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Urban Planning Strategies Based on Green and Low-Carbon: A Case Study in Guangzhou City, China

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Abstract: The promotion of urbanization has become a major trend in the development of the new era. It brings cities rapid economic growth but also leads to significant carbon emissions. Cities are crucial in adopting low-carbon development policies and carrying out carbon reduction initiatives since they are large sources of energy use and emissions of greenhouse gases. The building of low-carbon cities has been essential at a time when carbon neutrality and carbon peaking have become the consensus and mission of humanity. Following the theory of low-carbon urban growth theory, the article takes Guangzhou city in China as an example, describes its low-carbon policies in urban planning during different periods, and discusses its low-carbon initiatives and effectiveness. It is known that Guangzhou is now constructing a low-carbon metropolis but has issues with two distinct aspects of transportation and industrial transformation. The urban transportation system needs to be improved, and the industry needs to upgrade and transform. In response to the problems, this article recommends countermeasures to intensify efforts to enhance public transportation and enable the low-carbon transformation of industry in order to promote the green and scientific growth of Guangzhou as a low-carbon city.

Keywords: low-carbon, urban planning, Guangzhou, low-carbon city

1. Introduction

Today, with the development of technology and economy, ecological and environmental issues, such as global climate change and the frequent occurrence of extreme weather, have become the major challenges facing people in the 21st century. Cities are concentrated regions with people, buildings, industry, transportation, and logistics, but they are also concentrated regions of high energy use and high carbon emissions from sources that produce greenhouse gases [1]. As the carrier of human production and living activities, the energy consumed by cities in the development process causes greenhouse gas emissions, which harm people and the ecological environment. The City of London in the United Kingdom has been exploring and developing a model fit for its low-carbon city construction over the years as a pioneer in low-carbon city design and practice. In 2007, “Acting Today, Protecting Tomorrow: Climate Change Action Programme”, which was issued by the city of London, set out carbon reduction targets and specific implementation plans for the city, including sections on existing housing stock, energy transport and waste disposal, and transport [2].

Low-carbon cities have become increasingly important in China’s urban planning over the years. Along with the fast growth of urbanization and social economy in China, carbon dioxide emissions

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continue to grow, and China is still facing unprecedented pressure in greenhouse gas emission reduction. With the increasing awareness of low-carbon, different regions in China have explored low-carbon development of cities and actively promoted low-carbon urban building [3]. For low-carbon city planning, the specific requirements include controlling the two types of data (greenhouse gas emissions and urban energy consumption) at a lower level, enabling city residents to form a low-carbon living concept and consciously cultivate a low-carbon lifestyle [4].

Guangzhou, as a first-tier city in China, is listed in the Chinese list of low-carbon pilot cities. In order to boost the construction of ecological civilization, Guangzhou promotes green and low-carbon sustainable development in six dimensions: urban space, land use, green buildings, green transportation, energy facilities and ecological carbon sinks, and constructs the field of territorial spatial planning to meet Carbon Peaking and Carbon Neutrality Goals. Abiding by urban low-carbon development theory, this paper describes the urban growth of low-carbon and the policy background of low-carbonization in Guangzhou, discusses the initiatives and effectiveness of low-carbonization in the city, and proposes countermeasures for the low-carbon urban building in our city in the fields of transportation and industrial transformation, for the reference of Guangzhou low-carbon urban construction.

2. Low-carbon City Development

The notion of low-carbon has been applied to the economy, culture, life, etc., resulting in the concepts of “low-carbon economy”, “low-carbon energy” and “low-carbon city”.In 2003, the UK government published the energy white paper named “Our Energy Future: Creating a Low Carbon Economy”, in which the concept of “low carbon economy” was formally introduced for the first time and attracted strong public attention.It noted that low-carbon economy is one in which more economic output is achieved by consuming fewer resources and polluting the environment less to realize a higher quality of life. The analysis shows that the gradual formation of “low-carbon cities” is the practical application of the concepts of low-carbon in urban planning.The low-carbon concept has begun integrating into urban development planning because of the increase in energy consumption and carbon emissions in cities. It has also been continuously improved and applied to encourage the growth of green and sustainable cities. The definition of a low-carbon city covers three levels: the city government using the society of low-carbon as a building blueprint, the inhabitants using the living of low-carbon as a philosophy and behavior, and the city economy with the production of low-carbon and the industries of low-carbon as the dominating model [5]. With the expansion of low-carbon-related research,the importance of low-carbon in urban planning is increasingly growing , and low-carbon practices are implemented in urban development in multiple countries and regions. Theoretically and practically, it has been established that the development of low-carbon city is a basic way for raising cities’ productivity and achieving sustainable urban development [6].

Regarding the low-carbon urban development, it is that the city maintains a lower level of consumption of energy and emission of CO_2 despite the high economic development as a premise [7]. Although the low-carbon urban building of China started relatively late, China also attaches great importance to the reduction of carbon emissions. At this stage, China is continuously exploring the development path of low-carbon cities, ensuring the use of low-carbon concepts in sustainable, social, and economic growth.Shanghai and Baoding were chosen as the “Low Carbon City Pilot”‘s pilot cities so that advance low-carbon and green growth in mainland China at the beginning of 2008. This initiative was jointly launched by the Ministry of Construction and WWF (World Wide Fund for Nature).In response to the ecological challenges faced,China launched the pilot of low-carbon cities in 2010, leading Guangdong, Shaanxi, Hubei, Liaoning and Nanchang as low-carbon pilot provinces and cities. It requires the above-mentioned provinces and cities to actively facilitate the building of green low-carbon cities, explore low-carbon sustainable development models,accelerate the

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formation of consumption patterns and industrial systems characterized by low carbon, and play a demonstration role in dealing with climate change.

3. Low-carbon City Construction in Guangzhou

3.1. Overview of Guangzhou City

Guangzhou, which has a total size of about 7,000 square kilometers and is located in southern China's Guangdong Province, is the province's capital (Figure 1). As a national comprehensive gateway city, Guangzhou is the political, economic, cultural, technological and transportation center of South China and one of the starting points of the Maritime Silk Road - the "Southern Gate" of China.

As a national low-carbon pilot, Guangzhou has been actively carrying out the low-carbon urban building, continuously innovating low-carbon city pilot construction, promoting a substantial decrease in the intensity of cities carbon emissions, positively integrating the low-carbon concept development into economic and social growth and other aspects, and promoting low-carbon urban development in all aspects. During the "13th Five-Year Plan" period, Guangzhou City vigorously promoted energy development and achieved excellent results. The city's energy system is also steadily developing, transforming toward clean, low-carbon, and safe efficiency. According to statistics,the total consumption of energy in Guangzhou in 2020 is about 61.915 million tons of standard coal, up 8.8% compared to 2015,and the city's regional GDP will be 2,501.9 billion yuan in the same year, which energy-related industries play a significant role.

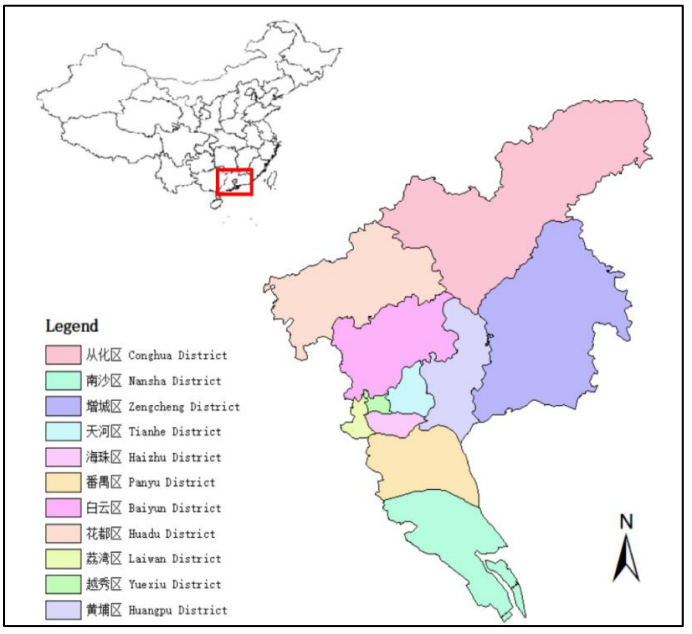

Figure 1: Administrative divisions of Guangzhou.

3.2. Low-carbonization Initiatives in Guangzhou

3.2.1. Decarbonization Policy Background

Since the 21st century, Guangzhou City has been exploring the road of decarbonization, gradually forming a road suitable for its development and achieving results. In 2010, Guangdong Province carried out pilot work to explore low-carbon development institutions and mechanisms, giving full effect to green low-carbon leading ecological civilization construction. Guangzhou has increased environmental protection and ecological construction throughout the 12th Five-Year Plan period

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(2011-2015),persisted in the path of sustainable development in an effort to address the urban ecological issues faced.

The Thirteenth Five-Year Plan for Energy Conservation and Carbon Reduction in Guangzhou (2016-2020) (referred to as "the Plan") was published by the Guangzhou Municipal Government in 2017. Guangzhou has built a low-carbon energy supply system during the 13th Five-Year Plan, including accelerating the promotion and application of natural gas, vigorously developing renewable energy, strictly controlling the total coal consumption amount and improving the level of grid intelligence.

In addition, in 2023, the municipal government issued the "Guangzhou Carbon Summit Implementation Plan" to implement the "Top 10 Carbon Summit Activities". Its mission is to focus on critical areas, industries, and key links of carbon emissions, increase efforts to optimize the energy structure, deepen energy saving and consumption reduction in critical areas such as industry, science and technology innovation, and transportation, and insist on the carbon peaking concept throughout the process of economic and social development, to drive Green and low-carbon growth in Guangzhou. At the same time, Guangzhou also has promulgated and implemented relevant measures in the optimization of energy consumption structure To accelerate the elimination of backward production capacity, Guangzhou has formulated and released the "Guangzhou Industrial Energy Efficiency Guide", strengthened the review of energy conservation in fixed asset investment projects, and strictly controlled the launch of high-emission projects and high-energy-consuming.

3.2.2. Urban Low-carbon Projects

With the implementation of pertinent policies, Guangzhou has progressively carried out the construction work of low-carbon projects in an effort to accelerate the development of low-carbon cities. The urban low-carbon project mainly starts from energy security projects and new energy demonstration and utilization projects for the purpose of ensuring reasonable carbon emissions in energy consumption.

Nowadays, Guangzhou's low-carbon projects fall into the following four categories: (1) environmental protection upgrading projects: Zhujiang Power Plant million, Nansha Hengli centralized heating units and Huangpu Power Plant and other units of the upgrade to strengthen environmental protection; (2) natural gas cogeneration projects: Huangpu Power Plant, Huadu Auto City, Xintang Yinsha and Yonghe GCL Blue Sky Phase II natural gas cogeneration and other projects use to ensure efficient energy usage. (3) Distributed energy station projects: In Sino-Singapore Knowledge City, Guangzhou Financial City and other areas, such projects are promoted and utilized to ensure good economic and environmental benefits in the region. (4) New and renewable energy projects: In response to the low-carbon policy, Guangzhou has added about 1. 85 million kilowatts of installed solar distributed photovoltaic power generation capacity, 300,000 kilowatts of installed biomass power generation capacity and 150,000 kilowatts of installed wind power generation capacity.

3.3. Effectiveness of Decarbonization in Guangzhou

Guangzhou's urban development has insisted on the resolute implementation of low-carbon policies over the years. The city has been moving forward in building a low-carbon city and has already made remarkable results. The Carbon Neutral Group of the 21st Century Institute of Economic Research released the "China Net Zero Carbon City Development Report (2021)" [8]. It evaluates the net zero carbon development level of 30 sample cities from two main aspects: economic development quality (total economic volume, development speed, people's living standard and urbanization level) and green development quality (urban air quality, greening coverage, solid waste treatment level, and

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urban carbon sink level). The outcome shows that Guangzhou ranks ninth in the overall ranking of net-zero carbon development level of the selected cities, with excellent performance in development quality index, which also indicates the remarkable effectiveness of Guangzhou's low-carbon city construction situation. From this, Guangzhou's high score on the Development Quality Index means that the city's general industrial solid waste disposal rate and greening coverage of built-up areas are higher in the sample cities. Guangzhou's GDP has grown at an average annual rate of 6% throughout the 13th Five-Year Plan period, and the intensity of the city's carbon emissions dramatically decreased during that time. In addition, Guangzhou has actively participated in national carbon market construction and the work of new industries in the local carbon market, and Guangzhou enterprises have completed carbon quota compliance for eight consecutive years (2013-2020). The city government actively assists Nansha District in declaring the first batch of national pilot projects on investment and financing to address climate change, and recommends declaring 20 enterprises in the province with outstanding contributions to reducing pollution and carbon, among which Zhuyuan Valley Green Low-carbon Park is selected as a typical case of green low-carbon in 2021 by the Ministry of Ecology and Environment.

Guangzhou's low-carbon city construction is productive with regard to carbon emissions and energy "double control" (total energy consumption control and energy consumption control per unit of gross regional product) and energy consumption structure optimization.

(1)Guangzhou's total energy consumption climbed by 1.7% annually throughout the 13th Five-Year Plan, and the cumulative energy consumption of the gross regional product declined by 19.4%, which indicates that energy conservation and consumption reduction are effective. (2) Meanwhile, Guangzhou vigorously promoted the development of high-end, intelligent and green manufacturing industries, accelerated the construction of a modern and economical industrial system led by advanced manufacturing industries, modern service industries and strategic emerging industries, and promoted the green development of transportation, thereby further promoting the transformation of urban-rural construction to green and low-carbon.

3.4. Problems and Strategies of Low-carbonization in Guangzhou

Despite the apparent effect of low-carbon measures in Guangzhou, some problems remain to be solved, mainly in industrial transformation and transportation. This article combines low-carbon development theories and presents relevant strategies to tackle the problems faced in these two aspects to refer to constructing a low-carbon city in Guangzhou.

3.4.1. Promote the Low-carbon Transformation of Industrial Development

In the "low-carbon city," which is defined by "low emissions, high energy efficiency, and high efficiency," the industrial structure and the transformation of the development model be adjusted so taht scientifically promote the economy of low-carbon. This would probably result in a new growth point without restricting city development, build a sustained momentum for city development, and ultimately improve urban life [9]. For more than thirty years of reform and opening up, industrial development has always been the most important driving force of Guangzhou's urban development.

China's cities are shifting from crude to intensive urbanization development, and developing low-carbon industries is beneficial to promoting the transition of Guangzhou's urbanization mode from crude to intensive. The rough urbanization model increases the intensity and quantity of resource and environmental consumption, while the intensive urbanization model, on the contrary, reduces the intensity and quantity of resource and environmental consumption. For further building a low-carbon city, Guangzhou should be more committed to reducing industrial carbon emissions. The current priority is implementing the city's industrial upgrading to complete the low-carbon transformation.

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Pushing the green and low-carbon transformation of traditional industries, actively developing green and low-carbon industries, and promoting high-quality industrial development are essential to meet carbon peaking and carbon neutral targets. The municipal government should strengthen the supervision of high-energy-consuming and high-emission projects, carry out energy-saving and emission-reducing work for the existing projects and eliminate the backward and overcapacity high-energy-consuming and high-emission projects.

3.4.2. Promote the Development of Low-carbon Urban Transportation

Urban transportation demand is on a growing trend, along with an increase in energy consumption, as society develops continuously. Statistics have shown that Guangzhou's traffic carbon emissions have continued to rise over the years, though the city's traffic has not reached its peak.

Hence, to achieve the goal of carbon neutrality and carbon peaking, Guangzhou should increase the building of a green and low-carbon transportation city with "urban public transportation + bicycle + walking" as the leading mode. It should also actively increase the number of urban public transportation to enrich the public travel options available to residents, guide residents to travel by public transport and achieve the effect of low-carbon emission reduction. Promoting low-carbon travel for residents and securing the urban transportation of low-carbon to achieve lower carbon emissions iscurrently among the key points of low-carbon urban building.

In order to meet urban transportation demands and reduce carbon emissions for a better environment, it is vital to facilitate low-carbon urban transportation development. The Guangzhou Municipal Government could enhance public participation in low-carbon travel by promoting environmental education, formulating relevant policies and measures, and developing "Internet + low-carbon transportation" to Promote public consciousness of low-carbon development [10].

4. Conclusion

As the key to carbon emission reduction, cities need to integrate low-carbon concepts in urban planning to facilitate the urban building of low-carbon. Accelerating the mode of economic development's transformation, as well as realizing urban transformation and upgrading, is an obvious choice and a general trend for Guangzhou's urban development. Guangzhou is constructing a low-carbon city with different development plans and measures in industry, energy, construction, transportation and living. The related activities include developing and growing green and low-carbon industries, promoting the reduction of coal consumption, developing green buildings, strengthening energy-saving standards for new buildings, developing public transportation, promoting energy-saving and environment-friendly transportation, promoting waste separation and collection, and cultivating public awareness of low-carbon.

Even though the city of Guangzhou has now achieved significant results in constructing a low-carbon city, there are still parts that can be worked on and implemented to implement the carbon peak and carbon-neutral target tasks. Given the situation of low-carbon city building in Guangzhou, while ensuring the current effectiveness of low-carbonization, Guangzhou should emphasize the role of low-carbon concepts in transportation as well as in industrial transformation for the purpose of making sure the perfection of low-carbon transportation in the city and complete the transition of industrial low-carbonization. The urban building of low-carbon is a significant direction of development in cities in China and is a fundamental way to cope with the energy crisis and climate change. It could better advance the construction of an environment-friendly society as well as ecological civilization,and is beneficial to the sustainable city development in China.

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