Energy saving and emission reduction 110 kWh

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In recent years, with the acceleration of urbanization in China, problems such as the rapid growth of urban populations, the growing demand for resources and environment, the urgent need to improve the unified management of cities and the unbalanced development of urban areas have become increasingly serious. As a punctual, fast, environmentally friendly, large-capacity and land-saving transportation mode, rail transit has gradually become a focus to achieve urban and regional development goals and spatial development strategies.

By the end of 2019, 208 urban rail transit lines had been opened in 40 cities across China, with a total length of 6736.2 km, including 5180.6 km of metros, accounting for 76.9%. A total of 3982 metro stations have been put into operation (transfer stations are not counted repeatedly), and a total of 317 car depots and parking lots have been put into operation [1].

According to incomplete statistics, Beijing handled 3.96 billion passenger trips in 2019, and Shanghai handled 3.88 billion passenger trips. The average daily passenger traffic in the two cities exceeded 10 million passengers. The four largest megacities, Beijing, Shanghai, Guangzhou and Shenzhen, contribute more than half of the total passenger traffic in China.

At present, electric traction is used in metros all over the world, and the supply and transmission of electrical energy is important to guarantee the safe and reliable operation of metros. In addition to supplying power to metro vehicles, electrical energy also supplies power to metro electromechanical equipment, including tunnel fans, station air conditioners, station escalators, automatic fare collection equipment, screen doors, drainage pumps, sewage pumps, platform doors, communication systems, signals, integrated monitoring systems, automatic fire alarm equipment, environmental and equipment monitoring equipment and various lighting facilities.

As the main energy source for metro systems, electrical energy consumption has continued to increase with the developing transportation network, and its magnitude cannot be ignored. In 2019, according to the statistical calculation of data reported by the operating units, the total power consumption of urban rail transit was 15.26 billion kWh, and year-on-year growth was 15.5%. Electricity charges account for 10.2% of operating costs [1]. With the continuous expansion of the urban rail transit network, its energy consumption will further increase, which will impose a heavy burden on urban energy supply, and at the same time, metro operators will face rising cost pressure.

In 2017, China issued the Comprehensive Work Plan for Energy Conservation and Emission Reduction in the Thirteenth Five-Year Plan, which requires vigorous development of public transportation, and clearly requires the share of public transportation in large cities to reach 30% by 2020.

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On September 22, 2020, at the general debate of the 75th UN General Assembly, President Xi Jinping announced that China will increase its national independent contribution, adopt more powerful policies and measures, and strive to achieve the goal of "Peak carbon emissions by 2030 and achieving carbon neutrality by 2060" [2].

Against the background of energy saving and emission reduction, energy-saving technologies of metro systems have been applied to metro design, and energy-saving awareness has been implemented in actual metro operation. Some metro companies have set up an energy management platform to monitor and record metro energy consumption, analyze the collected basic data, manage energy quotas and implement cost accounting, which requires correcting waste behavior to improve the economic benefits of enterprises. At present, the configuration of meters in a metro energy management system can be basically divided into four levels [3]; the specific classification is shown in Table 1.

In the existing metro companies, in terms of energy meter allocation, typically only secondary meters are installed on the operation lines to measure the power consumption of vehicle traction and power lighting, to monitor the overall energy consumption of station and vehicle traction. The main reasons that only secondary meters are installed are as follows.

Since the existing metro lines in some cities were built some time ago, the original system needs to be transformed to build an energy management system and add meters. For example, each system of the weak current system has an independent backup power supply and distribution system, the transformation cost is high, and the utilization value of the collected energy measurement data is uncertain, which makes it more difficult for the metro company to build and utilize the energy metering network.

For these reasons, even if the metro company has built an energy consumption statistics and monitoring system, most of them only achieve a measurement range of level II, and only measure the total amount of the system or the total amount of the local range of energy consumption. The energy consumption data provided are only the common energy consumption data for local areas and multiple equipment, but do not measure and collect the energy consumption of the main energy-consuming equipment. Moreover, real-time synchronous statistical measurement data are not achieved, and the energy consumption process cannot be monitored and managed in real time.

The metro company lacks a complete energy metering network and cannot realize the energy metering of the main energy-consuming equipment. For energy management, the main defects are as follows.

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