Scientific Research Publishing

Open Journal of Social Sciences, 2022, 10, 55-71
https://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

The Necessity and Feasibility of the Guangdong-Hong Kong-Macao Greater Bay Area to Achieve the Dual Carbon Target and Practice Path Research

Qing Guo*, Wenlan You, Keying Hu, Ziyu He

School of Economics and Trade, Guangdong University of Foreign Studies, Guangzhou, China
Email: *qingguovip@gmail.com

How to cite this paper: Guo, Q., You, W. L., Hu, K. Y., & He, Z. Y. (2022). The Necessity and Feasibility of the Guangdong-Hong Kong-Macao Greater Bay Area to Achieve the Dual Carbon Target and Practice Path Research. *Open Journal of Social Sciences, 10,* 55-71.
https://doi.org/10.4236/jss.2022.1013006

Received: November 9, 2022
Accepted: December 12, 2022
Published: December 15, 2022

Abstract

In the face of the severe situation of global warming, at the 75th session of the United Nations General Assembly in 2020, the Chinese government made a commitment to achieve carbon peaking by 2030 and carbon neutrality by 2060, fully demonstrating its role as a great nation. As one of the regions with the highest level of economic development and openness to the outside world, the Guangdong-Hong Kong-Macao Greater Bay Area has a good foundation to take the lead in achieving the double carbon target. The article first explained the reasons why the Guangdong-Hong Kong-Macao Greater Bay Area must promote the achievement of peak carbon and carbon neutrality from the perspective of necessity. Then we analyzed the favorable conditions for the Greater Bay Area to achieve the dual-carbon goal from the perspective of feasibility. Finally, we proposed five practical paths to achieve peak carbon and carbon neutrality: namely, to continuously promote the structural reform on the supply side, optimize the industrial structure system, and vigorously develop the tertiary industry; to make the best use of local conditions and gather synergies to strengthen the coordinated development of regional low-carbon; and to optimize the development of the tertiary industry. The company also proposes to strengthen regional low-carbon coordinated development; optimize energy production and consumption structure, improve energy utilization efficiency and conserve energy; build green finance, learn from advanced experience and empower low-carbon energy-saving industries; establish a total carbon control mechanism, build a national unified carbon market and improve the carbon trading market system.

Keywords

Guangdong, Hong Kong, Macao and the Greater Bay Area, Carbon Peaking,

Carbon Neutrality

1. Introduction

The climate issue has been widely concerned by countries around the world since it was raised because it is closely related to the development of human beings. At the seventy-fifth session of the United Nations General Assembly, as the largest carbon emission emitter (Xu, Dong, Xu, & Bhattarai, 2022), the Chinese government is striving to achieve a two-carbon target. The two-carbon target aims to achieve carbon peaking by 2030 and carbon neutrality by 2060. The "two-carbon" goal advocates a green, environmentally friendly and low-carbon lifestyle. Accelerating the pace of reducing carbon emissions will help guide green technology innovation, enhance the global competitiveness of industries and economy, and help the world address the severe situation of climate change. This fully demonstrates the moral responsibility of the world's largest developing country, playing a positive and constructive role in the global response to climate change (Cai et al., 2022). The realization of the "double carbon" goal involves the adjustment of industrial structure and energy structure, and has a significant impact on consumption and regional economic structure (Zhou, 2022). However, considering that China still has a long way to go in its socialist modernization process, and that there is still a long way to go in urbanization compared to developed countries, and that the urbanization process still needs to be accelerated, China has a tight schedule and a heavy task to achieve the double carbon target. China is expected to achieve the carbon peak by 2030. However, for carbon neutrality, both the "hardware"—forest cover vegetation, natural ecological system, and the "software"—carbon capture, utilization and storage technologies are relatively lacking, and relevant technologies are in urgent need of breakthrough. As the leader of China's regional economic development and the frontier of reform and opening up, the Guangdong-Hong Kong-Macao Greater Bay Area is at the forefront of the country in terms of investment in innovative technologies and economic development. The Greater Bay Area should become a pioneer in promoting the achievement of the dual carbon target, make a difference in green and low-carbon development and play an early and pilot demonstration role. For example, it should take the lead in achieving the dual carbon target nationwide, explore a carbon neutral realization path that can be promoted and applied on a large scale nationwide, and contribute the Bay Area's strength to the arduous task of achieving carbon peaking and carbon neutrality in China.

2. The Need to Achieve the Dual Carbon Goal

China's current proposal of a dual-carbon target is based on its role as a major country to actively participate in global climate governance, and is also based on

the objective and realistic needs of China's economic development. For the Guangdong-Hong Kong-Macao Greater Bay Area, there are profound socio-economic realities that it faces in adhering to the dual-carbon target. Specifically, it is manifested in the following five aspects.

1) The shortcomings of energy resource endowments are obvious and constrain economic development

China's vast territory and diverse topography have also created the problem of imbalance in economic development between regions due to resource endowment and topographic differences, sometimes with very different levels of development from region to region and from city to city. This has also led to the phenomenon of imbalance of supply and demand between regions, such as the southeast coastal region with high energy consumption demand but relatively scarce resources, while the northwest is rich in oil and gas and wind and solar energy resources but more backward in economic development. This results in a mismatch between the total amount of resources and the level of economic development. The Guangdong-Hong Kong-Macao Greater Bay Area is located in the southeast coastal region of China, and its economic development is at a leading level nationwide, with huge demand for and consumption of energy. The Greater Bay Area used to rely mainly on thermal power generation and power input from outside the province to maintain its energy supply, and its non-fossil energy resource endowment is relatively weak. It does not have the advantages of wind power generation and solar power generation, and hydro power generation and nuclear power generation are difficult to replace as the source of primary power supply due to geographical and environmental conditions. Primary energy consumption in Guangdong, Hong Kong and Macao is dominated by solid fuels, and the share of coal consumption in the nine prefecture-level cities in the Greater Bay Area with a relatively heavy manufacturing sector is much higher than that in Hong Kong and Macao, where the tertiary sector is developed (Bian, 2021). However, the development approach of high carbon emissions in exchange for GDP growth is always not a long-term solution, and low-carbon development is an inevitable trend to follow a sustainable development path. Adopting the strategy of carbon peaking and carbon neutrality can not only play a good role of demonstration and leadership for China to achieve the double carbon target, but also force the production industry to think about system reform and technological innovation. That is, use the scale effect to reduce R & D costs, accelerate the process of energy transformation, and then improve their own energy efficiency and reduce production costs, circumvent the shortcomings of the energy resource endowment of the Greater Bay Area, effectively enhance the safety and security of economic development, and provide an provide an important foundation for sustainable development.

2) The global climate change situation is serious and the carbon reduction process is urgent

With the acceleration of the global economic development process, the natu-

ral ecosystem and climate environment have been irreversibly damaged by human economic activities than before, which may have serious negative impacts on the future of humanity. Even if the Paris Agreement constrains countries to meet their respective carbon reduction targets within a specified period of time, it is estimated that, based on current temperature developments, it may not be possible to achieve the goal of keeping global temperature increases to 2˚C below pre-industrial levels by the end of the twenty-first century, as proposed in the Agreement. According to the current situation, the global warming trend is still intensifying, with the global average temperature increasing year by year, the frequency of extreme weather showing an upward trend, the rate of glacier melting accelerating, and the global sea level showing a rising trend. All signs indicate that the living environment and living conditions of human beings are deteriorating little by little, and the public is increasingly concerned about carbon emissions, and the demand for achieving net zero carbon dioxide emissions is growing. Achieving carbon peak and then carbon neutrality and accelerating the completion of net-zero carbon emissions is related to the future of all human beings, and is the common expectation and common interest of all human beings, and has far-reaching significance for the protection of human living conditions and development. The global climate change situation is so severe that carbon emission reduction is urgent. As an important component of the development strategy of our country, the Guangdong-Hong Kong-Macao Greater Bay Area has an unshirkable responsibility and commitment to achieve carbon peak by 2030 and carbon neutral by 2060. As one of the regions with the highest level of openness to the outside world and the fastest economic development, it should play a pioneering and exemplary role, take the lead in achieving the double carbon target nationwide, and provide data samples and factual basis for the formulation of policies by the motherland.

3) High level of environmental pollution and urgent need to improve environmental quality

As a major manufacturing province in China, Guangdong has a high share of secondary industries in GDP and is still in the process of industrialization. Manufacturing, a pillar industry in Guangdong, accounts for about 80 percent of industrial energy consumption, according to the Guangdong CPPCC website. These industries tend to pollute the environment to a high degree and do a lot of environmental damage, and industrial structural pollution is a serious problem. At the same time, industrial development has squeezed a large amount of ecological space, to a certain extent destroying the regulation function of the natural ecosystem. On the one hand, although economic development has improved people's living standards; on the other hand, environmental pollution and destruction have also reduced people's quality of life. There is no doubt that relying on high carbon emissions does enable high economic development, but the crude economic growth method over the years has also brought irreversible damage to the environment. Human life and economic activities depend heavily

on the health of the environment, and this is not a once-and-for-all development path. Green and low-carbon development is the mainstream trend of global development. As a national development strategy that has received much attention at home and abroad, the construction of the Guangdong-Hong Kong-Macao Greater Bay Area is to achieve the goal of building a world-class city cluster and an international first-class bay area, and to directly benchmark with the three major international bay areas. The center of future GDP growth is bound to be put on the tertiary industry, looking for a low-carbon and zero-carbon economic growth mode, improving the natural ecological environment, protecting the environmental and ecological level, improving the environmental governance level, adjusting the industrial structure, and Vigorously develop the green economy and strategic emerging industries, create green industrial chains, and take the sustainable development path of low-carbon development.

4) The need to achieve major national strategies and the requirements of economic and social development

In 2017, China proposed to vigorously build the national strategy of Guangdong, Hong Kong, Macao and the Greater Bay Area, the positioning of the Greater Bay Area is a world-class city cluster and an international first-class bay area, and a number of documents and policies have been introduced to help the rapid economic development of the Greater Bay Area. Thanks to the unique location advantage of the Greater Bay Area and the national resource inclination, the development of the Greater Bay Area has achieved considerable results, and the speed of economic development is evident to the whole country. The amount of carbon emissions in developed countries has begun to decline, but the required plateau period is long; late-developing countries can consider accelerating the peak of carbon emissions and shortening the high plateau period through the way of peak-cutting development to achieve asymmetric decarbonization (Pan, Liao, & Chen, 2021). Studies show that China's CO2 emissions are expected to peak at about 10.8 billion tons in 2025 and at the latest in 2030 (Yu et al., 2021). Therefore, for achieving China's commitment to the double carbon target, reaching the peak is not the hard part, but the core issue is how China can achieve accelerate the process of achieving carbon neutrality after reaching the peak. As one of the regions with the highest level of economic development, the greatest openness to the outside world and the strongest innovation strength nationwide, the Guangdong, Hong Kong and Macao Greater Bay Area should take the lead in assuming the pioneering role of low-carbon development in respect of the dual-carbon commitment made by the country. For example, it should do a good job in the early trial work and the pilot work of implementing the dual-carbon policy, striving to take the lead in achieving the carbon peak, leading the development of innovative technologies and promoting the implementation of the carbon neutral plan, so as to provide the country with the opportunity to accelerate the peak. This will provide a Greater Bay Area answer sheet for the country to accelerate peak attainment, shorten the high plateau period and

thus achieve carbon neutrality at an early date.

5) The need to promote high-quality, sustainable economic development

Carbon reduction and decarbonization is the trend of global development and a necessary path to long-term sustainable development. The implementation of the dual carbon strategy of carbon peaking and carbon neutrality can force domestic enterprises to think about reform and innovation, encourage investment in research and development of innovative technologies, develop non-fossil energy sources, improve the relatively unbalanced industrial structure, promote the green transformation of manufacturing industries, increase the number of high value-added industries, achieve longer-term development in the foreseeable future, and promote high-quality economic development. The process of achieving carbon neutrality is a systematic project, which requires the Greater Bay Area to do a good job of top-level design (Mai, 2022), top-down integrated planning for the achievement of the dual carbon targets, grasp the current industrial status and carbon emissions and other characteristics of various industries across the board, scientifically formulate a reasonable and feasible plan to work against the original intention of Carbon Dafeng carbon neutrality, and lay a good foundation for the economy to achieve sustainable, high-quality development.

3. Feasibility of Achieving the Dual Carbon Goal

As a national model for high-quality economic development and a pivotal city cluster for building a new pattern of high-level opening, the Guangdong-Hong Kong-Macao Greater Bay Area has laid the foundation for taking the lead in achieving the dual-carbon target due to its unique advantages in politics, economy, culture and technology. Specifically, its feasibility is reflected in the following five aspects.

1) The institutional advantage of "one country, two systems"

"One country, two systems" is a unique political advantage of China, which has made a significant contribution to the peaceful reunification of China and is also an important force in promoting our economic development. Our major decision to build a world-class city cluster in the Guangdong-Hong Kong-Macao Greater Bay Area has taken the institutional advantage of "one country, two systems" to a new level. Nowadays, thanks to the "one country, two systems" and the policy support of the Greater Bay Area, the Guangdong-Hong Kong-Macao Greater Bay Area has continued to strengthen its development in terms of economic, social and ecological civilization, and the total economic volume has been at the forefront of the world. Macaoand Hong Kong have developed tertiary industries, with Macao's gaming and tourism industry and Hong Kong's financial industry being world-renowned. Both have long entered the post-industrial era, with higher carbon productivity than the nine cities in Guangdong in the Greater Bay Area, and are at the forefront of economic development in China (Wang, Dai, & Nie, 2019). In comparison, the Guangdong 9 cities in the Greater Bay

Area have a prominent share of GDP in the secondary industry and a relatively weak tertiary industry. Even Guangzhou and Shenzhen are in a better situation compared to other Guangdong regions but there is still much room for improvement in the industrial structure and the dominance of heavy chemical industries in production, Hong Kong and Macao provide two good sample examples for China to achieve the double carbon target and provide a good example for China to achieve early Hong Kong and Macao provide two good examples for China to achieve the double carbon target, and provide a good experience for China to achieve the "carbon peak" and "carbon neutral" policies. Guangdong, being adjacent to Hong Kong and Macao, enjoys a great geographical advantage, not to mention that under the new development pattern of "double cycle", China is now focusing on promoting the development of the Guangdong-Hong Kong-Macao Greater Bay Area city cluster in various aspects. In order to take the lead in achieving carbon peaks and moving towards the goal of carbon neutrality, the Guangdong-Hong Kong-Macao Greater Bay Area can learn from the advanced experience, policies and technologies of Hong Kong and Macao, which are at the forefront of low-carbon development, analyze their strengths and internalize them for its own use, formulate a low-carbon development path suitable for the Guangdong-Hong Kong-Macao Greater Bay Area itself, avoid the high energy-consuming and sloppy economic development model, and strive to take the lead in achieving carbon peaking nationwide and accelerate the formation of a carbon-neutral path in the Greater Bay Area.

2) A strong base of economic and social strength

As one of the regions with the strongest economic vitality and the highest level of openness to the outside world, the Guangdong-Hong Kong-Macao Greater Bay Area has a good industrial system and industrial foundation, and has the basic conditions to build an international first-class comprehensive bay area, and its economic development is at the forefront of China and even the world. Nowadays, under the strategy of the motherland to vigorously promote the economic construction of the Greater Bay Area, the economy has been developed even more rapidly. As early as 2018, the per capita GDP level of the Guangdong, Hong Kong and Macao Greater Bay Area is already comparable to that of developed countries, with the per capita GDP level of the Hong Kong Special Administrative Region and the Macao Special Administrative Region far surpassing it. Table 1 lists the GDP of each region since the introduction of the Guangdong-Hong Kong-Macao Greater Bay Area Strategy. Although the per capita GDP of Hong Kong, Macao and other cities declined due to the epidemic in 2020, the per capita GDP of Guangzhou, Shenzhen and other cities was still higher than that of 2019, and the per capita GDP of the whole Greater Bay Area showed an increasing trend year by year. With a large scale economy, the institutional support of "one country, two systems", two windows to the world for external exchanges in Hong Kong and Macao, and two free trade zones in Qianhai and Hengqin, the Greater Bay Area is already on par with the three

Table 1. GDP by region since the introduction of the Guangdong-Hong Kong-Macao Greater Bay Area strategy (2018-2020).

Cities	2018		2019		2020	
	GDP (Billions of dollars)	Gross regional product per capita (USD)	GDP (Billions of dollars)	Gross regional product per capita (USD)	GDP (Billions of dollars)	Gross regional product per capita (USD)
Guangzhou	3454.43	23497.30	3425.18	22675.57	3627.22	19578.86
Shenzhen	3660.35	28646.90	3903.33	29497.58	4011.58	23096.31
Zhuhai	440.47	24092.24	498.06	25445.12	504.80	21115.34
Foshan	1501.48	19296.25	1558.46	19402.75	1568.15	16550.22
Huizhou	620.04	12908.09	605.55	12472.78	612.07	10176.08
Dongguan	1251.03	14951.34	1374.57	16308.93	1399.07	13363.50
Zhongshan	548.96	16711.25	449.53	13438.94	456.91	10362.68
Jiangmen	438.30	9569.92	456.13	9885.34	464.07	9711.27
Zhaoqing	332.73	8049.54	325.98	7818.49	335.14	8164.84
Hong Kong	3630.17	48720.83	3660.95	48764.10	3494.50	46707.49
Macao	545.43	82609.00	538.62	79979.93	243.34	35713.80
aggregate	16423.38		16796.38		16716.83	

Source: Guangdong statistical yearbook (2019-2021).

world-class Bay Area cities in developed countries. The developed manufacturing industries of the nine cities in Guangdong and the leading service industries of Hong Kong and Macao, the world's largest ports in terms of throughput, and the world's largest cluster of airports and seaports, give the Greater Bay Area a good location advantage in terms of external development and transportation convenience, laying a solid foundation for its strong economic strength. The energy consumption structure of the Greater Bay Area also has advantages relative to the nation. Compared with the national average, the Greater Bay Area has a lower proportion of coal consumption, more non-fossil energy consumption, and a leading electrification level in the country, which can make the future low-carbon energy transition in the Greater Bay Area go more smoothly. Thanks to its unique geographical advantages and the strong support of the state, the future economy of the Greater Bay Area has some room for growth and a strong foundation of economic and social strength, which provides a good basis for optimizing the energy structure and transforming the economic development model in the future.

3) Broad prospects for the development of science, technology and innovation

The Guangdong-Hong Kong-Macao Greater Bay Area has unique advantages in science and technology innovation, with abundant innovation resources, the highest level of investment in R & D expenditure in the country, strong innovation vitality and broad prospects for the development of science and technology

innovation. In several development planning outlines issued by the Party Central Committee, China has clearly proposed the positioning of the Greater Bay Area as an international science and technology innovation centre and a comprehensive national science centre. In the "China Regional Innovation Capacity Evaluation Report 2020" released by the state, it is mentioned that the score of Guangdong's regional innovation capacity in this year is 62.14, which has ranked the top of the national list for four consecutive years. According to the report published by the Guangdong Provincial Bureau of Statistics 2020, the total number of patents granted in Guangdong province in 2020 was as high as 709,700, an increase of 34.6% over the previous year, with the total number of patents granted in the country; among them, the number of invention patents granted exceeded 70,000, an increase of 18.3%; by the end of 2020, the province had 350,500 valid invention patents, ranking first in the country. The investment in R & D in the PRD is even closer to developed countries such as Germany and the United States; the Shenzhen-Hong Kong-Guangzhou innovation cluster ranks second among the top 100 global innovation clusters. All kinds of data show that the R & D and innovation strength of the Guangdong-Hong Kong-Macao Greater Bay Area is strong, and the scale of investment in R & D funding is large. At the same time, the Guangdong-Hong Kong-Macao Science and Technology Innovation Center is one of the core pillars and power sources for the formation of an innovative country in China, and is the gathering place of China's innovation resources, which has a great role in promoting China's innovation and R & D. During the "13th Five-Year Plan" period, Guangdong, Hong Kong, Macao and the Greater Bay Area continue to promote the vigorous development of transportation and postal and telecommunications industries, make up for the shortcomings of infrastructure, comprehensive planning of transport layout, and clear the obstacles for the development of innovation in the Greater Bay Area in advance. The level of economic development and openness of the Greater Bay Area at the forefront of the country, and the atmosphere of encouraging innovation is an excellent and fertile soil for innovation in the Bay Area. The more innovation is encouraged, the more innovation is promoted, the more innovation is encouraged, so a virtuous cycle is formed, and the development of science and technology innovation in the Greater Bay Area has broad prospects. As one of the regions with the most concentrated innovation resources, the Greater Bay Area not only has the atmosphere of innovation, but also the strength of innovation. Technological innovation has a significant impact on regional carbon productivity, putting the spirit of innovation into carbon emission reduction and carbon neutral regions, strengthening the development of zero-carbon energy innovation technology, helping to accelerate the cultivation of low-carbon or zero-carbon industries, innovating energy utilization and energy systems, accelerating technological innovation in emission reduction, allowing technology become the dominant factor in the market, and let the market in turn advance the depth of technology development (**Figure 1**).

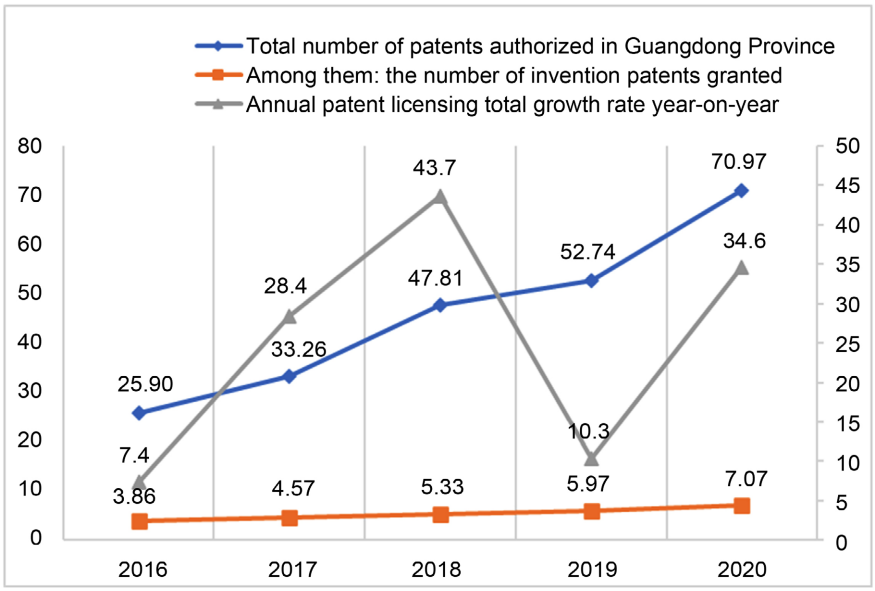

Figure 1. Patent grants in Guangdong, 2016-2020 (unit: 10,000). Source: Guangdong provincial bureau of statistics.

4) High level of openness to the outside world

Guangdong has been the window of China's opening to the outside world since ancient times. Zhuhai and Shenzhen were already considered in the earliest establishment of special economic zones in China, while Hong Kong and Macao are world-renowned free ports for trade. Nowadays, as one of the highest-level windows of China's opening to the outside world, the intersection of the 21st Intercontinental Maritime Silk Road and the Silk Road Economic Belt, with five billion ton ports and several international airports, the policy of opening up to the outside world allows the Greater Bay Area to be directly connected to the world's information frontier and can be quite sensitive to changes in the world's development winds. Compared with Tokyo Bay, San Francisco Bay and New York Bay, which are the representatives of international bay areas, the economic extroversion level of Guangdong, Hong Kong, Macao and the Greater Bay Area is even higher, both in terms of total import and export volume and container throughput, which are far above the other three international bay areas; it is located in the world's largest group of airports and seaports, and has a convenient transportation network system. At the same time, the Guangdong-Hong Kong-Macao Greater Bay Area also includes a number of free trade zones and two special administrative regions of China, which are geographical areas with a very high level of openness to the outside world, forming an extremely strong regional linkage under the development strategy of the Greater Bay Area and effectively improving the level of openness of the overall cities in the Greater Bay Area (Table 2).

5) Strong national policy support

Since China made its commitment to achieving peak carbon and carbon neutrality, it has taken a series of proactive measures to explore the path to achieving

Table 2. Foreign trade data since the introduction of the Guangdong-Hong Kong-Macao greater bay area strategy (2018-2020).

Cities	2018		2019		2020	
	Port container throughput (million TEU)	Total imports and exports ($ billion)	Port container throughput (10,000 TEU)	Total imports and exports ($ billion)	Port container throughput (million TEU)	Total imports and exports ($ billion)
Guangzhou	2192.21	1485.05	2323.62	1450.54	2350.53	1376.12
Shenzhen	2573.59	4539.23	2576.91	4315.70	2654.79	4409.01
Zhuhai	230.77	493.53	255.58	422.15	183.87	394.98
Foshan	399.49	697.66	443.88	700.67	404.97	732.39
Huizhou	43.42	505.58	41.27	393.60	46.39	359.80
Dongguan	355.95	2033.49	404.77	2006.17	379.63	1920.99
Zhongshan	145.09	355.09	144.30	346.75	141.84	318.99
Jiangmen	151.37	223.19	158.27	206.89	166.89	206.48
Zhaoqing	75.05	59.04	66.87	58.66	57.60	59.86
Hong Kong	0.00	11327.74	1830.30	10726.77	1797.00	10568.69
Macao	13.86	126.71	13.30	127.54	12.14	129.39
aggregate	6180.82	21846.30	8259.07	20755.43	8195.63	20476.70

Source: Guangdong statistical yearbook (2019-2021).

the dual carbon goals. China has taken the lead in three batches of low-carbon pilot projects in more than 80 provinces and cities, as well as in seven provinces and cities in carbon emissions trading and the construction of a national unified carbon market, and has introduced relevant support policies for renewable energy generation projects such as wind power and photovoltaic power generation to encourage low-carbon development in enterprises. In terms of green low-carbon development, the Guangdong-Hong Kong-Macao Bay Area has taken the lead, with Guangzhou, Shenzhen, Zhongshan and other cities being selected as pilot low-carbon provinces and cities, and is a pioneering area for low-carbon reform in the country; moreover, Guangdong is also a national carbon emission trading pilot. In addition, Guangdong Province has also introduced a special carbon inclusion policy to motivate the general public and SMEs to actively adopt low-carbon behaviors and help the public to build up environmental awareness of low-carbon living. Although still facing many challenges in technological innovation, thanks to the national support for low-carbon and zero-carbon technologies, more and more enterprises and R & D institutions have carried out relevant technological innovation work, and the scale effect is gradually emerging.

4. Practical Pathways to the Dual Carbon Goal

Based on the above necessity and feasibility study on achieving the dual carbon goal in the Guangdong-Hong Kong-Macao Greater Bay Area, this paper pro-

poses a pathway for the practice of the dual carbon goal in the Guangdong-Hong Kong-Macao Greater Bay Area, mainly.

1) Continuing to promote structural reform on the supply side, optimizing the industrial structure system and vigorously developing the tertiary industry

A look at the structure of the secondary and tertiary sectors before and after reaching the carbon peak is generally characterized by a more pronounced change in the structure of the secondary sector, with the share of the secondary sector in the gross national product tending to decline while the tertiary sector tends to increase (Cai, Li, & Liu, 2021). In developed countries, which have entered the post-industrial stage, the high share of GDP is mainly in low-energy-consuming and low-emission industries such as services. In contrast, China is still in the industrial process, urbanization and industrialization are still being vigorously promoted, and the industrial structure is dominated by industries with high carbon emissions and high energy consumption, such as the secondary industry. Carbon emissions are closely related to the country's industrial structure. Vigorously promoting supply-side structural reform will not only help China achieve carbon peaking as early as possible, but also further reduce the peak level at the time of peaking (Hong, Li, & Cai, 2021). To achieve net-zero carbon emissions and double carbon targets, we must continue to vigorously promote supply-side structural reform, dig deeper into the potential of net-zero carbon on the supply side, give strong support to new materials, new energy, energy conservation and environmental protection and other green and low-carbon strategic emerging industries, take advantage of agglomeration potential and scale effects, encourage greater investment in low-carbon production technologies and low-carbon industrial chains, promote the transformation and development of manufacturing industries in the direction of high quality, create green supply chains, eliminating backward production capacity, reducing industries with high carbon emissions and low energy efficiency, and thus building a modern industrial system and transforming towards achieving high-quality and sustainable economic development. The economic development level of the Guangdong-Hong Kong-Macao Greater Bay Area has already reached the threshold of developed countries, so when exploring the path of achieving "carbon neutrality", we can benchmark developed countries, make reference to their zero-carbon transformation methods, draw on relevant low-carbon development experience, consider introducing the parts of their practices that are suitable for the Greater Bay Area and vigorously implement them, vigorously develop the tertiary industry and gradually increase the proportion of tertiary industries in the gross domestic product, optimize the industrial structure system, maintain economic growth while achieving low-carbon emissions, decouple carbon emissions from economic growth, and improve China's carbon productivity.

2) Local adaptation, pooling synergies and strengthening regional low-carbon coordinated development

Although the overall economic volume of the Guangdong-Hong Kong-Macao

Greater Bay Area city cluster is huge, the quality of regional development varies within it due to differences in administrative and legal systems. In order to achieve the "carbon peak" as early as possible, it is necessary to combine low-carbon objectives with coordinated regional development, improve regional differentiated development strategies, strengthen regional synergistic development of low-carbon industries in the Greater Bay Area, coordinate the institutional differences between Guangdong, Hong Kong and Macao, promote administrative coordination among regions through industrial integration and infrastructure integration, and jointly to carry out cooperation in green industries, guide the industrial structure of slightly less developed regions to develop into green industries and strategic emerging industries, promote complementary advantages of Guangdong, Hong Kong and Macao in the Greater Bay Area, broaden the level of cooperation, strengthen cooperation ties and deepen cooperation, give full play to the unique advantages of "one country, two systems" and the positive agglomeration effect of city clusters, avoid carbon leakage, and gradually change the situation of coarse carbon emissions. This will help the cities in the Bay Area to achieve coordinated development and win-win cooperation in the region. It also helps to promote the construction of ecological civilization, protect the natural environment and vegetation in the Bay Area, maintain the natural ecosystems of mountains, hills and coastal mangroves, help the Bay Area to build an ecological protection barrier, help the innovative application of carbon capture, utilization and storage technologies, and help to achieve the goal of carbon neutrality. At the same time, given the vast territory of China and the rich variety of resources, it is necessary to fully consider the possibility of collaborating with other regions to develop together and complement each other's shortcomings, strengthen the cooperation model of mutually beneficial and synergistic development between regions, and make concerted efforts to jointly achieve the goal of net zero carbon emissions.

3) Optimizing the structure of energy production and consumption, improving the efficiency of energy use and conserving energy use

The endowment characteristics of our energy resource distribution make coal the largest main source of energy for production and consumption activities in the country. To achieve our dual carbon goal, reducing the use of fossil fuels and shifting the dominance of coal in our energy sources is an important way. The lower the share of coal in carbon peaking and the higher the share of non-fossil energy sources, the shorter the time needed to reach carbon peaking (Zhao et al., 2021). For the Greater Bay Area to take the lead in achieving carbon peaking and hence carbon neutrality, it should be committed to changing the consumption structure of energy, building a safe and efficient energy consumption system with low carbon emissions and low pollution, reducing the burning of fossil fuels such as coal, and striving for net zero carbon emissions. Encourage active development of energy development and innovation fields; encourage the use of clean energy and gradually reduce the use of high-carbon fuels; change the way

energy is used, explore diversified uses of energy, make full use of energy and improve energy use efficiency; increase investment in research and development of renewable energy, increase the public's preference for renewable energy, and vigorously promote the development of renewable energy; accelerate technological innovation in emission reduction; optimize the energy We should optimize the structure of energy use, accelerate the energy transition, and use energy sparingly. We will always bear in mind the development policy of "green water and green mountains are the silver mountain of gold", vigorously cultivate the public's awareness of environmental protection and promote low-carbon living.

4) Building green finance and learning from advanced experience to empower low-carbon and energy-saving industries

During the 14th Five-Year Plan period, the State has made the vigorous development of green finance one of the important elements in building a comprehensive green development policy system. If the Guangdong-Hong Kong-Macao Greater Bay Area is to become a dynamic and internationally competitive world-class city cluster, compete with international bay areas and achieve sustainable, high-quality economic growth, it is important to accelerate the construction of a green financial system and continuously promote the improvement of green financial services. The high level of openness to the outside world and strong innovative vitality is important features of the Guangdong, Hong Kong and Macao Greater Bay Area. The Greater Bay Area has unique advantages in the development of green finance. The Guangdong-Hong Kong-Macao Greater Bay Area should seize the opportunity of being the highland of national reform and opening up, take the "Belt and Road" as a grip, rely on the potential of China's huge domestic consumption market, learn from the experience of Hong Kong's developed modern service industry, especially the financial industry, and analyze and study the potential of the system between the nine cities of Guangdong and Hong Kong-Macao according to the industrial structure, resource endowment and location characteristics of different regions within the Bay Area. The nine cities in Guangdong, Hong Kong and Macao should analyze and study the differences in systems, development models and development directions, and explore their own carbon neutral paths in the light of their own strengths and weaknesses. For example, Hong Kong has developed a more mature system in terms of green bonds, carbon audits and carbon disclosure, and can learn from its advanced experience and stand on the shoulders of giants to make up for its shortcomings and shortcomings. Efforts will be made to build an efficient and orderly green financial system, encourage the development of strategic emerging industries, inject financial vitality into energy-saving and low-carbon industries, fully support the green transformation of the economy, and further enhance the domestic and international influence of finance in the Greater Bay Area.

5) Establishing a mechanism for controlling the total amount of carbon, building a national unified carbon market and improving the carbon trading market system

As a major manufacturing province, Guangdong's carbon emissions come mainly from the consumption of locally produced products and services, while the demand for imported high-carbon products from abroad is not small (Wang, Zhao, Liu, Duan, & Song, 2021). To achieve carbon emission reduction, it is necessary to establish a mechanism to control the total amount of carbon and reduce the import of high carbon emission products from abroad, while its own industries should transform to a green structure and produce more green and low carbon products and services. We should make good emission reduction targets and strategies for major carbon emitting industries, grasp the construction of carbon emission management systems for high carbon emission and high energy consumption industries, supervise relevant industries to put carbon emission reduction targets in place, and control the quantity and intensity of carbon emissions. The higher the peak level of carbon emissions at peak, the greater the impact on economic growth rate (Zhang, Jia, & Liu, 2021). Therefore, we should do a good job of supervising carbon emissions at low peaks to avoid enterprises from exploiting the loopholes of the peak before the carbon peak, which will further increase the pressure to achieve the carbon neutral target after the carbon peak, and to minimize the negative impact on the economy when the carbon peak is reached. The national carbon market mechanism is a decisive mechanism to help China achieve the carbon peak within the commitment time (Yang, Tian, & Xu, 2021). The introduction of market mechanisms can optimize the allocation of carbon resources by using the function of spontaneous market regulation, and the construction of carbon emission trading market has been carried out one after another within the country. However, as the carbon trading market system is still in the initial development stage, many details and systems have not been well developed. The Guangdong, Hong Kong, Macao and the Greater Bay Area, as a pioneering area for the dual carbon target, should fully consider the shortcomings of the current carbon trading market and make up for the shortcomings, fully draw on the advanced experience of foreign carbon markets, successively improve the carbon trading market operation environment and system, and actively integrate into the national unified carbon market.

Acknowledgements

The authors disclose receipt of the following financial support for the research, authorship, and/or publication of this article:

We gratefully acknowledge supported by the National Social Science Foundation of China (21CJL007), the Humanities and Social Science Project of China's Ministry of Education (20YJC790036), the Natural Science Foundation of Guangdong (2020A1515010629), the Basic and Applied Basic Research Project of Guangzhou (202102021185), Education Science Planning Project of Guangdong Province (Party history Study and Education Special Project) (No.: DSYJ023), Guangzhou International Trade Centre Research Base Project (JDZB202104), Guangdong University of Foreign Studies, Pacific Island Countries Strategy Re-

search Centre Project (2021PIC003), Guangdong University of Foreign Studies, African Research Institute Project (HX-FZ2022-2), Guangdong University of Foreign Studies, Asia-Pacific Security and Economic and Political Cooperation Research Centre Project (YT2022001), Guangdong Postgraduate Education Innovation Project (2022XSLT027).

Conflicts of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Bian, Y. (2021). Guangdong, Hong Kong, Macao and the Greater Bay Area Take the Lead in Achieving Carbon Neutrality Strategy. *Open Guide, No. 3,* 105-112. (In Chinese)

Cai, H., Li, H. J., & Liu, J. (2021). Insights from International Comparison of Carbon Peak to China's Economy. *New Finance, No. 5,* 23-29. (In Chinese)

Cai, L., Luo, J., Wang, M., Duan, J. L., Li, J. T., Li, Shuo., Liu, L. T., & Ren, D. P. (2022). Pathways for Municipalities to Achieve Carbon Emission Peak and Carbon Neutrality: A Study Based on the Leap Model. *Energy, 262,* Article No. 125435. https://doi.org/10.1016/j.energy.2022.125435

Hong, J. K., Li, Y. C., & Cai, W. G. (2021). Simulation of China's Carbon Peak Pathways from a Multi-Scenario Perspective—Based on the RICE-LEAP Model. *Resource Science, 43,* 639-651. (In Chinese)

Mai, W. J. (2022). Systems Thinking in System Dynamics and Its Application to the Vision of "Carbon Neutrality"—An Example of Carbon Reduction in the Transportation Industry. *Journal of Systems Science, 30,* 17-22. (In Chinese)

Pan, J. H., Liao, M. L. & Chen, S. M. (2021). Carbon Neutrality: How Fast Can China Go? *Reform, No. 7,* 1-13. (In Chinese)

Wang, H., Dai, X. L., & Nie, X. (2019). Analysis of Carbon Productivity Differences in Guangdong, Hong Kong and Macao Greater Bay Area Based on Thiel Index. *Science and Technology Management Research, 39,* 214-221. (In Chinese)

Wang, X. E., Zhao, S. H., Liu, X. Y., Duan, H., Y., & Song, J. N. (2021). A Study on Carbon Emission Reduction Model of Provincial Consumption Side with Carbon Neutrality Target-Oriented-Based on Multi-Regional Input-Output Model. *Ecological Economics, 37,* 43-50. (In Chinese)

Xu, G., Dong, H., Xu, Z., & Bhattarai, N. (2022). China Can Reach Carbon Neutrality before 2050 by Improving Economic Development Quality. *Energy, 243,* Article No. 123087. https://doi.org/10.1016/j.energy.2021.123087

Yang, C. J., Tian, Y., & Xu, X. (2021). A Price-Tax Mechanism for Achieving Carbon Peaking and Carbon Neutrality. *Price Theory and Practice, No. 1,* 20-26, 65. (In Chinese)

Yu, B. Y., Zhao, G. P., An, R. Y., Chen, J. M., Tan, J. X., & Li, X. Y. (2021). Study on China's Carbon Emission Pathway under Carbon Neutral Target. *Journal of Beijing University of Technology (Social Science Edition), 23,* 17-24. (In Chinese)

Zhang, S. G., Jia, H. Q., & Liu, M. (2021). Analysis of the Economic Effects of Different Scenarios for China to Achieve the "Double Target" of Carbon Emissions by 2030. *Journal of Chongqing University of Technology (Social Science), 35,* 8-15. (In Chinese)

Zhao, M. X., Lu, L. H., Wang, S., Bai, Z. H., Zhang, N., Luo, H., & Fu, J. F. (2021). Me-

ta-Regression Analysis of Carbon Peaking Pathways in China. *Environmental Science Research, 34,* 2056-2064. (In Chinese)

Zhou, J. (2022) Analysis and Countermeasures of Green Finance Development under Carbon Peaking and Carbon Neutrality Goals. *Open Journal of Social Sciences, 2,* 147-154. https://doi.org/10.4236/jss.2022.102009