Energy supply and Strategy of Core Urban agglomeration—taking Guangdong-Hong Kong-Macao Greater Bay Area as an example

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Abstract. With the proposal of Guangdong-Hong Kong-Macao Greater Bay Area, its development is bound to become a world-class economic bay area that our country should pay attention to. However, the Greater Bay Area is located in the Pearl River Delta, where the energy is scarce and the economic development cannot be separated from the supply of energy, so solving this contradiction is a problem that cannot be bypassed in the development of the Greater Bay Area. Under the background of advocating energy-saving and environmental protection and green development, the energy utilization in Guangdong-Hong Kong-Macao Greater Bay Area is more and more important. Based on the analysis of the energy predicament in the Greater Bay Area and the energy strategy of Japan and the United States, this paper puts forward some ideas to solve the energy dilemma in the Greater Bay Area.

1. Introduction
The rapid development of the global economy has led to world-class large urban agglomerations, such as the New York City agglomeration (also known as the New York Bay Area), the Tokyo Urban agglomeration (also known as the Tokyo Bay Area), and the Pearl River Delta region of China, such as Guangzhou, Shenzhen, Hong Kong and Macao are the most important cities represented by Pearl River Delta region. All of these urban agglomerations are the economic centers of the country and even the world, with the characteristics of well-developed economy, scientific and technological progress, high per capita wage and high regional GDP. However, these cities are located in areas where the energy is scarce, and the resources needed for economic development, such as oil and natural gas, depend on external supply, so in order to ensure these large and core urban agglomerations can develop economy sustainably and efficiently with timely energy supply, it is particularly important
to formulate relevant energy development strategies.[1]

On February 18, 2019, the State Council issued the outline of Guangdong-Hong Kong-Macao Greater Bay Area's Development Plan [2]. The large-scale urban agglomeration established by the Central Committee plays an important role in the economic development of our country. Guangdong-Hong Kong-Macao Greater Bay Area includes Hong Kong and Macao Special Administrative regions, as well as Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen and Zhaoqing nine cities in Guangdong Province. Guangdong-Hong Kong-Macao Greater Bay Area has a total population of 69.58 million, a gross domestic product of US $1.5134 trillion, a per capita gross domestic product of US $21750, an airport passenger throughput of 201.69 million and a port container throughput of 66.48 million. Behind these data are the strong economic development strength and important economic position of the Greater Bay Area. Compared with the other three famous economic bay areas in the world, the appearance of the Greater Bay Area is no less than that of the other three famous economic bay areas in the world.

The Greater Bay Area is located in the Pearl River Delta region of China, the terrain is flat, the climate is warm and humid, the water network is dense, the transportation is convenient, the labor force is abundant, has the talented person and the technical advantage. Besides, Guangdong Province has a historical tradition of opening to the outside world, and many Chinese people abroad come from Guangdong Province. In addition, with the reform and opening up, the State has implemented the policy of "opening up to the outside world and giving priority to development" to the Pearl River Delta region. More importantly, the Greater Bay Area has complementary advantages that other urban agglomerations in China do not have. The Greater Bay Area includes Hong Kong and Macao, one Bay area and two systems. Hong Kong is a famous international financial centre, its information resources and human resources are rich, however the labor cost is too high and the market capacity is small. Macao is a world-famous tourist city, but the development space is narrow. In contrast, Guangzhou and Shenzhen are rich in market and human resources. The rapid economic development of Guangzhou and Shenzhen has attracted a large number of cheap labor and technical personnel in the mainland China, coupled with the radiation of its economy, thus forming a huge consumer market. The Greater Bay Area covers the geographical advantages of Hong Kong and Macao, not only provides a large number of funds and technology for economic development, but also can learn a wealth of experience and lessons [3-4].

2. The important position of energy supply in the development of Greater Bay Area
Building a world-class economic bay area and a core urban agglomeration cannot be separated from a certain material basis—energy [5]. Energy occupies an indispensable position in economic development. In the outline of Guangdong-Hong Kong-Macao Greater Bay Area's Development Plan, it pointed out that the development of the Greater Bay Area requires the construction of an energy security guarantee system. The sustainable development and green development of Greater Bay Area are two main aspects: the optimization of energy supply and the strengthening of energy storage and transportation system. The full text of the outline of Guangdong-Hong Kong-Macao Greater Bay Area's Development Plan consists of 11 chapters. In the fifth chapter, "speeding up infrastructure connectivity", using the content of section III, "Building Energy Security Guarantee System", points out that the energy supply and security are significant in Guangdong-Hong Kong-Macao Greater Bay
Area's development. The significance of regional development and the role of realizing the security and stability of energy supply in the economic development of Greater Bay Area cannot be ignored.

After a careful study of the full text of Guangdong-Hong Kong-Macao Greater Bay Area's Development Planning outline, we can see that the word "energy" has appeared 19 times in the planning of Greater Bay Area, not only in the fifth chapter, but also in other chapters. Key words directly related to energy, such as energy saving, energy consumption, wind energy, solar energy and so on, occur 11 times, nuclear power occurs once, coal transit and reserve, oil and gas pipelines and oil and gas reserves are also explicitly mentioned in the planning outline. It can be seen that ensuring the energy supply in the bay area plays an important role in the construction of the bay area. This is due to the realization of the development goal of "building a world-class bay area and enhancing the international competitiveness of the bay area" cannot be achieved without the energy as the source of power, even if it has talent and advanced technology in these core urban agglomerations, and the energy supply can provide power and blood for the development of the bay area.

3. The present situation of energy utilization in Greater Bay Area

Based on the important position of the Greater Bay Area, its economic development cannot be separated from the use of energy, the dense population of the core urban agglomeration, transportation, production, the lives of residents and so on all need a large number of energy resources, how to make effective use of energy and provide energy supply in a timely manner is of great significance to formulate a reasonable energy strategy for the economic development of Greater Bay Area. However, the lack of energy in the Bay Area and seriously dependent on the external supply are very disadvantageous, so the utilization rate of energy needs to be improved. According to the contents of the 13th Five-year Plan for Energy Development of Guangdong Province formulated by Guangdong Provincial Government, during the 12th Five-year Plan period, the total energy consumption in Guangdong Province was 301 million tons of standard coal, of which coal accounted for 175 million tons, about 48 million tons of oil, 14.5 billion cubic meters of natural gas, 531.1 billion kilowatt-hours of electricity for the whole society. In 2015, coal, oil, gas and other energy accounted for 40.5%, 24.6%, 8.3% and 26.6% of the disposable energy consumption structure, respectively. Coal still accounts for the largest share of energy consumption. The above energy consumption data show that Guangdong Province is still a big energy consumption province, and Greater Bay Area is located in Guangdong Province, which has the highest per capita GDP in Guangdong Province, it also requires a large supply of energy. Reasonable planning of energy use and efficient energy consumption in Greater Bay Area are bound to achieve the sustainable development and green development required in the outline of Bay Area Development Plan.

Through the data found (figure 1), we can know that in recent years, the energy structure of Guangdong Province has been optimized to a certain extent, the utilization rate of coal has been reduced, and the utilization rate of gas and other energy has been increased. But coal is still the most used source of energy. Although the proportion of non-fossil fuels such as wind power in energy consumption has increased, but the proportion is still low. This shows that when the sustainable development and green development of the Bay Area are realized in the future, the development prospect of clean energy will be broad, and a large number of related technologies and enterprises will emerge. Hong Kong's resources are even scarcer, with more than 90% of its energy consumption
dependent on imports and the rest supply from the mainland China. More than half of Macao's energy supply comes from the Southern Power Grid, partly by Macao Power and partly by the municipal solid waste incineration. Macao Power and municipal solid waste incineration are thermal power generation, which has a great adverse impact on the environment. Therefore, compared with the Beijing-Tianjin-Hebei and Yangtze River Delta urban agglomerations, the Greater Bay Area has a certain degree of progress in energy utilization and environmental protection, but there is still a big gap compared with the economic bay area of other developed countries.

| The 12th Five-Year Energy Development Strategy of Guangdong Province |
|---------------------------------------------------------------|
| 1. Total                                                      |
| Total energy consumption (100 million tons of standard coal) |
| 2010                                                         | 2.72 |
| 2015                                                         | 3.01 |
| Electricity consumption for the whole society (100 million kilowatt-hours) |
| 4060                                                         | 5311 |
| 2. Primary energy consumption structure                       |
| coal                                                         | 44.5% | 40.5% |
| petroleum                                                    | 27.2% | 24.6% |
| gas                                                          | 7.6%  | 8.3%  |
| other                                                        | 20.7% | 26.6% |
| non-fossil fuels                                             | 14%   | 20%   |
| 3. Terminal energy consumption structure                     |
| coal                                                         | 23.5% | 20.3% |
| petroleum                                                    | 35.0% | 32.4% |
| gas                                                          | 10.2% | 10.8% |
| electric power                                               | 25.3% | 30.8% |
| other                                                        | 6.0%  | 5.7%  |
| 4. Supply capacity (10,000 kilowatts)                        |
| coal electricity                                             | 4084  | 5795  |
| pneumoelectric                                               | 1026  | 1427  |
| nuclear power                                                | 503   | 829   |
| hydroelectricity                                             | 810   | 842   |
| wind power                                                   | 75    | 246   |

Figure 1. Achievements in Energy Development in Guangdong Province in recent years
(The data above are sorted out by the website of Guangdong Development and Reform Commission)
4. Problems faced by energy supply in Greater Bay Area

The energy resources of Greater Bay Area is scarce and needs to be transferred and supplied by the outside world, as is known to all, the development of economy cannot be separated from energy supply. Therefore, the demand for economic development and the shortage of energy supply constitute a group of contradictions. The analysis of the problems of energy supply in Greater Bay Area is helpful to clarify the direction of improvement in the future and to provide a material basis for the realization of sustainable development and green development in Greater Bay Area.

(1) Lack of energy and low rate of energy self-sufficiency

Guangdong-Hong Kong-Macao Greater Bay Area is located in the Pearl River Delta region of China, although the Pearl River Delta region has warm climate, flat terrain and superior natural conditions, it lacks the necessary energy for modern economic development. Guangdong-Hong Kong-Macao Greater Bay Area is generally scarce in energy and low in energy self-sufficiency. It belongs to a typical energy input area, coal, oil, natural gas and other energy mainly rely on transfer and import. In 2012, for example, the external dependence of energy supply in Guangdong Province reached 82.5%, including 100% coal, 77.8% oil and 21.3% electricity. Due to the lack of energy and the high degree of dependence on external supply, the future economic development of the Greater Bay Area may be seriously affected by the external energy supply and restrictions, which is a disadvantageous factor for its economic development.

(2) Low risk resistance of energy

Guangdong Province is short of energy and relies heavily on imports, but the existing energy input in Guangdong Province is unstable and disturbed by weather, war, price and other factors. For the domestic energy transfer, there are typhoons in summer in Guangdong Province, and the appearance of heavy rain and bad weather has caused hidden dangers to the transmission of energy. For imported energy, it is greatly influenced by war, politics and global economy, and its own energy reserves are low, which leads to the low anti-risk ability of energy in the Greater Bay Area in the future.

(3) The proportion of coal use is large and the use of clean energy is low.

Through the relevant data collected above, it can be seen that coal is the most widely used energy source. In 2010, coal accounted for 44.5% of the primary energy consumption, which was significantly higher than 27.2% of oil and 7.6% of gas. Coal accounted for 40.5 percent of primary energy consumption in 2015, down from 2010, but it is still the most used energy. Coal will cause serious air pollution in the process of use, which will have a negative impact on the environment of Greater Bay Area.

5. The reference of overseas Energy Supply and Strategy

The energy predicament faced by the Greater Bay Area has produced unfavorable factors for its development, and other developed countries are also facing the same problems, but some countries attach importance to energy strategy and its experience that is our country worth learning from. It is high time to solve the energy problem in the Greater Bay Area at present.

Japan is located in the east of China, the land area is small, the energy is also extremely scarce, its economic development is also facing the problem of insufficient energy supply. However, the Japanese government pays high attention to the energy development strategy and formulates a series of energy development measures to protect the development of the Japanese economy [6-7]. Japan's
favorable experience is worth learning from. Since 2003, the Japanese government has been working out the Energy Strategic Plan to point the way for the development of energy. According to the "Energy Strategic Plan" framework, the Japanese government, society, enterprises and even individuals are actively practicing to make efforts to ensure energy safety.

First of all, to ensure the safety of oil and gas supply, the import and reserve of energy strategy were enacted [8]. Japanese government pursues the diversification of oil-importing, and establishes good diplomatic relations with oil-rich countries in the Middle East, and ensures the stability and security of energy imports. At the same time, although Japan is short of energy, it still attaches importance to the research of energy exploration and the development of technology, cooperates energy projects with other countries and signs energy contracts, such as participating in the development of oil fields in the United Arab Emirates and in the Abu Dhabi onshore mining area, participating in shale oil and gas development in North America, participating in Australian LNG production and other projects.

Secondly, saving energy and improving its efficiency. To this end, the government of Japan has formulated energy conservation standards and added energy consumption efficiency standards for some products to the newly revised Energy Conservation Act in 2013. According to the Act, large enterprises are required to implement their energy conservation every year, and the improvement of energy consumption efficiency is reported accordingly. At the same time, in the hot artificial intelligence, the Internet of things and other aspects, the Japanese government began to consider the use of hot technology in commerce, housing, transportation and other areas to achieve energy conservation and environmental protection. In terms of the main body of the market, Japan makes use of fiscal policy to promote the research and development of energy-saving technology and the purchase of energy-saving products. For example, if enterprises buy energy-saving equipment, the government gives tax concessions or financial subsidies. Also, consumers buy energy-saving cars, energy-saving refrigerators and so on will receive corresponding government subsidies.

In addition, much attention be paid to the development and utilization of clean energy. In the Energy Strategic Plan of 2018, it pointed out that in order to achieve the goal of energy transformation and decarbonization by 2050, the utilization of clean energy is particularly important in the process of energy transformation and decarbonization. Clean energy mainly includes wind energy, solar energy, geothermal energy, biomass energy and so on. The use of these energy sources is conducive to increasing the security of Japan's energy supply and greatly reducing CO2 emissions. At the same time, the Japanese government attaches special importance to the development and utilization of hydrogen, which has the advantages of wide source of preparation, high density and low carbon dioxide emission. In this way, it is beneficial to reduce the overseas dependence on energy, improve the self-sufficiency of energy, reduce greenhouse gas emissions and realize the transformation of energy structure.

The United States is not only an economic power in the world, but also an energy power country. The United States has an area of 9.37 million square kilometers, ranking fourth in the world, with rich energy and resources. However, the United States is also a major energy consuming country, and its economic development cannot be separated from energy as the material basis. In 2017, the United States passed the Energy Independence and Security Act [9-12], the main content of which is to increase energy imports and expand domestic energy production, also massively develop its shale gas
and renewable energy. Through the combing of the Act, we can find that the energy strategy of the United States presents the following key points: firstly, the use of financial tax and other economic means to regulate the use of energy, the state supports and encourages energy-saving equipment, energy-saving projects to use. The second is to promulgate the legal policies related to energy and then strictly implement them, and punish enterprises and individuals who violate the law. The third is to develop diversified energy import channels, including neighboring countries (mainly Canada) and other major energy producing countries in the world (mainly the Middle East). The fourth is to actively develop renewable energy and utilize new energy.

Through the reference of the energy development strategy of Japan and the United States, this paper holds that as a world-class bay area built by China, the utilization of energy and the supply capacity of energy can make sure the development of economy in the Guangdong-Hong Kong-Macau Greater Bay Area.

6. The Conception of Energy Supply and Strategy in Greater Bay Area
For the sustainable development of Greater Bay Area in the future, it is necessary to optimize the energy structure, control the total amount of energy consumption reasonably, and construct a diversified, high-quality, low-carbonation energy consumption structure system.

(1) Cleaning and optimizing the utilization of traditional energy sources
For the traditional fossil energy, the pollutants produced by its utilization will cause great harm to the environment, but the use of these fossil energy is essential in the economic development. So, weighing the weight, the use of traditional fossil energy in economic life needs to improve the efficiency of its use and reduce the emission of pollutants. The specific approach can be to promote clean utilization and promote clean recycling of fossil energy. It can also promote the use of "Contract Energy Management". Contract Energy Management is an agreement between the energy-saving service company and the energy use unit to agree on the cooperation of energy-saving project, and the energy-saving service company is to provide the service of energy-saving, and the cost of the energy-saving project is paid by the benefits of energy-saving. Under the background of advocating the protection of the environment, "Contract Energy Management" is the inevitable development trend of society to make effective use of energy and realize the optimization of energy utilization. Contract Energy Management has a good promotion prospect in our country.

(2) Development of new and renewable sources of energy
The development and utilization of new and renewable sources of energy plays an important role in increasing energy demand. It is a strategic choice to solve the contradiction between supply and demand of energy and to realize sustainable development. The development of new and renewable sources of energy requires strengthening the research and development of new energy sources such as wind power, solar energy, marine energy, nuclear energy and biomass energy, mastering the core technologies for the development and utilization of these energy sources, and increasing the proportion of renewable energy consumption. The specific approach can be done in consumer terminals, such as enterprises, home, school and so on, certain economic incentives or subsidies are given to people who use the clean energy, and everyone is called upon to use clean energy, and tax concessions are given to companies that develop clean energy, financial incentive policies support for commodities such as cars that use clean energy.
(3) Promoting energy scientific and technological innovation

Science and technology are the primary productive force. Promoting energy transformation and optimizing energy use cannot be separated from technical support. The development and utilization of new energy, clean energy and renewable energy all depend on scientific and technological progress. The government must increase the investment of energy science and technology innovation, overcome the difficult problems of energy technology, develop and utilize new energy and put into market operation. For the emergence of energy science and technology innovation projects, government can give certain financial supports for researchers who study energy technology innovation, researchers can be rewarded after developing innovation results, so as to encourage and support technological innovation.

(4) Expanding international cooperation in energy and broadening energy import channels

The energy of the Greater Bay Area depends not only on domestic transfer, but also on foreign imports, so there is a lot of room for international energy cooperation in the Greater Bay Area in the future. Firstly, we should strengthen cooperation in the field of energy technology, draw advanced energy technology and management experience from foreign countries, and make up for the shortcomings of our country. Secondly, through the form of joint development, the establishment of a multi-channel way of energy import to reduce the pressure to buy energy from outside the province. Thirdly, under the background of "Belt and Road Initiative", we should strengthen ties with neighboring countries, carry out energy cooperation projects, and realize the diversification of energy imports.

(5) Collection of environmental taxes and emissions fees

In the process of energy utilization in Greater Bay Area, we should play to the positive role of the market. In addition to subsidizing new energy vehicles, we can also make use of the market mechanism to regulate people's use of energy. For cars with large emissions, heavily polluted chemical industry, paper industry and so on, environmental taxes and sewage charges will be levied to increase the cost of using fossil energy, so that the competitiveness of new and renewable energy sources is gradually higher than that of fossil energy. In this way, we can guide people to use more energy-saving products spontaneously.

7. Conclusions

Based on the analysis of the dilemma of energy supply in the Greater Bay Area and the energy development strategy of Japan and the United States, the above five suggestions in the future development of the Greater Bay Area are summarized. The development of economy cannot be separated from the supply of energy, so as to prevent the possible energy problems and build ecological livable Guangdong-Hong Kong-Macau Greater Bay Area, we must make some measures to realize sustainable development and green development for Guangdong-Hong Kong-Macau Greater Bay Area.

References

[1] Xu J F 2019 Bay Area Development and Energy Policy Southern Energy Construction 3 1-2
[2] Yu F J, Wang M 2018 Guangdong-Hong Kong-Macau Greater Bay Area Energy Science and Technology Development Direction and Technology Strategy Guangdong Science and
Technology 27 78-82

[3] Yi W J, Liang Q, Fu G Y, Bai Q 2018 The present situation and potential of Guangdong-Hong Kong-Macau Greater Bay Area's green and low-carbon development China Energy 40 21-4

[4] Guangdong, Hong Kong and Macao New Energy Application and Material Innovation Industry Exchange Conference held to help the development of new energy industry in Dawan Area Science, Technology and Finance 2018 40 21-4

[5] Xia Z S 2018 Study on the changing trend and influencing factors of Guangdong-Hong Kong-Macau Greater Bay Area’s conventional air pollutants University of the Chinese Academy of Sciences (Guangzhou, China)

[6] Zhang H Z, Zhang J 2019 Japan's energy transformation research based on energy strategic planning Modern Japanese Economy 38 14-23

[7] Yin X P, Sun P 2019 The role of the Japanese government in the development and utilization of new energy Modern Japanese Economy 38 24-34

[8] Yin Q S 2019 Research on New Energy Development and Policy in Japan Modern Trade Industry 40 58-9

[9] Recent Studies from United States Department of Energy Add New Data to Energy Energy Weekly News, 2019

[10] Qi Q 2019 U. S. Energy Policy Trends Analysis Chinese Price 3 57-9

[11] Yuan J 2018 American energy policy: the basis and cost of inclination International Studies 5 74-89+128