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Strategic Choice and Practice of Low Carbon Urbanization in China

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Abstract

The rapid development of China's economy in the past 35 years is essentially the rapid development of urbanization, which has not only raised the economic level, but also brought huge environmental risks. It is estimated that China's urbanization is about 20 years away. Facing the future, how can we meet the economic development needs and minimize the impact on the environment, which is a problem for China's development and a global problem. In recent years, China has been exploring and practicing this path.

Keywords

Energy conservation and environmental protection, Low-carbon economy, New-type urbanization, Positive climate

1. Introduction

On December 12, 2015, the 21st United Nations conference on climate change concluded a landmark “Paris Agreement”, marking the beginning of a new global climate order. “Paris Agreement” sets a long-term goal of the global response to climate change, which is compared to pre-industrial levels, the global average temperatures increase amplitude is controlled within 2 ℃, the global carbon emission is controlled in 40 billion tons by 2030, achieving net zero emission in

2080.

As countries around the world move towards “zero emission” target, the goal of China's carbon reduction is also being updated. In 2015, China's goal was to reach peak carbon emission by 2030, and to reach a peak as soon as possible. Carbon emission per unit of GDP fell by 60-65% over 2005 levels. Non-fossil energy accounted for about 20% of total energy consumption; Forest storage increased by 4.5 billion m^3 over 2005[1] .

Also, to play a leading role in dealing with climate change as a large country, China may well according to the situation of the domestic carbon emission and the own ability, gradually improve the emission reduction targets of the national independent contribution in the last year of each five-year plan. In the future, China will be more and more independent and will be much stricter [2].

However, China is still a developing country and is in the process of "urbanization". How to solve the contradiction between urban development and energy conservation and emission reduction is a difficult problem for Chinese policy makers. To this end, China's leaders have proposed a path of "new-type urbanization" to guide urban development to a low-carbon model, which is the only way for China to combat climate change.

2. The course of China’s urbanization

In the past 35 years, China has experienced an unprecedented urbanization process in human history. In 1980, at the beginning of the reforming and opening, there were only 15 megacities in China with more than one million people. In 1990, it reached 31, and in 2012, it reached 65. It makes China the country with most megacities in the world. In 2012, China became the second largest economy in the world after the United States, with a national urbanization level of 52.6%, which reached the medium level of the developing countries[2,3]. The urbanization process that China has experienced, both in scale and speed, is unprecedented in human history. Urbanization rate increased from 20% to 40%, the UK has experienced 120 years, France has experienced 100 years, Germany has experienced 80 years, the United States has experienced 40 years (1860 ~ 1900), while China has only used 22 years (1981 ~ 2003)[2,4].

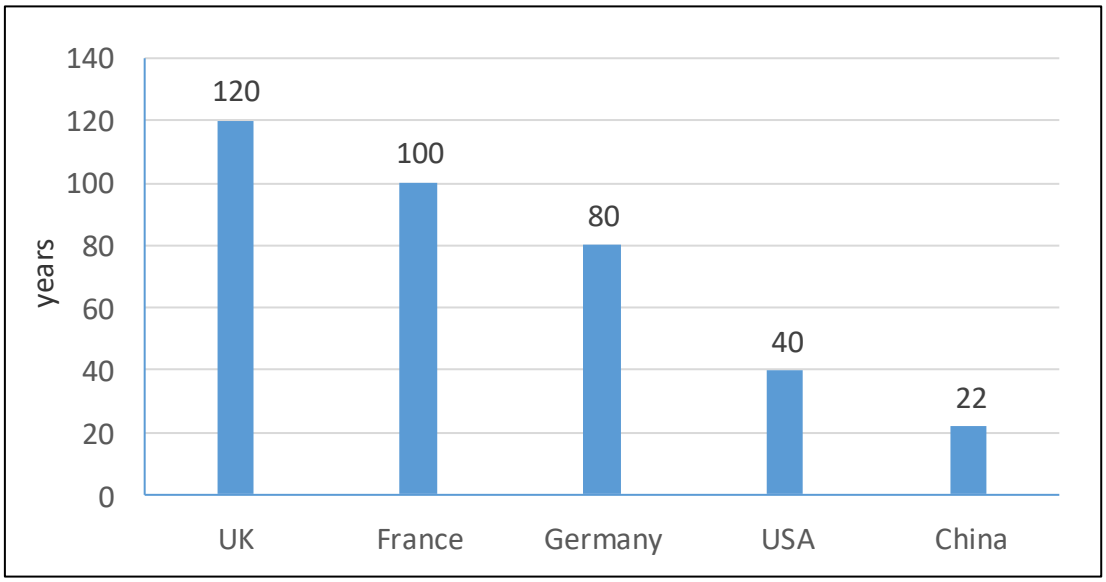

Fig.1. How long that the urbanization rate of major countries increased from 20% to 40%

The historical process of “high-speed urbanization” is essentially the expansion of China’s urban construction land. In the past 35 years, China has implemented the “urban priority policy”, urbanization and industrialization have become the top priority of development, and the “urbanization” promoted “industrialization”. The government, in the form of auction land, attracts a large amount of capital for urban real estate development. Real estate development brings the development of the iron and steel, nonferrous metal, cement, glass, plastic and other related industries, the government uses the auction of land income to supply industry at the same time, introduces the foreign advanced technology, equipment and management experience, and consummates the industrial gradually. At the same time, the "urban priority policy" has moved a large number of agricultural people to cities, and the expansion of urban population has driven the development of the service industry and promoted employment and consumptions.

This "urban priority policy", on the one hand, promotes the great development of China's economy and society, and greatly improves the housing conditions and living standards of the people. On the other hand, the rapidly expanding urbanization process consumes a lot of energy and resources, causing serious pollution, and China has also paid a high environmental cost[5].

3. A low-carbon city for the future

3.1 Challenges in China’s future urbanization process

It is estimated that if 80% of the urbanization rate is completed, China's urbanization process still has about 20 years to go, and China's urbanization will face many challenges in the future.

First, because China has a huge population, it is a relatively resource-poor country. China's most abundant coal reserves are only 55% of the world's average, while the per capita oil and gas reserves are only 7.4% and 6% of the world average respectively. To reach the level of the developed countries, even China uses the most energy saving, high efficiency like the model of Japan (about 17 barrels of oil per capita annual energy consumption), multiplied by the existing population in China, the annual oil demand will be up to 3.2 billion tons while the international oil trade volume is only about 2 billion tons per year, it will not be able to meet China’s future energy needs. Therefore, the road of China’s development must exceed Japan’s energy- saving model.

Second, China has overtaken the United States as the world’s largest emitter of greenhouse gases. The data shows that the average annual growth rate of carbon emission in the United States is about 1%, the emissions from Germany and Russia have decreased to negative growth, while China is still 4.7%. Currently, 30% of China’s emissions is the transfer emission, which means the emission is essentially for the high waste of the developed world through the international trade.

At last, the development model of the city is related to China’s future energy security. The three major sectors of energy consumption are industry, transportation and construction. In terms of the world average, industry accounts for 37.7% of the energy consumption structure, 29.5% in transportation and 32.9% in construction. China’s current construction energy consumption is about 25%, transportation is about 10%, and industrial is about 60%-70%. According to the development trend of developed countries, China’s industrial consumption ratio will fall to about one third with economic and social development. The future of China’s energy security is mainly determined by the urbanization model[6, 7].

3.2 Strategic choice of low carbon urbanization

Faced with many challenges, the Chinese government has proposed to take the "new-type urbanization" road and build a low-carbon and green eco-city. In March 2014, the national new urbanization planning (2014-2020) pointed out that China's future urbanization is the basic

principle of "ecological civilization, green low carbon " --- combining the ecological civilization idea into the urbanization process, promoting green development, the development cycle, low-carbon development and use of resources such as land, water and energy saving, strengthen environmental protection and ecological restoration, and reducing the interference and damage of urban development on natural, promote green low-carbon production, life style and urban construction operation mode.

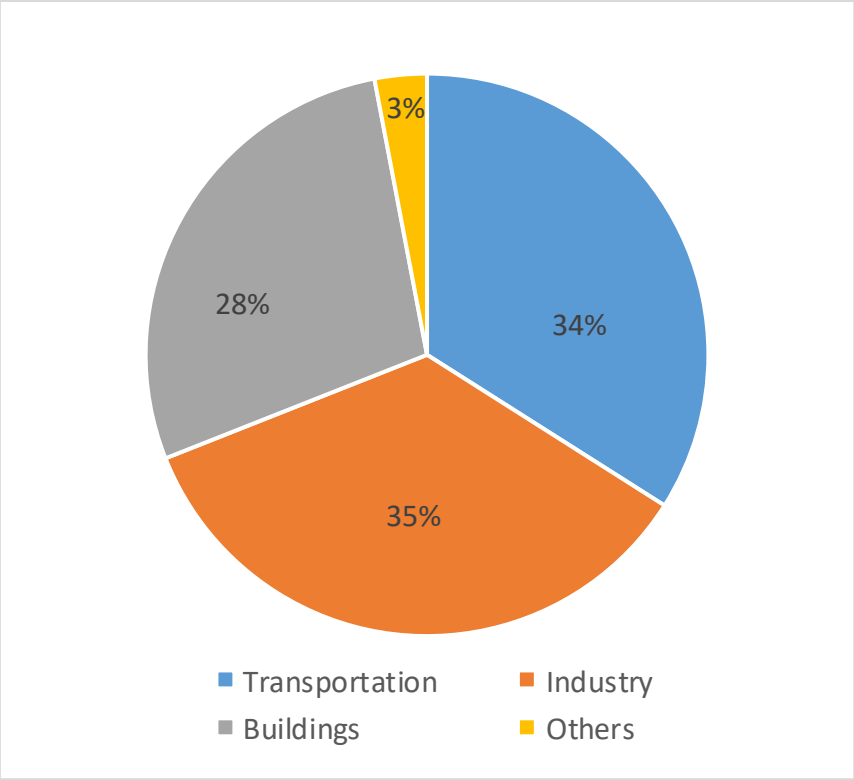

Fig.2. China's energy consumption distribution in 2016

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construction operation mode.

In August 2016, the “13th Five-year plan of Urban and Rural Housing Construction” pointed out that city to promote the construction of low-carbon ecological community, according to the low-carbon ecological concept to revise the planning and construction standards, and incorporate “green development” into city planning; to promote green building, green transportation and the development of green city, efforts to achieve low impact development mode, strengthen the renewable energy utilization, vigorously construction ecological settlements, ecological park, ecological new district; to continue to carry out low carbon ecological city, green ecological city pilot demonstration, encourage the exploration low-carbon ecological city planning method and the construction mode, timely summarize and promote the mature practice and applied technology.

4 Exploration and practice of low-carbon city construction in China

4.1 Exploration of ultra-low energy buildings

With China's promise to reduce carbon emission in the future, different majors and research institutes have been exploring "zero energy consumption" construction in recent years, especially in the area of community and architectural design. The discussion and practice of "zero energy consumption" in foreign countries has existed for more than 40 years[8]. In 2008, the Department of energy of the United States issued “zero energy consumption public building” program, which proposed that all new office buildings should be adopted “zero energy consumption” technology by 2030. In 2006, the British government proposed that all new residential buildings would achieve zero carbon emission by 2016[9].

China, by contrast, is still at the beginning of this field. In 2014, organized by the Ministry of housing and urban–rural development of science and technology, China Academy of Building Research implemented the research activities of “ultra-low power passive green building project” which can be said to be one of the major nodes[10]. The project of all kinds of nearly zero energy consumption building and technology of China has made the analysis and summery, and gives the detailed definition of zero energy consumption of Chinese architecture: calculate year cycle, in the form of terminal energy usage as a measure, the total energy generated by the building and the nearby renewable energy system is greater than or equal to the amount of energy consumption

of the building.

Fig.3. London zero-carbon pavilion at the Shanghai World Expo

In recent years, a number of “zero-carbon building” have been implemented in different climate zones in China. The first zero-carbon building in China is the London zero-carbon pavilion at the Shanghai World Expo. Its prototype comes from the UK’s zero-carbon community, the Beddington community. The London zero-carbon pavilion combines the local climate and geographical environment of Shanghai with the local materials. The total construction area is 2,675m^2, consisting of four floors in the north and south buildings which are connected by an overpass bridge. Zero-carbon pavilion used solar energy hot water driven liquid desiccant and absorption refrigeration system to dehumidify and cool down the indoor air, at the same time, the 22 flexible rotating air caps use the wind energy to drive the indoor ventilation and heat recovery. The London zero-carbon pavilion also uses the river water source heat pump system as a building power supply, and sets up the cold radiation ceiling to provide visitors a comfortable experience with a minimum energy consumption.

The “Sino-Singapore Eco-City Public Housing Exhibition Center” in Tianjin is the first zero-carbon building in the cold area of northern China. The project is located in Tianjin Sino-Singapore Eco-City, with a total construction area of 3,467 m^2, two floors above ground,

one floor underground. The structural system is steel frame structure, the shape factor is 0.22, and the area ratio of window to wall is 0.2.

Fig.4. Sino-Singapore Eco-City Public Housing Exhibition Center

The project adopts the design method based on computer simulation and adopts advanced energy consumption simulation system to continuously optimize the architectural design scheme. During the design process, the design team minimized the energy demand of the building through "passive housing" technology, and improved the efficiency of the building by using the "active technology". At the same time, the designers also use ground source heat pump system to reduce the building demand for fossil fuels, and use the photovoltaic power generation system to realize the energy production of building to achieve annual operating cycle "zero energy consumption".

4.2 Exploration of the positive climate development model

The “Positive climate development plan” is the world’s leading cities and communities development project. It’s organized by C40 and co-founded by the Clinton foundation and the United States green building council, aims to create an economic development plan for cities and communities to realize negative emission of greenhouse gases.

Fig.5. Technical routes in Shougang positive climate project

Located in Beijing, the “new Shougang high-end industrial integrated service zone” is

“Positive climate” means that construction projects should have a positive effect on urban climate change: first, minimize the energy consumption and carbon emission of the project itself in operation; through the demonstration of the project, the emission reduction of the surrounding district is led to the overall effect of “net negative emission” after a period of operation. This is the meaning of “positive climate”[11].

China’s first project to join the “C40 positive climate development program”, and also the world’s 19th “positive climate” project. The project introduces the best practice experience of international cities to cope with climate change, and works with low-carbon cities in different cities in the world to provide a template for China's future urbanization. The specific ways of implementing the "positive climate" include:

(1) Perfect road transportation system

The park takes TOD as the dominant land development model and has built a perfect road network to encourage people to use the green travel. First of all, by public transport network consists of the backbone of rapid transit (BRT + rail transit network), the conventional public

transportation main lines network, conventional public transportation branch lines network. The three networks are connected by a public transportation transfer hub. The project increases the density of the public transportation system and adjusts the density and time of the bus line according to staffs' working hour schedule. It is unified dispatched by the public transportation command center.

Secondly, the public rental bicycles are arranged in the rail way stations, bus stops, parks, leisure entertainment and other public service facility areas, and the bicycle rental network are established. The size of the bicycle parking lot is set according to the requirements and needs to increase the frequency of use.

Pedestrian network system construction is the last step, which consists the ground pavement, commercial pedestrian zone, underground commercial pedestrian street, pedestrian corridor, urban riverside landscape trail, etc.

(2) Construction of water ecosystem

Firstly, through the construction of "sponge city", the project can effectively control rainwater runoff and realize the mode of natural accumulation, natural permeability and natural purification. "Sponge city" is conducive to the repair of urban water ecology, water conservation and urban waterlogging capability. Secondly, using the principle of species symbiosis and material circulation regeneration, the self-cleaning ecological system of water dominated by artificial wetland is established.

(3) Green building and green energy systems

The buildings in the park use "passive house" technology to reduce energy consumption and meet green building standards. At the same time, we can make full use of renewable energy to supply energy for building, including solar water heater, solar photovoltaic power generation system, ground source heat pump, sewage water source heat pump and biomass energy. According to the characteristic of energy structure and energy use, set up a number of regional energy centers, use the natural gas "heat, electricity, cold" technology to supply the power to the building and improve the overall efficiency of the energy system.

(4) Resource utilization of the whole process

Garbage collection, garbage green transformation and waste recycling technology can be used to realize the "reduction, resource and harmless" of garbage. First, the garbage classification

standard is set up, and garbage classification is strictly enforced. Secondly, food waste can be transformed from biomass to biomass energy through biotechnology, which can be used to generate electricity by means of advanced incineration technology, and the toxic and hazardous materials can be treated harmless.

5. Conclusion

The rapid development of China's urbanization has not only promoted economic development, increased the standard of living for people, but also brought great environment risks. In 2015, with China's accession to the "Paris Agreement", China's future urbanization must be a low-carbon road. To effectively guide the development of Chinese city to reach the peak emission as soon as possible is an important method to cope with climate change. On the one hand, we will minimize the carbon emission of the new urban area in the future, at the same time we also grasp the urban development and renewal opportunity to promote the project of low-carbon investment, the market means and system reform. Bringing the surrounding urban area the external effect of carbon emission reduction, so as to achieve the "positive climate" effect of the overall net negative carbon emission. This is a strategic choice and also the only way for China.

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