

Comparative Analysis of Transport Energy Consumption between High-speed Railway and Air Transport

Rong Li, Guanlong Cao*, Bo Qiu *
Hebei University of Technology, Tianjin 300401, China

ABSTRACT

Transportation is a big energy consumer especially for high-speed railway and air transport. This paper firstly compares passenger turnover and energy consumption between high-speed railway and air transport. Secondly, air transport mainly uses aviation kerosene, which has a relatively large impact on the environment, while high-speed railway is based on electricity. Moreover, this paper proposes a plan to provide electricity for high-speed railway derived from wind and solar energy. By comparison, it is concluded that high-speed railway is more environmentally friendly and more energy-efficient than air transport.

Keywords: air transport, high-speed railway, resource shortage, energy consumption, environmentally

1. INTRODUCTION

The issue of energy consumption has always been eagerly concerned by researchers at home and abroad. The Chinese government has recently issued a series of policies on energy conservation, emission reduction and environmental protection. Transportation is a basic industry of the national economy, and it accounts for a large proportion of energy consumption, inside which high-speed railway and air transport are the biggest 'contributor'. Since both high-speed railway and air transport can meet people's travel needs, which one is better?

This paper compares and analyzes the passenger turnover using high-speed railway and air transport, energy consumption, and emissions. How to better deal with the shortage of non-renewable energy and the large-scale use of new energy is worthy of us to think further [1]. At the same time, with the rapid economic development of China, energy consumption has also

increased, and environmental problems have become prominent. Energy-saving and emission-reducing transportation methods will inevitably be welcomed by everyone. The energy consumption of the two transportation methods must be the focus of attention and the focus of research.

2. RELATED WORK

Energy is consumed all the time, but most of the energy is non-renewable energy, and the global energy storage is certain. Therefore, it is urgent for us to save energy and protect the environment. The use of energy will inevitably bring about carbon emissions and will affect the country's economic development. Trade opening has different effects on the decoupling of economic growth and carbon emissions in countries with different degrees of development[2]. At the same time, economic opening can improve energy efficiency and reduce energy demand[3]. Nowadays, the proportion of energy consumption in the global transportation industry is showing a clear upward trend. Many scholars are looking for the relationship between transportation energy consumption and other influencing factors, such as the relationship between transportation, the environment and GDP. The more energy consumption, the environment quality will deteriorate, and GDP will increase accordingly[4]. In order to cope with global warming, China has demonstrated the responsibility and responsibility of a major country and proposed the goal of achieving carbon neutrality. The transportation sector is bound to be an important area that affects energy consumption, improves air quality, and achieves the goal of carbon neutrality[5]. In terms of clean energy, renewable energy is more environmentally friendly than non-renewable energy. The main energy consumed by air transportation is petroleum, which is a

non-renewable energy source, and a large amount of greenhouse gases will be generated when the air transport is flying, which will cause a series of climate effects. In the process of railway transportation, sound and vibration energy is generated, and the collection of these energy must have great application potential[6]. Therefore, in long distance transportation, from the perspective of environmental protection, the development of high-speed railway is bound to have an impact on air transport, and it has an advantage in cost performance.

The previous work only analyzed the energy consumption data of a certain mode of transportation. The difference between this paper and the previous work is that it focuses on comparing the two mainstream modes of transportation, air transport and high-speed rail, and analyzes the data related to energy consumption. Comparing the relevant data with energy consumption, it has certain guiding significance for people to choose a certain way of travel, and it also promotes the large-scale use of clean energy in the future.

3. CORRELATION AND ANALYSIS OF HIGH-SPEED RAILWAY AND AIR TRANSPORT

The data in this paper is based on the official statistics of the relevant departments in China, and the data obtained is used to compare and analyze. Moreover, due to the small amount of data that specifically fits the subject, this paper also carries out some reasonable data speculations.

3.1 Turnover data statistics

Passenger turnover refers to the product of the number of passengers transported and the distance traveled. Figure 1 shows the passenger turnover volume of high-speed railway and air transport from 2012 to 2020. It is used to measure the total amount of transportation work. The greater the total work volume, the more energy consumption will be. We can see that the passenger turnover of high-speed railway and air transport has been increasing year by year before 2019. However, in 2020, due to the impact of COVID-19, the air transport market has suffered a major impact, and passenger turnover has fallen precipitously. At the same time, since no official data on the turnover of high-speed railway in 2020 have been found, here is only a reasonable guess. The turnover of high-speed railway transportation will inevitably be affected by the epidemic, and the turnover will inevitably decrease.

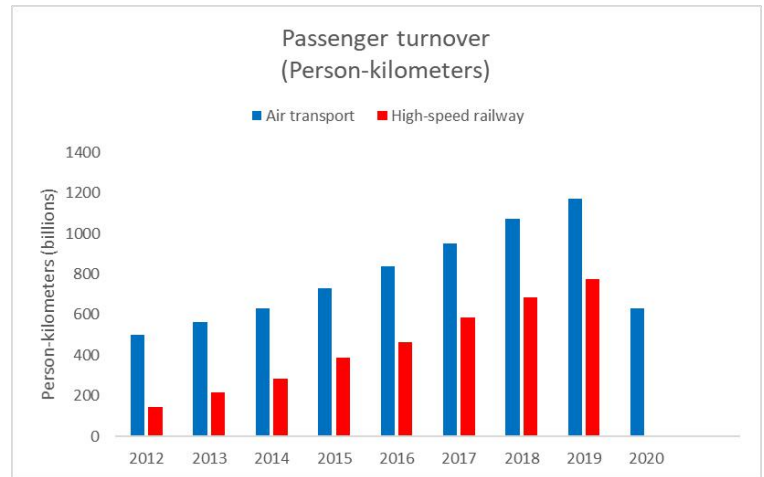


Fig. 1 Passenger turnover

3.2 Energy consumption

As we all know, most of the high-speed railway is driven by electricity, and the amount of energy consumed by the high-speed railway is closely related to the speed of the high-speed railway. Take the two speeds of China's high-speed railway as an example, when the speed is 250 kilometers per hour, the power consumption is about 4800 degrees, and when the speed is 350 kilometers per hour, the power consumption is about 9600 degrees. Through the relationship between the speed of the high-speed railway and the power consumption, we can see that the faster the high-speed railway runs, the power consumption will increase accordingly. At the same time, the higher the turnover of the high-speed railway, the more power consumption will be. The relevant annual data has not been found here, so we will not discuss it in detail.

For air transport, aviation kerosene is mainly consumed. Figure 2 shows the apparent demand for aviation kerosene from 2012 to 2020. According to relevant data, nearly 95% of aviation kerosene is used in aviation every year. So this part of the data is used for air transportation by default in this paper. From Figure 2, we can see that before 2019, the use of aviation kerosene increased linearly, but it was affected by the COVID-19 in 2020. People's travel was reduced, and at the same time, the number of flights decreased to control the spread of the epidemic, so the demand has dropped significantly.

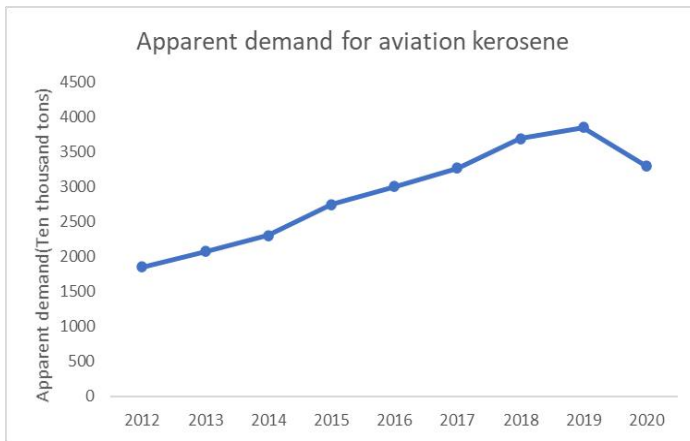


Fig. 2 Apparent demand for aviation kerosene

3.3 Utilization of energy during transportation

Aviation kerosene is the main energy consumed by air transport. At this stage, only this non-renewable energy can meet the requirements of air transport flying at high altitudes, and there is no other alternative energy source. The high-speed railway is driven by electricity and will not waste precious oil resources, but there are still areas for further improvement. Based on the analysis of the above data in this paper, a solution is proposed that can utilize wind and solar energy during high-speed railway, which can reduce the consumption of traditional power generation energy, make high-speed railway more environmentally friendly, and strive to achieve China's carbon neutral goal.

3.3.1 Utilization of wind energy

Wind energy will be generated during the operation of high-speed railway, and when it at a speed of 200 kilometers per hour, it will generate a gale equal to or higher than level 7. This part of the energy is mainly used in the scheme. Considering that the installation of windmills like the current wind power generation on the body of the high-speed railway will increase the resistance of the train and lead to a part of the energy offset. The scheme proposes to install a wind energy collection device at intervals of a distance on the high-speed railway track, and then store this part of the energy on the contact net used to power the high-speed railway above the track to provide part of the power resources for the high-speed railway operation.

3.3.2 Utilization of solar energy

Solar energy is currently the most representative green energy source and an absolute ideal energy source. The use of solar energy proposed in this plan is mainly solar panels, covering the top of each carriage with panels, and using the energy of the sun to generate electricity. In the actual transportation process of high-speed railway, there will always be non-sunny days. Considering that in this case, continuous generation of electric energy cannot be guaranteed. So this part of the electric energy is mainly used to power the interior lighting, air conditioning and other systems of the carriage.

4. CONCLUSION

High-speed railway and air transport occupy half of the transportation industry in China. When a large number of passengers need to travel, the consumption of traditional energy will have an impact on the environment. The situation that air transport needs to consume traditional energy is unable to make a new breakthrough for the time being, and there are still many shortcomings. However, for high-speed railway, the power resources it consumes are mainly supplied through the power grid. In daily life, the electricity of the grid is mainly obtained through thermal power generation, and it will more or less cause resources shortage and environmental pollution. But it is insignificant compared to the fuel consumption of the air transport. This also provides us with a new idea, that we can use clean energy to generate electricity, such as wind energy, solar energy and other natural energies to provide electricity for high-speed railway. It seems that it is a feasible choice to continuously improve the utilization of new energy. Energy-saving, green and environmentally friendly transportation can be realized, but the realization of this goal has a long way to go. In this paper, we did not consider the energy consumption problem of the maintenance of airports and high-speed railway stations. Obviously, this problem should also be considered, and a lot of work will be needed to improve it in the future.

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