

The Application of Low-carbon City Theory in Urban Planning

Kui Li*

Administrative Examination and Approval Service Bureau of Yangling Demonstration Zone, Yangling 710002, Shaanxi province, China. E-mail: 68249497@qq.com

Abstract: With the development of modern society, environmental pollution has become the most important problem in today's society, especially the large amount of greenhouse gas emissions. It not only makes a variety of natural disasters occur frequently, but also seriously affects the safety of people's lives and property. So it is necessary to take low-carbon life as the main design concept in urban planning so as to maintain the healthy development of the whole city and society. The paper further explains the application and development prospect of low-carbon life theory in cities by studying the current situation and problems of low-carbon city and discussing the relationship between spatial layout, transportation system and industrial structure in urban planning and low-carbon city theory.

Keywords: Low-carbon Theory; Urban Planning; Application

1. The current situation of low-carbon city researches

1.1 The concept of low-carbon city

How to solve the global warming and climate change caused by greenhouse gases has become a major problem for global development. Since 2003, the theory of low-carbon cities has gradually come into people's view and it is considered as the first choice to curb global climate problems. Urban planning has a certain limiting effect on urban operation and urban elements, which is the core means of low-carbon city. Therefore, the application of low-carbon city theory in urban planning has become the focus of social attention.

There is no consistent definition about the concept of "low-carbon city" theory in academic circle. The Sustainable Development Strategy Research Center of Chinese Academy of Social Sciences defines "low carbon city" as developing low-carbon economy with urban space as the carrier, implementing green transportation

and construction, changing residents' consumption concept and innovating low-carbon technology, so as to achieve the goal of minimizing greenhouse gas emissions^[1]. From the definition, we can see that low carbon city includes all aspects of urban life. City is the key to carbon dioxide emission reduction, and urban planning, as the basic means of urban construction and management, undertakes the important mission of promoting "low carbon city". Ideologically speaking, it is necessary to improve the theoretical awareness of low-carbon life of urban residents. It is also necessary to establish a low energy consumption, high energy efficiency, low emission, high cycle urban operation mode from the material basis.

From the perspective of urban construction, survival and development, we can understand the basic form of the city, the causes and ways of carbon emissions in the pattern of urban construction, and the energy transfer process in the process of carbon emissions. And we can also summarize the appropriate planning methods in dif-

ferent attributes of urban space according to the impact of carbon emissions, so as to make targeted urban environmental policy and implement planning and construction, and shape the urban living environment in line with the requirements of the times.

1.2 Related researches of low carbon city

Scholars all over the world are keen on the research of low-carbon cities, and the research levels are also different. Each country has also formulated relevant policies to strengthen the construction of low-carbon cities based on the results of national researchers. The white paper: Our energy future: Creating a low-carbon economy published in 2003 in the UK mentioned that in order to cope with global climate change, we should promote the reduction of greenhouse gas emissions in human production and life. The book, starting from the compilation principles, implementation contents, public participation, feedback and other aspects, comprehensively and systematically planned the sustainable development of low-carbon urban construction road^[2]. The UK government also said it would reduce carbon dioxide emissions year by year. Similarly, in China, as early as the 2007 APEC meeting, Jintao Hu proposed to vigorously develop the low-carbon economy and promote the R&D and application of low-carbon energy. In the pilot ecological park funded by China, all life styles are carried out according to the theory of low-carbon life. Through long-term observation of the life content in the living area, scientists and social science investigators find some problems in our low-carbon lifestyle in real life, and it is of great significance to study and solve these problems, so as to take a step closer to build a comprehensive low-carbon city^[3].

Low carbon concept is a targeted direction. In the process of urban planning and construction, on the premise of not affecting the social, economic and cultural development and the quality of people's production and life, we can continuously reduce the total amount of urban carbon emissions, save energy, protect the environment, give "green water and mountains" to future generations, and improve people's quality of life through formulating reasonable policies, regulations and rules and adhering to the practical idea of adjusting measures to local conditions and using advanced scientific and technological means. China has also issued a series of

policies to promote low-carbon development in recent years, including "National Plan to Deal with Climate Change", "Comprehensive Work Plan for Energy Conservation and Emission Reduction", indicating that low-carbon is an important direction to solve urban energy consumption and environmental pollution.

2. Existing problems in urban development in China

Since the Economic Reform and Opening up, China's economy has stepped into the fast lane. At present, it is the second largest economy in the world. In 2020, its GDP even exceeded 100 trillion. It has made remarkable achievements. However, the rapid development of the economy has brought many environmental and energy problems, the most prominent of which is the problem of urban energy transition consumption. At the same time, the environmental pollution and food safety problems are becoming more and more serious. In winter, fog and haze frequently occur in northern China. In addition, there are also problems of air pollution, water pollution and solid waste pollution. All those had an extremely adverse impact on the natural resources and our environment. Environmental protection departments have been increasing their efforts to improve all kinds of governance related to environment protection. But under the huge urban development trend, population and production and business activities continue to concentrate in cities, there will inevitably a huge energy consumption and repeated environmental damage, thereby the efforts of government departments are also becoming more and more important.

The production and life of human beings are closely related to energy and environment. Due to the economic development and the unrestricted and disorderly expansion of urban construction, the urban land layout is unbalanced, where the urban center is too dense and there is no necessary green space and leisure space. And the population and industrial layout is unreasonable, resulting in the continuous deterioration of urban traffic problems and environmental problems.

Since 2020, the COVID-19 has been rampant, and it has been spreading rapidly in large cities, especially in densely populated areas, which is inevitably related to the current intensive urban life and environmental dete-

rioration.

3. The application of low-carbon city theory in urban planning

As the fundamental basis of urban construction and management, urban planning plays an important role in economic and social development. It is the key measure to integrate the concept of low-carbon city into urban planning so as to realize the construction of low-carbon city. The economic development mode under the concept of low-carbon advocated by China in the new period is a new adjustment of urban development with low-carbon energy and low-carbon technology, and also a new opportunity and challenge for the profound change of urban planning mode^[4].

3.1 Spatial layout of low carbon city

In the initial stage of urban master planning and spatial layout, we should ensure the implementation of the concept of low-carbon city from the macro level and decision-making source. On the basis of the control indicators of specific plots, the urban regulatory planning should also increase the requirements of specific indicators, such as supporting facilities and reserved space, which are conducive to deepening the low-carbon concept. Detailed urban planning should adopt a variety of ways to realize the implementation of low-carbon design concept at the operational level.

3.1.1 Spatial structure of low carbon city

Urban carbon emissions and urban spatial structure are inextricably linked. How to deal with the contradiction between urban population density and spatial structure layout is the key to achieve the goal of low-carbon city. For a long time, the spatial layout of many cities has been developing in a way like cooking a big pie, resulting in the dense construction in some urban areas, the excessive population density, and the prominent Urban Heat Island Effect. First of all, we should curb this disorderly urban expansion, reduce the Urban Heat Island Effect, reduce the power consumption of cooling energy in summer, and improve the quality of life of local residents. Secondly, we need to continuously evacuate the population and the scale of construction, introduce the concept of “garden city”, integrate the green corridor, wind corridor and sight corridor into the city, reasonably divide and space different functional blocks, and avoid

the excessive concentration of urban construction and population in a certain area. At the same time, it is also necessary to integrate convenient urban public transport into low-carbon urban planning, so that people can enjoy a good landscape environment while the quality of life continues to be improved.

In terms of urban spatial structure, we should select the most suitable low-carbon urban planning and construction scheme according to the analysis and research of the regional characteristics, industrial characteristics, climate and temperature, living habits and other aspects of the city and determine the spatial structure layout of the city according to local conditions. At the same time, in different regions of the city, it is necessary to demonstrate and study the low-carbon planning scheme in combination with the regional functions, and formulate different low-carbon construction measures according to the functional characteristics, so as to ensure that the measures can be combined with the reality and enhance the feasibility and practicability of implementation.

3.1.2 Land use planning of low carbon city

In the new round of land and space planning, it is necessary to scientifically formulate the nature and development intensity of urban land, reasonably divide the “three red lines” of urban basic farmland, urban land development and ecological environmental protection, and delimit the scale and scope of each functional area in combination with the characteristics of regional landscape and forest fields. At the same time, it is also necessary to avoid the problems of single use and waste of resources caused by the functional zoning in the traditional urban planning through allocating the production and living land reasonably and reducing the traffic congestion, pendulum work and disconnection between education and health care and residence caused by people’s interpenetration between different functions, thus greatly reducing the high carbon emission caused by unreasonable layout. We should also constantly optimize the functions of the planned or under construction areas, such as setting up some small office and business land in the residential area, so that some people in the area can work in the area and reduce the energy consumption of commuting. We can also arrange restaurants, bars and temporary kindergartens in the industrial zone, so that the workers’ needs for work, taking care of children, leisure and entertainment can be met in the park, bringing prac-

tical convenience and comfort to workers. Through the regional function mixing and demand-oriented function upgrading, we can constantly correct the unreasonable regional function layout or rigid zoning.

3.2 Transportation system of low carbon urban

To build a low-carbon urban transportation system, the most important thing is to reduce the city's road emissions. At present, China's motor vehicle ownership and production and sales have been ranking first in the world for many years, and there is a growing trend. While automobile life brings convenience to modern urban life, it also brings many problems, such as traffic congestion, energy waste such as gasoline, automobile exhaust pollution, urban traffic safety and so on. The research of relevant environmental protection agencies shows that the haze problem in China in recent years has a direct relationship with the excessive number of road vehicles in China. Therefore, it is more and more urgent to reduce the carbon emissions of urban roads as well as the environmental and exhaust pollution, and improve the urban traffic efficiency. First of all, it is necessary to plan the urban roads on the basis of low carbon theory. Low carbon urban transportation system mainly includes urban road system planning and green urban transportation system.

3.2.1 Low carbon urban road system planning

The planning of urban road system includes the layout of all levels of urban roads and the design of road section. Road network is the skeleton of urban development, whether it is reasonable will not only directly affect the size of urban traffic carbon emissions, but also seriously affect the production and living activities of urban residents. Reasonable planning of urban road network is very important for reducing carbon emissions and building low-carbon cities. Due to the rapid development of cities, the road network planning of many cities in China is not very reasonable. Traffic congestion exists in most central cities, especially in developed cities like Beijing, Shanghai and Guangzhou, and even in some small cities. Therefore, when we plan the road system, we should pay attention to the effectiveness of the road, and build a convenient and fast trunk road running through each center in a big city, so that the main traffic

flow of the city can be quickly accessible between different regions, and reduce congestion and waste of resources. It is necessary to build transit express outside the city so that the transit vehicles and logistics vehicles can pass through without entering the internal traffic of the city as far as possible and reduce the impact on urban internal traffic flow. In the main residential and commercial areas of small and medium-sized cities, we can appropriately improve the level of road configuration, reduce the length of trunk road and increase the number of branch road. In road construction, we should fully consider the economic activity and population density of the region, and also understand the development direction of future urban construction. We should add more branch roads in densely populated areas while reducing branch roads in sparsely populated areas, so as to realize the reasonable distribution of main roads. Moreover, we should establish a more convenient and efficient traffic road to reduce unnecessary waste of resources, thus forming a multi-level and multi specification low-carbon urban road system to meet different traffic needs.

3.2.2 Green urban transportation system

In order to establish a complete low-carbon transportation system in low-carbon cities, the first thing is to develop public transportation. With the development of society, the traditional mode of public transport is unable to meet the needs of urban development, so people turn from the ground traffic to the underground rail subway. As an emerging public transport mode, subway has the characteristics of high speed, large traffic volume and low carbon emission. Therefore, in the planning of building a low-carbon city, the assistance of subway is essential. Of course, the traditional way of public transport is also indispensable. In some urban areas where underground conditions are limited and subway cannot be built, public transport is an irreplaceable means of transportation. Public transport can not only take away some of the passenger flow pressure for the subway, and its network density can easily cover all the main living areas of the city, which is convenient for residents to reach the destination. In some big cities of our country, university towns, industrial parks, satellite cities, commercial office areas and other areas with large traffic demand are also introducing BRT (Bus Rapid Transit) or LRT (Light Rail Transit) and other modern

means of transportation to realize the rapid delivery of population point-to-point large capacity across regions.

The construction of low-carbon urban planning not only needs planners' wisdom of urban hardware design, but also needs people's increasing awareness of low-carbon life. Because the increase of road carbon emissions has a lot to do with the affluence of people's lives and the widespread purchase of private cars, the speed of urban road planning and construction is far behind the speed of the increase of cars on the road, which makes the urban road network unbearable and urban traffic congestion inevitable. According to the research, the carbon emission in the process of traffic jam is 3-5 times larger than that of normal driving, which aggravates the damage to urban roads and causes noise pollution such as car honking, and the energy waste and environmental pollution are incalculable. Therefore, while building a low-carbon city, we should strengthen the efforts to encourage green travel, that is, to encourage people to go out by bike or on foot. Of course, this must be guaranteed by complete green travel facilities. In urban planning, we should consider the traffic safety and traffic space of green travel, and combine with the planning of urban green space, parks and squares to build "urban slow road" with bicycle lane and promenade as the main part. According to the requirements of "five minute life circle" and "15 minute life circle", we should reasonably arrange various living facilities and public service facilities in the city, and control the service radius of various facilities, so that citizens can use bicycles and walks to solve their basic living needs. At the same time, we should also pay attention to the beautification and safety of the traffic environment. No one is willing to walk carefully on the road full of gasoline. When planning the road, we should reserve enough green traffic space in advance. Combined with road greening, we should form a slow road system with beautiful environment, fresh air and safe facilities. In many cities, the slow track is connected by plastic runway and green space, forming a green corridor throughout the city, which has become an ideal place for the general public to exercise. At the same time, the road travel management departments also need to develop a reasonable system to provide convenience for people who travel by bicycle. Bicycle stops and pedestrian rest points should be set up near the subway and bus to facilitate citizens to transfer to various means

of transportation as soon as possible. Only when we are considerate for people's green travel in many aspects can we guide more people to join in the action of green travel. Finally, it can create an effective and efficient green urban transportation system that fully considers the human scale and human needs.

3.3 Industrial structure of low carbon city

The process of China's rapid economic development is the process of huge energy consumption, which will inevitably show the energy demand characteristics of some developed countries. China consumes 50% of the world's coal, 40% of its cement and steel, and 30% of its oil every year, ranking first in the world. Meanwhile, China's urbanization process is accelerating. According to the National Bureau of Statistics, China's urbanization rate exceeded 60% in 2019, and registered residence urbanization rate was 44.38%. The rural population has been constantly gathering to cities, especially in large and medium-sized cities. The urbanization rate has continued to improve and a series of problems need to be solved urgently. For the hundreds of millions of new urban population flowing into the city every year, it is not only necessary to provide adequate housing, but also put forward higher requirements for public facilities such as transportation, medical and health care, urban greening, etc. The construction, operation and maintenance of these urban infrastructures need to consume more energy. Similar to developed countries, China is bound to experience the process of urbanization, which is characterized by high energy consumption and high emissions at the initial stage; unlike developed countries, China's urbanization process is also facing many global challenges, such as climate change, food security, energy scarcity and so on. Therefore, in China's urban planning and development, we must use the concept of low-carbon city as the most important principle, in order to achieve the sustainable development of the city and environment.

At the same time, we must reasonably adjust the original industrial structure of the city. On the basis of meeting the production and living needs of the continuous influx of urban residents, the urban industrial structure should take the realization of low-carbon as the goal, guarantee the technological upgrading of traditional industries, encourage and develop emerging industries, and constantly realize the optimization of industrial struc-

ture^[5]. The basic characteristics of traditional industries are high energy consumption, high pollution, low added value and large carbon emissions. To improve the transformation, we should improve the comprehensive utilization rate of energy by promoting clean, reduced and efficient production and constantly eliminating backward production capacity, and strengthening the governance of pollution emissions, so as to realize the balance between environmental protection and industrial benefits. At the same time, we should increase the support for emerging industries and expand the urban industrial structure according to the city's characteristics and resource endowment, thus developing modern low-carbon, environmental protection and high value-added industries such as new energy, new materials and new technologies. Combined with the change of urban production and life style, we should vigorously develop new industries such as solar energy, bioenergy, ground source heat pump, new energy vehicles, urban garbage power generation, and reclaimed water reuse, so as to meet the employment of urban population and effectively reduce carbon emissions.

4. Conclusion

The application of low-carbon city theory in urban planning covers the utilization of urban resources, trans-

portation system, industrial structure and other aspects, and it aims to jointly create a new and more dynamic urban organic system. The system itself and its subsystems shall form a balanced and harmonious state under the new principles, so as to make the urban environment and appearance more comfortable and pleasant, creating a more low-carbon economic urban life, which also have the power of continuous development and renewal. We live in cities. The theory of low-carbon city is closely related to the life of every individual in our society. Let's practice the concept of low carbon in every aspect of our life and create a beautiful and sustainable urban future.

References

1. Sun G. Introduction to low carbon economy. Shandong People's Publishing House; 2010.
2. Ren L. Low carbon economy and sustainable development of China's economy. *Social Scientist* 2009; (2): 48.
3. Huang W, Ge Y, Zhou Q. Research progress of low carbon urban community planning (in Chinese). *Journal of Anhui Agricultural Sciences* 2010; 38(11): 59–69.
4. Chen X, Yuan Z. Application of low carbon concept in urban planning (in Chinese). *Science & Wealth* 2015; (08): 365.
5. Wang Y. Application of low carbon city concept in urban planning. *Construction Materials & Decoration* 2017; (03): 109.