Research on energy saving and emission reduction of urban transportation under the concept of low-carbon life

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Abstract. In response to the national concept of green and low carbon, the carbon emission analysis and peak prediction of transportation in 20 cities were carried out by using the carbon emission calculation model based on residents' travel, and the quantitative effects of various improvement measures were evaluated. The results show that the urban transport structure and residents' travel distance are positively correlated with the urban carbon emission intensity, and the urban transport carbon emission in China will reach the peak around 2023. Accelerating the application of new energy, optimizing the urban transport structure, building a green transport system, and optimizing the urban transport line network all have good emission reduction effects.

1 Introduction

The progress and development of society has promoted the continuous growth of people's living standards. In this context, as a very convenient means of transportation, cars are loved by the majority of people. As most of the cars still use traditional energy, it has a serious impact on the ecological environment. The sustainable development of China's society and economy can be realized by introducing and applying the low-carbon economic development mode in the construction of modern green and environmentally friendly civilized city and optimizing and improving the content of urban construction management system. Based on residents' travel data, this study analyzes the related factors of urban passenger transport carbon emissions, which is helpful to put forward targeted energy saving and emission reduction measures.

2 Current status of urban transportation carbon emissions

2.1 research method

The current urban transportation carbon emission calculation methods mainly include the IPCC top-down method, the carbon emission calculation method based on residents' travel [1], the whole life cycle emission calculation and the quantitative analysis method of carbon emission influencing factors. Among them, the urban transportation carbon emission calculation model based on residents' travel is

$$E_i=N*S_i*T_i*M_i \quad (1)$$

In the formula: E_i is the carbon emissions of the mode of transportation; N is the total number of resident trips; S_i is the sharing rate of the mode of transportation; T_i is the per capita travel distance of the mode of transportation; M_i is the type of transportation Ways of carbon emissions per person per kilometer.

The formula variables are closely integrated with city characteristics; data is easy to obtain. Therefore, this paper uses the urban transportation carbon emission calculation method based on residents' travel to evaluate and analysis the residents' travel data of 20 cities of different levels.

2.2 Current status of transportation carbon emissions

In 2018, China's urban transport carbon emissions totalled about 230 million tons, accounting for 3.9% of the country's total carbon emissions and 30% of the total transport carbon emissions. As shown in Table 1, the proportion of transportation carbon emissions in cities of different levels varies greatly, and the per capita carbon emissions increase with the expansion of city size.

Table 1. Statistics of population and traffic carbon emissions in cities of different levels.

	population proportion	Carbon emission ratio	per capita Carbon emissions (t/ yr)
megacities	22	30.4	0.55

Type I big city	13	13.8	0.35
Type Ⅱ big city	32	29.3	
Medium-sized city	16	13.8	0.31
Type I small city	15	11.9	0.28
Type Ⅱ small city	2	1.2	

3 Problems of urban transport development

3.1 Single urban traffic structure

China's urban traffic is mainly based on buses, cars, bicycles and small electric vehicles. With the continuous increase in the number of cars, the pressure on urban traffic has increased, which has restricted the development of urban traffic to a certain extent. The large increase in private cars has reduced the amount of urban public transportation, the development of public transportation has slowed down, carbon emissions have increased year after year, and the pollution caused by the environment is increasing. Take first-tier cities in mainland China as an example, the proportion of public transportation trips is less than 50%, and this is even in the case of vehicle license plate restrictions in cities. While in Tokyo, Japan and Hong Kong, the proportion of public transport trips is more than 85%, a very big gap. At the same time, the carbon emission intensity of urban transportation is significantly higher than that of other cities of the same size. While in Tokyo, Japan and Hong Kong, the proportion of public transport trips is more than 85%, a very big gap. At the same time, the carbon emission intensity of urban transportation is significantly higher than that of other cities of the same size.

3.2 Backward urban transportation planning

The number of permanent residents in China continues to increase. As of 2019, the permanent urban population has reached 60.6%, and it is still rising at a constant rate every year. The permanent population of small and medium-sized cities has increased several times in the past 20 years, and the population of big cities has increased by more than 30% in the past 20 years. The increase of population makes the city scale expand continuously, which further increases the difficulty of traffic planning and development, making it difficult for traffic planning and development to bear the pressure of urban development. Traffic congestion becomes more and more serious. Frequent acceleration and deceleration increase the fuel consumption of cars, which in turn leads to the increase of traffic carbon emissions.

3.3 Low level of urban traffic management technology

From the perspective of China's urban traffic management, except for the first and second tier cities, the traffic management of other cities have the problem of low technical management ability. In the management work, most of them need manual management, which cannot realize the timely collection and transmission of traffic information. The development speed of smart transportation is slow, and the vehicles cannot realize the effective connection, which affects the transportation efficiency. Secondly, the construction of urban traffic information management platform and safety guarantee system based on low-carbon mode lags behind, which seriously affects the efficiency of urban traffic management.

4 Prediction of peak urban traffic carbon emissions

Based on the calculation results of 2020 data, four scenarios are set to predict the peak of carbon emissions from urban transport.

Scenario 1: The 2020 urban traffic development indicators will continue in the long-term, and the traffic structure and travel distance will remain unchanged.

Scenario 2: Slightly increase the share rate of urban public transportation and slow traffic.

Scenario 3: Reduce travel distance by linking urban land use and traffic.

Scenario 4: By increasing the share rate of new energy transportation and reducing the travel distance.

The forecast results of transportation carbon emissions in each scenario city are shown in Table 2.

Under Scenario I, it is estimated that urban traffic carbon emissions will reach its peak emissions in 2023, an increase of 12.3% relative to the current situation; Compared with 2020, urban transport carbon emission in 2030 will be reduced by 13.4%, and per capita carbon emission intensity will be reduced by 28%. Under each optimized scenario, the peak of carbon emission can be reached 1-2 years ahead of schedule; Compared with 2020, urban transport carbon emissions in 2030 can be reduced by 23%-33%, and per capita carbon emission intensity can be reduced by 35%-44%. As show in Table 2, four scenario comparing.

Table 2. Forecast results of urban transportation carbon emissions.

	Total carbon emissions (10k tons)		Per capita carbon emissions(t/ yr)		Total carbon emissions (10k tons)	Per capita carbon emissions （t/ yr）
	Peak	Year	Peak	Year	2030	
Scenario 1	28450	2023	0.43	2021-2022	24385	0.30
Scenario 2	28350	2022	0.42	2021	21789	0.29
Scenario 3	28300	2022	0.42	2021	21330	0.27
Scenario 4	28250	2021	0.42	2021	18960	0.25

5 Urban traffic emission reduction measures

5.1 Speed up the application of new energy technologies

Attach importance to the integration of urban transportation development and energy-saving and emission-reduction technologies, innovate transportation energy conservation and emission reduction technology, replace oil with new energy and other environmental protection energy in the application of transportation industry, develop new energy-based transportation vehicles, and reduce the carbon emissions of transportation vehicles. On the one hand, to strengthen independent innovation, strengthen the cooperation between government departments, scientific research institutions and social organizations, build a coordinated linkage technology research and development system, innovation of low-carbon technology research and development mode, in order to achieve low-carbon key technology breakthroughs in the field of transportation; On the other hand, the government should attach importance to the publicity and promotion of environmental protection and low-carbon technologies such as new energy technologies, and formulate relevant policies and measures to help the promotion of such products in the market.

5.2 Build a green transportation system

In modern urban transportation, different modes of transportation have great differences in form, proportion of traffic sharing and combination. In order to improve people's travel efficiency, it is necessary to build a green transportation system operation mode according to urban development and traffic planning [2]. Guided by the concept of green and low carbon, it promotes public transport, walking and cycling and other modes of transportation. To support and guide the planning model of urban development with public transport, to examine the shortcomings of rail transit and regular bus in a service-oriented way, and to further improve the level of public transport service [3].

5.3 Optimize the urban traffic structure

In urban transportation planning, public transportation is the mainstay and private car transportation is supplemented to ensure the scientific nature of the transportation structure. Controlling the use of private cars is an effective way to promote the rational planning of urban traffic structure. Traffic control needs to be people-oriented, to ensure that the traffic system is scientific and convenient, so that people have a stronger tendency to choose public transportation in the process of travel.

5.4 Optimize the urban transportation network

According to the urban spatial planning, the layout of urban transportation line network and traffic nodes should be optimized, so as to drive the comprehensive construction of various urban transportation means, realize fast and convenient transfer, and build a large number of comprehensive transportation hubs to improve efficiency. At the same time, we will make overall arrangements for all kinds of transportation lines, and scientifically allocate all kinds of resources for the convenience and benefit of the people.

6 Conclusion

The energy saving and emission reduction of urban transportation should be promoted by speeding up the application of new energy, constructing green transportation system, optimizing urban transportation structure and optimizing urban transportation line network. The peak of carbon emissions is based on the national smooth implementation to the requirement of urban transportation structure for the conditions to predict.

Therefore, China needs more stringent traffic management policies, and promotes the construction and application of urban transportation carbon emission management platform [4], so as to achieve the goal of carbon emission peak as soon as possible.

References

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