image)

3.2. Energy supply reliability issues
According to the actual situation in Tianjin, the overall development and utilization of local renewable energy is small. The development of renewable energy is limited. Due to the constraints of resource conditions such as actual exploitability and the lack of conditions for the development of large-scale hydropower, the wind power development space has become increasingly saturated, the geothermal sustainable development capacity is limited, and the development of solar photovoltaic is slow.

3.3. Market mechanism issues
In the increasingly developed natural gas industry, although the overall market has formed a relatively systematic competitive operation system, due to the lack of favorable supervision of the corresponding departments, Tianjin Gas Group is one of the largest, accounting for 90% of Tianjin's market share. Small and medium-sized companies compete fiercely in the remaining 10% of the market, bringing in hidden dangers in certain construction projects in order to save costs.

4. Tianjin energy production and consumption implementation path

4.1. Energy supply side reform implementation path
4.1.1. Renewable energy generation
Vigorously developing new energy and renewable energy is an important measure to help the energy production and consumption revolution, promote the reform of the energy supply side of Tianjin, and promote the clean, efficient and intelligent development of energy.

Solar power generation. Continue to adhere to the principle of equal emphasis on both distributed and centralized, increase government guidance and support, and issue relevant policies to encourage new energy development. Wind power. Tianjin should develop distributed resources and develop energy-efficient integrated systems for efficient storage and intelligent collaboration. Geothermal aspects. In the future, we should plan and develop geothermal resources in an orderly manner, realize the utilization of resources, and develop ground source heat pump systems according to local conditions to promote the replacement of energy systems. Biomass power generation. Encourage the comprehensive utilization of various forms of biomass including garbage and crop straw. Develop straw power generation according to local conditions, and actively promote the comprehensive utilization of biomass energy to replace coal combustion in areas with good resources and application conditions.

4.1.2. Efficient use of clean energy
Construction of a new energy storage system. Energy storage refers to the storage of electrical energy in the power system, energy storage technology in the power system, with functions such as adjusting energy supply and demand and battery storage time [4]. Energy storage will penetrate into the power generation, transmission, distribution and power consumption of the power system, and its multiple operational benefits and economic value will become increasingly prominent. Construction of multi-energy complementary projects. The "13th Five-Year Plan for Renewable Energy Development in Tianjin" clearly states that it is necessary to vigorously develop a multi-energy complementary integrated energy supply system and increase the scale of development and utilization of renewable energy. Develop distributed resources according to local conditions, and realize complementary advantages between resources [5]; Promote electric energy replacement. Electricity is a high-quality, high-efficiency clean energy. Tianjin actively promoted the “three demonstrations” of the global energy Internet in Tianjin, launched a coal-fired market survey, vigorously promoted the replacement of electric energy, and strived to increase supply and expand.

Table 1. Tianjin Electric Energy Substitution Field

| Serial number | Domain name     | Whether the focus area | Remarks                                                                 |
|---------------|----------------|------------------------|-------------------------------------------------------------------------|
| 1             | Electric heating | ★                      | As of March 2017, the total heating area is 1.7 million square meters.  |
| 2             | manufacturing   | ★                      | As of March 2017, 389 electric kiln projects were implemented in Wuqing and Jinnan. |
| 3             | Port shore power| ★                      | As of March 2017, 65 shore power installations were promoted in Tianjin Port and Haihe River downstream. |
| 4             | Integrated energy| ★                      | The implementation of the State Grid Customer Service Center North Park cold, heat, electricity, multiple energy storage operation and maintenance services. |

4.1.3. External clean electricity
Mengxi-Tianjin South 1000 kV UHV AC power transmission and transformation project will realize the new energy power into Tianjin and the safety and stability level of the large power grid in Tianjin area will be significantly improved. The arrival of the “external power into Tianjin” UHV era will not only increase the voltage of Tianjin Power Grid. Grades have far-reaching implications for economic
and social development, ecological environmental protection and building a strong main network.

4.2. Energy consumption side reform implementation path

4.2.1. Heating and cooling

Tianjin Municipality actively implemented the Beijing-Tianjin-Hebei air pollution control measures and vigorously promoted electric heating to replace coal-fired heating. By the end of 2016, the area of electric heating in Tianjin has been promoted to 1.7 million square meters, the area of electric heating has increased by more than 40% year-on-year. The proportion of electric heating area to the city's heating area increased from 0.12% in 2013 to 0.41% in 2016.

Table 2. the statistics of electric heating area of the whole city from 2013 to 2017

| years | Tired electric heating area (Ten thousand square meters) | Full heating area (100 million square meters) | Proportion of the city's heating area (%) | Annual replacement of electricity (100 million kWh) | Remarks |
|-------|--------------------------------------------------------|---------------------------------------------|------------------------------------------|-----------------------------------------------|---------|
| 2013  | 41                                                     | 3.51                                        | 0.12%                                    | 0.25                                           |         |
| 2014  | 64                                                     | 3.7                                         | 0.17%                                    | 0.35                                           |         |
| 2015  | 108                                                    | 3.94                                        | 0.27%                                    | 0.59                                           |         |
| 2016  | 170                                                    | 4.12                                        | 0.41%                                    | 0.85                                           |         |
| 2017  | 1442                                                   | 4.53                                        | 3.18%                                    | expected 2.31                                  | Wuqing coal to electricity factor |

4.2.2. Industrial production

In various industries where production processes require hot water, steam, and hot air, Tianjin gradually promotes the application of regenerative and direct thermal industrial electric boilers and heat pumps. In the metal processing, casting, ceramics, refractory, glass products and other industries, promote electric furnaces. In the material transportation of mining, building materials, food processing and other enterprises, the promotion of electric drive belt transmission.

4.2.3. Transportation

Building intelligent and efficient green transportation projects. Tianjin demonstrates the application of electric vehicle infrastructure operation safety and interconnection technology, expands urban and intercity fast charge networks, actively promotes interconnection with social operators, promotes resource sharing, realizes intelligent and efficient operation of charging service network, and reduces vehicle exhaust emissions.

Construction of port shore electricity interconnection project. Demonstrate the application of advanced technologies such as shore-based GM and mobile cable vehicles, and build a “one river, one river” standard shore power demonstration project to realize the interconnection and intercommunication of standardized shore power facilities along the river along the Yangtze River. By 2020, the utilization rate of Suzhou ships by port and shore will reach 60%, and the cumulative replacement of electricity will be 50 million kWh, reducing the fuel consumption of ships by 26,000 tons.

4.2.4. Home life

Building a home electrification project. Support the plug-and-play of photovoltaic power generation, distributed power supply, electric vehicle and other systems, continuously increase the proportion of electric energy in household energy consumption, and realize friendly interaction between residents' homes and power grids. To meet the needs of diversified and interactive electricity service, the energy consumption level of residential households has increased significantly.
5. Conclusion
This paper analyzes the current situation of energy supply and demand in Tianjin from the aspects of energy supply and energy consumption. Based on the analysis of Tianjin's energy status and related energy development plans, the dilemma of Tianjin's energy development is clarified. Through the analysis of the dilemma from the aspects of environmental protection, energy supply reliability, market mechanism, etc., the road to solve the dilemma is proposed, namely the implementation road of Tianjin energy production and consumption. The Tianjin energy structure reform was promoted from the supply side and the consumption side, and achieved good results.

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