附件 2-1　E-NNOVATE 2025 波兰国际创新展览会线上展

发明项目展板英文图片内容(一)

CAI No. 09-1

Invention: A computing transfer demand response system for coordinating data centers and power grids

一种面向协调数据中心与电网的计算转移需求响应系统

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Patent No.: ZL 2022 1 1002763.0

Introduction：

The present invention discloses a computing transfer demand response system for coordinating data centers and power grids. This system is innovative and economical, and can play a role in alleviating the pressure on the power system, exploring potential resources, achieving the optimal allocation of response resources.

I. Innovation and Practicality

1. The operation of the coordinated power grid and communication network is coordinated, and the constraints and characteristics of both the communication network and the power grid of data centers with different nodes are proposed. By using the method of computing task transfer, the load is transferred to nodes with distributed generation or energy storage, enabling the data center to participate in the power grid demand response plan and playing a positive role in peak shaving and valley filling for the power system during peak electricity consumption periods.

2.Based on the declaration calculation module, the optimization algorithm reconstruction module is constructed. It is used to receive the mathematical models of the objective function module and the declaration constraint module, and the improved and efficient Lagrange reconstruction multiplier method is adopted to solve the optimal value. The key point lies in that the improved and efficient Lagrange reconstruction multiplier method reconstructs the inequality constraints in the index constraint function into the objective function in the form of penalty terms. The calculation speed is faster than that of the typical genetic algorithm and has a higher global optimal value. While maintaining the accuracy of the optimal solution, it greatly shortens the calculation time, thereby playing a role in reducing energy consumption for the data center.

3. Based on this system, an intelligent quotation module is constructed. It is used to receive the temporal virtual output boundary output by the declaration calculation module, the historical market clearing result - the temporal winning quantity, and the execution result output by the historical execution calculation module, including the temporal output capacity and the execution resource combination. The key point lies in continuously using historical data and the existing data through machine learning methods to find the optimal declared electricity price for data Center A to participate in the current power market demand response, maximizing the benefits, and outputting the sequential reported electricity prices for the current participation in the power market demand response.

4. Based on this system, the execution calculation module is constructed. It is used to receive the time series output capacity obtained by data center cluster B from data center A. Through the internal optimization calculation module, the optimal execution result of data center cluster B is output, including the time series output capacity and the combination of execution resources. The key point lies in implementing the virtual output winning scalar of data center A in the electricity market while constructing a mathematical model with the goal of minimizing the power generation cost of data center cluster B, so that data center managers can obtain the optimal resource combination and the highest revenue.

Figure 1 Flowchart of a demand response system for coordinating computing transfer between the data center and the power grid

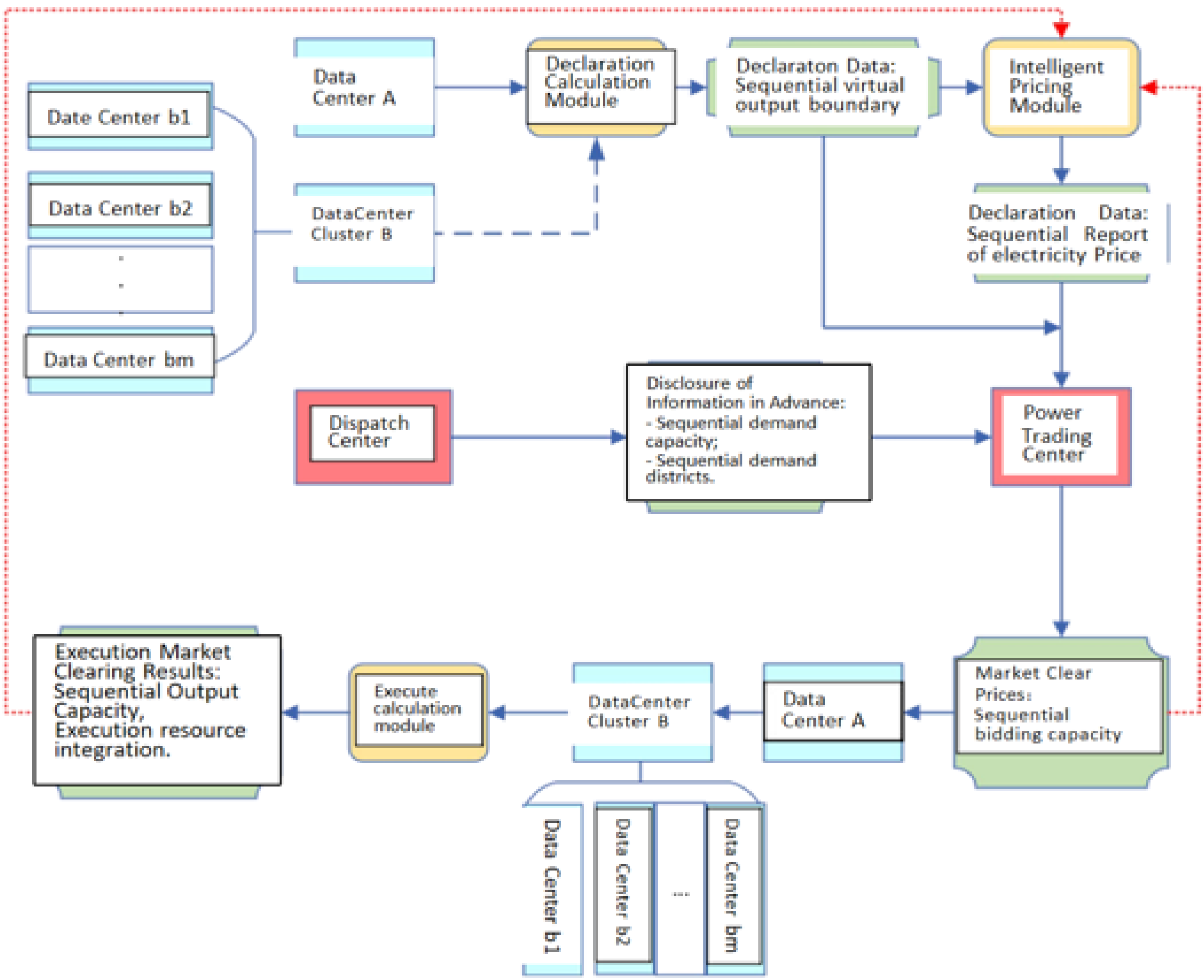
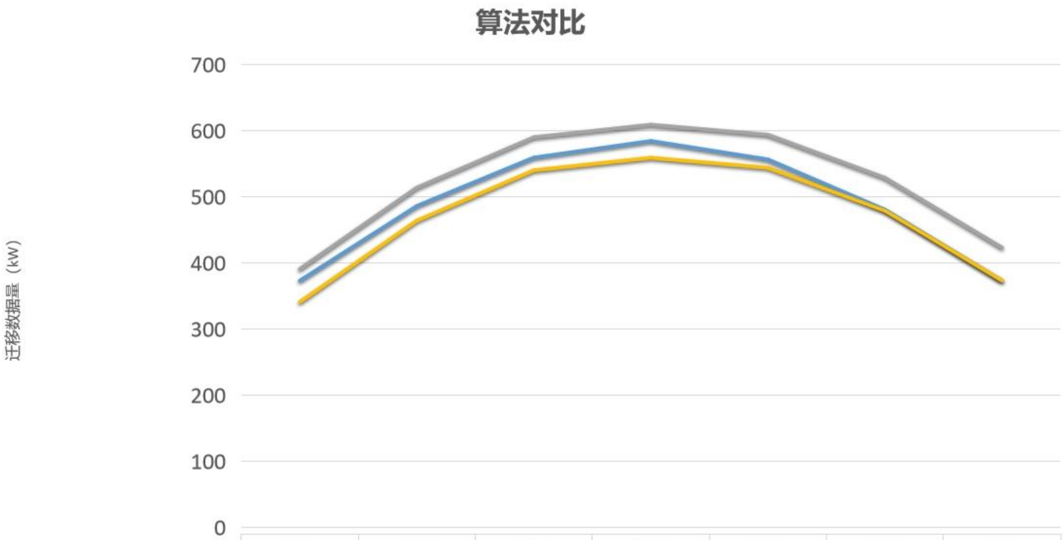


Figure 2 5G macro infrastructure station Demand response simulation Analysis platform



	9:00	10:00	11:00	12:00	13:00	14:00	15:00
实际迁移的数据量	373.08225	486.05295	559.2747	584.3793	556.4853	480.47415	373.08225
遗传算法下迁移的数据量	390.7962471	513.8392309	590.0621024	609.0158519	593.8178275	528.7359256	423.1008837
优化算法下迁移的数据量	340.7962471	463.8392309	540.0621024	559.0158519	543.8178275	478.7359256	373.1008837

Figure 3 Comparison of the optimal solutions for data transfer between the optimization algorithm and the genetic algorithm

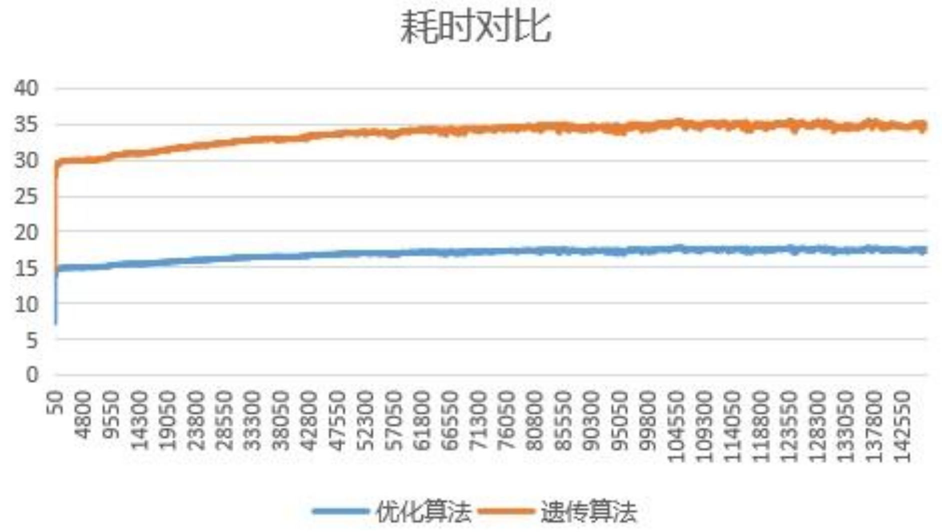
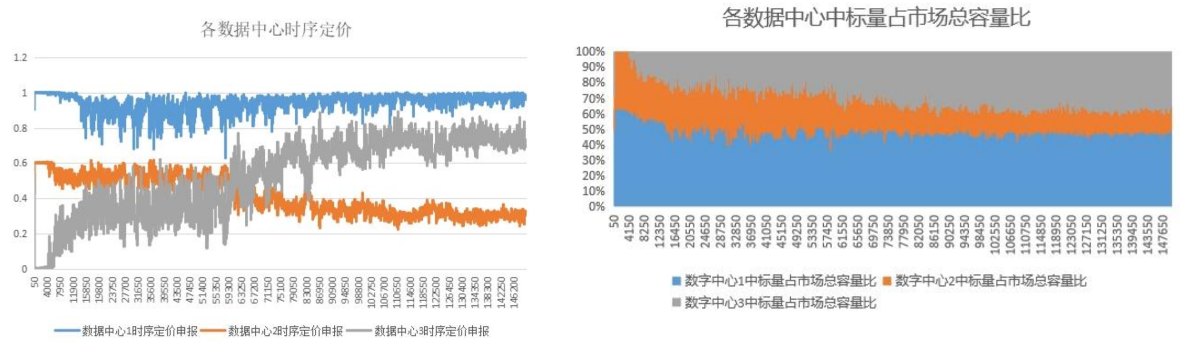


Figure 4 Comparison of the solution time consumption between the optimization algorithm and the genetic algorithm



(a) Timing pricing for each data center

(b) The proportion of scalar quantity in each data center to the market demand capacity

Figure 5 Smart quotation module： Analysis of the winning bid proportion of each data center

2.Economic benefits

Table 1 Comparison of the results between the traditional independent operation mode and the collaborative power grid communication operation mode

	Training set		Test set	
	Traditional independent operation mode	Collaborative power grid communication mode	Traditional independent operation mode	Collaborative power grid communication mode
Total electricity quantity error ratio (%)	13.425%	8.276%	12.414%	6.509%
Maximum positive bias error (kW)	540.56564	383.73578	570.17678	363.49421
The average daily cost	105.03764	36.56137	117.96669	27.72333

required to enhance the maximum reserve capacity of the power grid (yuan)				
The average daily total cost of the power grid (yuan)	1689.7190	1532.8892	1771.4533	1564.7701
Average daily total revenue of the data center (yuan)	961.05747	1434.2341	1014.2753	1502.2879
Data center bidding electricity price (yuan/kWh)	0.4153	0.3891	0.4153	0.3839

It can be concluded from Table 1 that the final revenue of the data center under the operation mode of collaborative power grid communication is approximately 488 yuan per day (48.13%) higher than that under the traditional independent operation mode. This revenue value can be used to reduce the bidding electricity price by approximately 0.0314 yuan per kilowatt-hour. This will enable the data center to gain a greater advantage and a higher winning bid in the bidding against other virtual power plants. Figure 6 shows the benchmark comparison of the data center.

Figure 6　Benchmark comparison of data centers

Meanwhile, the average daily total cost of the power grid under the collaborative mode has decreased from 1,771.4533 yuan under the traditional mode to 1,564.7701 yuan, reducing the total cost by 11.69%. Figure 7 shows the benchmark comparison of the power grid.

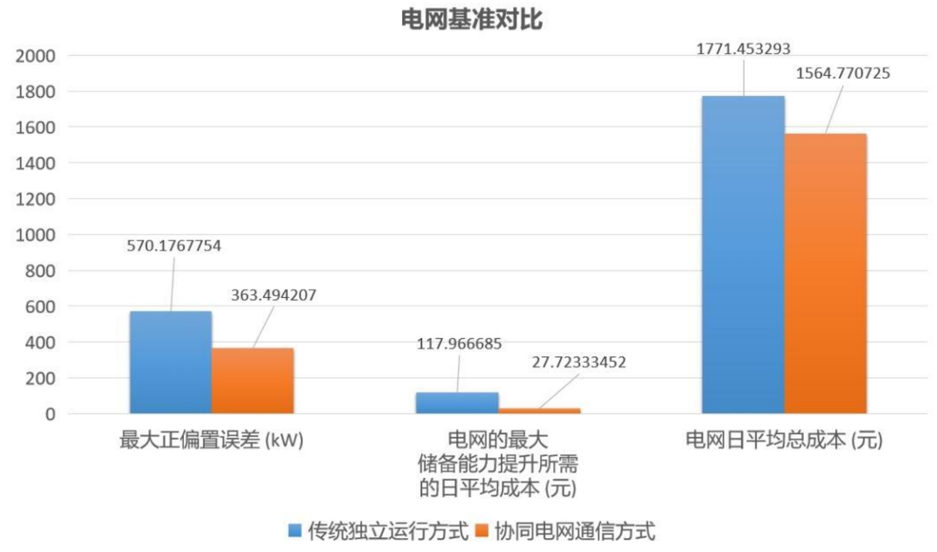


Figure 7 Comparison of power grid benchmarks

2) The proposed optimization algorithm reconfiguration model, while maintaining the accuracy of the optimal solution, also significantly shortens the computing time, thereby reducing the energy consumption of the data center. but the optimization algorithm consumes less energy, which is 31.4% higher than that of the traditional method. It shows that a higher compensation electricity price is obtained, and thus the benefits are higher.

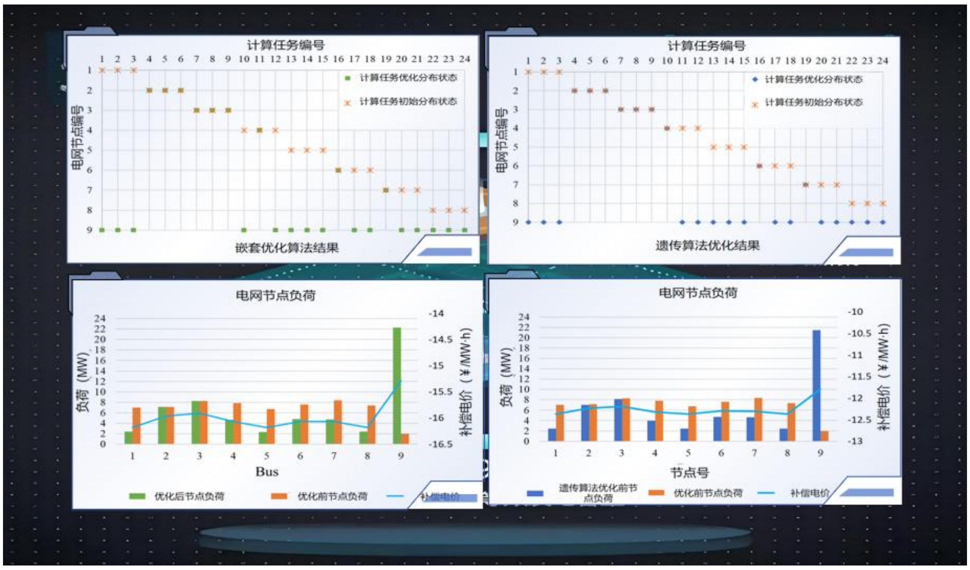


Figure 8 Comparison graph of the optimization algorithm with the traditional genetic algorithm

(2) Social benefits

This system plays a guiding role for high-load aggregators of communication data to participate in the demand response market. At the same time, it helps the power grid to peak shaving and valley filling, reduces the high-load operation cost of the power system, and improves the social energy efficiency level. In situations where power supply is tight and there is a power shortage, or when there are risks of heavy overload in local areas such as transformers, lines, and feeders, it plays a role in alleviating the pressure on the power system, exploring potential resources, achieving the optimal allocation of response resources, and providing a positive effect for the stable and reliable operation of the power system. Under the circumstances of limited computing resources and tight power supply, the present invention can effectively explore potential resources. While ensuring the quality of user experience, it can also fully and reasonably optimize resource allocation and utilize potential resources.

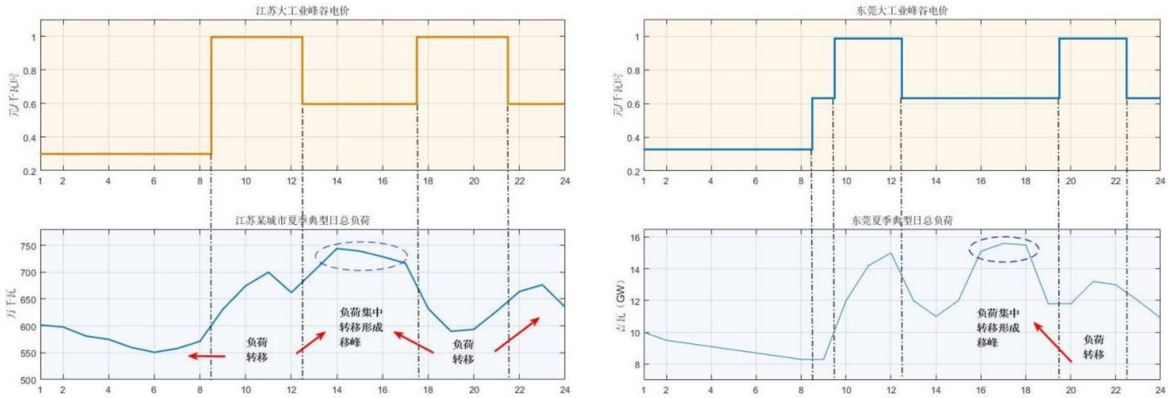


Figure 9 The peak shifting phenomenon that occurred in Wuxi City, Jiangsu Province and Dongguan City, Guangdong Province

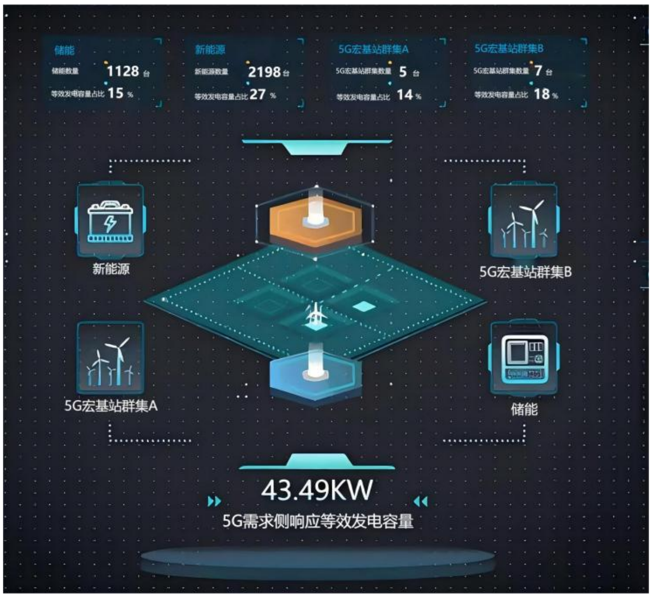


Figure 10 Simulation results of data center participation in market demand response

III.Development prospects

1. It plays a guiding role for high-load aggregators of communication data to participate in the demand response market.
2. It features high efficiency, economy and innovation, and can effectively explore potential resources and optimize resource allocation.
3. It can participate in the global relevant power market demand response platform. Under the

requirement of meeting its market rules, it can provide individualized collaborative operation modes for big data users, so as to make the load transfer trend of big data users different from that of other users under the peak and off-peak electricity prices of large users, thereby reducing the level of peak shifting and improving the operational efficiency of the power system. Reduce the cost of power grid construction and operation.

IV. Winning Awards

The project carried by this invention won the first prize of the Science and Technology Progress Award of Guangdong Power Grid Co., Ltd. in 2023.


中国南方电网
CHINA SOUTHERN POWER GRID

广东电网公司创新奖励

证 书

为表彰在广东电网创新工作中做出的
贡献，特发此证，以资鼓励。

奖励类别：科技进步奖
获奖项目：可再生能源主配用协同消纳关键技术研究与应用
获 奖 者：高志华，陈荃，赵敏彤，邹嘉嘉，张丹宏，刘晓光，王世龙，董朕，王岳，欧锋，汤瑞欣，刘思麟，甘团杰，胡克，李铭

获奖单位：规划部（乡村振兴办），电网规划中心，云浮供电局，阳江供电局

奖励等级：一等奖
奖励年度：2023年

二零二三年十二月

证书编号：2023KJ109

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附件 2-2　E-NNOVATE 2025 波兰国际创新展览会线上展

CAI No. 09-2

单位/公司介绍展板英文、图片内容（二）

Company/Unit Name：Guangdong Power Grid Corporation Zhaoqing Power Supply Bureau

Introduction：

The Lei Yu Model Worker Innovation Studio of Zhaoqing Power Supply Bureau, Guangdong Power Grid Co., Ltd. was established in 2014, with Comrade Lei Yu, a senior skills expert from China Southern Power Grid, serving as the studio's director. The team currently has 20 core members, with an average age of 29. Among them, 7 have master's degrees, 3 are leading-level skill experts, and 2 are top-notch skill experts. In 2020, it was awarded the one-star Studio of China Southern Power Grid Company, and in 2024, it was recognized as an outstanding innovation studio of Guangdong Power Grid. From 2020 to 2024, under the technical guidance of the studio, the Jizi major completed the acceptance of 3 new 220kV stations, 22 new 110kV stations, and 6 new 110kV stations. It also carried out technical renovations for 32 500kV intervals, 61 220kV intervals, and 734 defect elimination tasks.

The studio team's innovative work is based on the work site and is committed to solving the difficult and painful problems in production work. Since the establishment of the Model Worker Innovation Studio, it has gathered the wisdom of the team, popularized advanced innovative concepts, technologies and methods, and driven enterprise members to improve their skill levels, overcome difficulties and innovate. It has won 2 national-level honor awards, 5 company-level honor awards, 18 provincial-level honor awards, obtained 17 authorized patents and 7 patents under substantive examination. I have participated in over 30 meetings for the formulation of company norms in the Network Province. Since 2019, I have undertaken and completed 7 professional innovation projects and 2 scientific and technological projects.

Figure 1 shows on-site photos of Lei Yu's Model Worker Innovation Studio

Figure 2 Talent Cultivation of Lei Yu Model Worker Innovation Studio

(2) Awards:

First Prize for Employee Innovation of Guangdong Power Grid Second Prize for Technological Innovation Achievements of China Electric Power Technology Market Association in 2024 Second Prize in the Guangdong Regional Competition of the "Bonn Cup" 2024 China Innovation Method Competition.

(2) Honors received:

The Second Prize for Employee Technological Innovation of Guangdong Power Grid Co., Ltd. in 2023, the Bronze Medal for Scientific and Technological Innovation Achievements of the "Power Innovation and Entrepreneurship Cup" in the power Industry in 2024, and the First Prize in the Guangdong Regional Competition of the China Innovation Method Competition in 2024.

Figure 10 First Prize of the 2024 China Innovation Method Competition Guangdong Regional Competition

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