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"SUMMER STORAGE AND WINTER FURNACE" – DATA CENTER WASTE HEAT RECOVERY AND UTILIZATION SYSTEM FOR SEASONAL HEAT STORAGE

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Summary. *As Chinese society moves towards a more intelligent and connected society, there is an increasing demand for data centers. Under normal circumstances, datacenter IT equipment runs 24 hours a day, which consumes a lot of power and emits a lot of heat. Therefore, when the data center consumes power, it also needs power refrigeration and the ambient temperature to ensure the normal operation of the data center, resulting in huge resource consumption. Combined with the background of carbon neutrality and the current situation of large heating demand and long heating period in Northeast China, this project proposes to use data center waste heat resources as the heat source of building heating, reduce the power consumption required for data center cooling, improve the utilization efficiency and economic efficiency of data center waste heat, and then reduce the carbon emission of data center and building heating.*

The project proposed a heating scheme that stored the waste heat generated by the data center into the soil in summer, and combined the cross-season stored heat with the waste heat directly supplied by the data center in winter. On the basis of combining the chip cold tube waste heat collection system, the seasonal soil waste heat storage system and the heat pump system of storing waste heat, the waste heat recovery and utilization of the data center is carried out seasonally, and the waste heat recovery and utilization system of the data center is formed by the "summer storage and winter furnace" seasonal heat storage, so as to realize the transformation of "waste" into "heat" and make the best use of everything. This project uses Trnsys, Comsol and other software to simulate the project system model and optimize the design and calculation of the waste heat recovery resource utilization rate and other related data, providing an effective solution for the green and low carbonization of the data center.

With the rapid development of data center industry, huge energy consumption is a common problem faced by data centers all over the world. In early 2019, China's Ministry of Industry and Information Technology and other three departments jointly issued guidelines on Accelerating the construction of green data centers, proposing that data centers should be "encouraged to build clean energy utilization systems such as waste heat recovery and utilization of their own systems in their own places". Waste heat utilization in data centers in countries such as Finland, Sweden and Russia has formed a fixed recycling model, and achieved good economic and environmental benefits. However, there are still few mature cases in China in this regard and they

have not yet formed a scale [1]. Based on this, in order to achieve China's carbon neutrality goal by 2060, it is inevitable to actively promote the waste heat utilization of data centers and guide data centers to take the green development path of high efficiency, low carbon, intensive and circular.

The traditional air conditioning system has always had the problem of high-power consumption, and the waste heat will also cause a certain degree of loss in the process of air-cooled recovery. According to the relevant data of “China Energy”, it is expected that in 2030, the electricity consumption of data centers will reach 1.5 %~2 % of the total electricity consumption of society, while the electricity consumption of refrigeration and air conditioning systems in data centers will 3 account for 30 %~50 % of the entire data center. The carbon emissions generated by the electricity consumption of refrigeration and air conditioning systems are huge. Therefore, optimizing the refrigeration and air conditioning system plays a key role in reducing energy consumption.

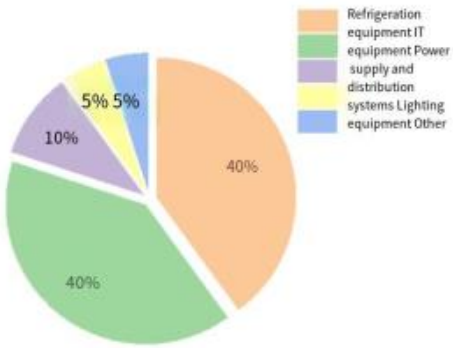

Figure 1 – Data center energy consumption composition

In the energy consumption of data center, the energy consumption of electronic equipment, power supply system and air conditioning system are the main components. In order to evaluate the energy efficiency of a data center, the indicator of power utilization efficiency (PUE) is usually used. PUE is the ratio of the total energy consumption of the data center to the energy consumption of the electronic equipment. The closer the PUE is to 1, the more [2] energy saving the data center is. In 2017, China's State Council issued the 13th Five-Year Comprehensive Work Plan on Energy Conservation and Emission Reduction, which requires the PUE value of new large cloud computing data centers to be less than 1.5 [3]. In 2021, the National Development and Reform Commission of China issued the Implementation Plan for Implementing the goal of Achieving Carbon Neutrality and Promoting the Green and High-quality Development of new infrastructure such as data centers and 5G, which requires the PUE of new data centers to be no higher than 1.30 [4]. However, statistics show that the average PUE of data centers nationwide in 2022 will be 1.49, while the PUE of data centers in North and East China will be close to 1.40 [5]. The energy consumption performance of existing data centers is difficult to meet the needs of current standards.