Research on the transaction mechanism of electricity retail market that satisfies the full liberalization of industrial and commercial users

Xi Luo[a], Xiaodan Zhuang[b], Wen Zhao[c], Jie He[d], Letian He[e]

Zhejiang Power Exchange Center Co., Ltd, Hangzhou 3100037, China

[a]1198356934@qq.com, [b]243101317@qq.com, [c]184164042@qq.com, [d]86895687@qq.com, [e]heletianly@163.com

Abstract. This paper proposes an electricity retail market transaction mechanism that satisfies the full liberalization of industrial and commercial users in the future environment of full liberalization of industrial and commercial users. The method and path of the whole process construction of the electricity retail market trading mechanism are analyzed. Aiming at the situation that a large number of industrial and commercial users all enter the electricity retail market, the electricity retail package system mechanism, diversified development and effective management and control paths have been constructed. Analyzed the countermeasures and mechanism suggestions for market transaction organizers to standardize the operation behavior of electricity sales companies and effectively prevent market risks, put forward relevant suggestions to guide electricity sales companies to diversify the development of retail services, and promote business model innovation, and analyzed the effect of case applications.

Key words: spot market, massive resources, market transaction, system design.

1. Preface

The power consumption of industrial and commercial users in my country accounts for about 70% of the total electricity consumption of the whole society. The load of industrial and commercial users has the characteristics of large capacity, stable load, and high level of automation. Therefore, such users are important user resources in the power market and can actively Promote the efficient development of the electricity market. Therefore, it is very necessary to consider the development of the electricity retail market under the condition that all industrial and commercial users are connected to the electricity market. The development and transformation of the spot market.

Platform business models are increasingly part of the distribution and retail market [1]. With the reform of the current electricity market and the release of electricity distribution and sales business to social capital, electricity sales companies urgently need information technology to support electricity market transactions. At present, there are a variety of retail platforms, such as the network-based reverse auction platform for the electricity retail market [2], the electricity sales business platform based on the micro-service architecture [3], and the distributed electricity market trading platform based on blockchain technology [4], the electricity sales platform based on the microgrid architecture [5], and the cloud platform based on the industrial Internet [6]. Literature [7] studied the operation mechanism of the electricity sales market after the release of the electricity sales side, and proposed a system architecture for the electricity sales trading platform for the main body of electricity sales and power users, and analyzed market risks and regulatory strategies. Literature [8] analyzed the business composition of the retail market under the spot model and the key issues in the construction of the electricity retail market.

The electricity retail market trading platform that satisfies the full liberalization of industrial and commercial users can refer to the above research content for in-depth research. This paper starts with the specific functions of the power spot market transaction management platform, analyzes the overall situation of massive distributed resources based on virtual power plants, explains the process of virtual power plants participating in market transactions, and designs the spot market transaction system.

2. Power retail transaction process for full access of industrial and commercial users

The voltage level of industrial and commercial users, power users of 110 kV and above are called wholesale market users, who can choose to participate in wholesale electricity transactions or participate in retail electricity transactions through power sales companies; industrial and commercial users of other voltage levels are collectively referred to as retail users. Retail users can choose to purchase electricity from one electricity sales company within a contract period. If they sign electricity sales contracts with two or more receiving companies at the same time, the power grid company will purchase electricity as an agent. The electricity price is composed of corresponding calculation regulations. It should include power purchase agency price, power transmission and distribution price, government funds and additional costs. Industrial and commercial users can carry out annual electricity price listing transactions in due course according to the bilateral negotiation and transaction status.

According to the principle of industrial and commercial users participating in market transactions, the following market transaction process is designed. When many industrial and commercial users participate in market bidding, they can obtain corresponding benefits according to the actual situation. For clean energy industry and commerce, users can purchase corresponding power auxiliary services at a reasonable market price through the trading market, so as to make up for the losses caused by the reduction of wind power and photovoltaics, thereby increasing the proportion of clean energy consumption. In the later stage, after the retail electricity market trading mechanism is improved, clean energy users can consider purchasing corresponding auxiliary services to avoid the deviation assessment of the power generation plan curve.

3. Electricity retail platform design under the access of industrial and commercial users

3.1. Requirements for the access of industrial and commercial users to the electricity sales platform

(1) Promote the participation of industrial and commercial users in the market mechanism

The participation of industrial and commercial users in the electricity retail platform is an important measure to promote electricity market transactions. Compared with ordinary residential users, industrial and commercial users have more scale in terms of electricity consumption behavior, and can participate in electricity market transactions with a larger volume to promote market-scale management. , so the participation of industrial and commercial users in retail transactions can not only broaden market entities, but also expand transaction varieties to meet the needs of different users for products in the retail platform market. reformation.

(2) Enhance market liquidity

Compared with the wholesale market, the retail market has more liquidity and variety of varieties, and the market participants are more active. The participants represented by industrial and commercial users are more active, and can participate in diversified resource allocation with lower market entry criteria. . At the same time, the diversified product portfolio in the retail market also meets the needs of various industrial and commercial users, thereby enhancing market liquidity, promoting the cost of participating in power transactions, and increasing the enthusiasm of industrial and commercial users to participate in the market.

(3) To meet user transaction needs

The electricity retail platform publishes transaction information and tracks price changes in real time to minimize the problem of information asymmetry in transactions. Trading on the platform can effectively improve transaction efficiency, reduce transaction costs, provide users with more convenient and diversified services, and truly realize transparent, concise and efficient power

transactions. At the same time, the flexible expansion of multi-market, multi-variety and multi-trading modes can be carried out to meet the diversified trading needs of users.

3.2. Introduction to the business role of the electricity retail platform

In the electricity retail platform, there are four indispensable business roles, namely electricity sales company, retail market user, platform operator and platform regulator.

(1) The electricity sales company is one of the market entities participating in the transaction, providing electricity sales services for end users in the retail market, including power products and auxiliary services. . As the seller of electricity transactions, electricity retail companies can issue electricity packages and participate in electricity demand auctions .

(2) As end consumers in the retail market where a large number of industrial and commercial users participate , they can not only understand the quotations, discounts and packages of electricity sales companies, choose the power supply services provided by electricity sales companies , but also publish electricity demand and purchase personalized Customized packages .

(3) The platform operator is responsible for the operation and management of the platform, including transaction rule setting, system basic parameter setting, data maintenance, etc., and provides market services for the public. It also includes the identification, supervision and management of other three parties of the electricity retail platform, as well as the supervision of business at all levels.

3.3. Functional design of electricity retail platform

The functional design of the platform includes nine basic modules, namely login management, market transactions, contract management, account management, complaints and disputes, credit information, data services, demand response and system settings, as shown in Figure 4.

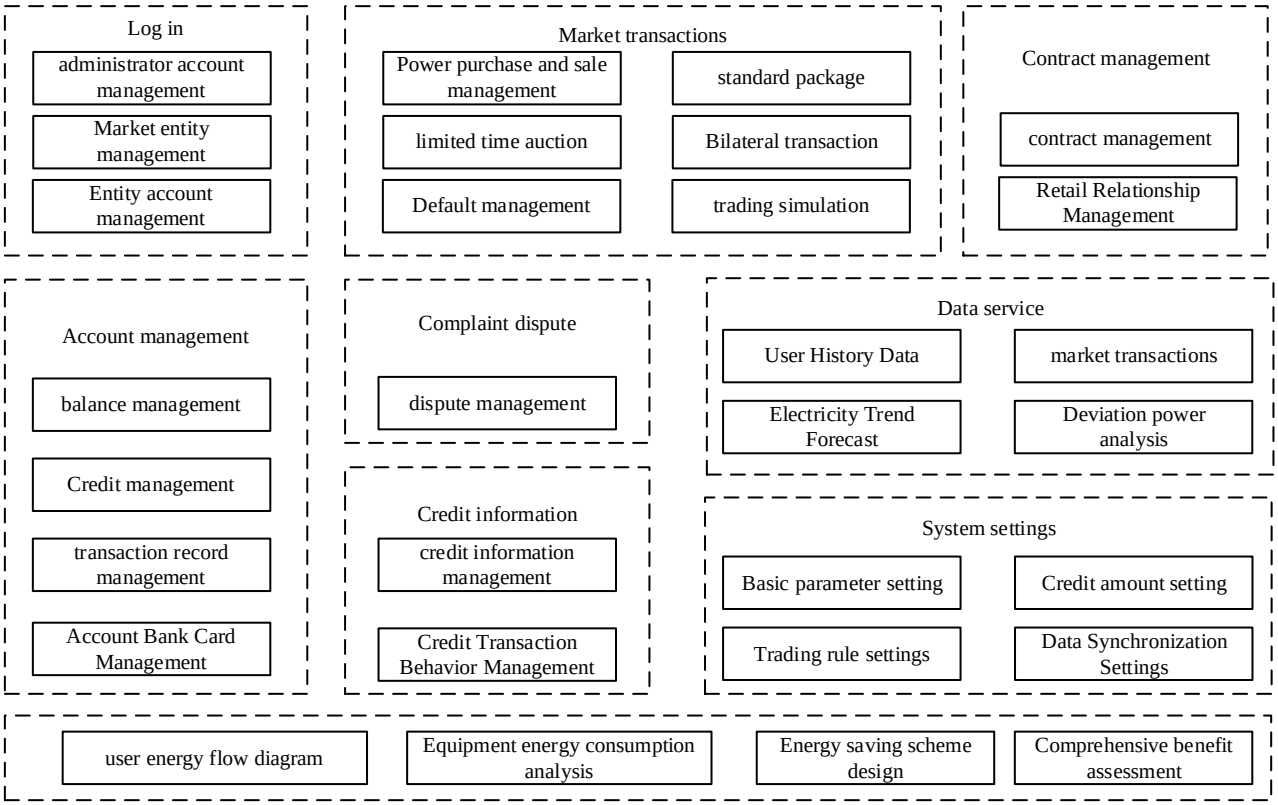


Figure 1. Functional framework of the electricity retail platform

(1) Login Management

Login management includes three modules: platform administrator account management, market subject management, and subject account management. It is mainly used for the authentication and management of the basic information of all parties.

(2) Market transactions

Market transactions include six modules: package selection, transaction process, transaction settlement, deviation assessment, default management and transaction simulation.

(3) Contract management

Contract Management consists of two modules: Contract Management and Retail Relationship Management. Market entities conduct transactions, formulate contracts, sign contracts, and manage contracts are all carried out in contract management. The information of the corresponding market subject and its related transaction information are conducive to the long-term transaction cooperation between the subject in the retail relationship management.

(4) Account Management

Account management includes four modules: balance management, credit management, transaction record management, account and bank card management, mainly managing user financial information.

(5) Complaints and disputes

Complaint Dispute contains one module: Dispute Management. If you need to complain, you can submit a complaint in this module, and the system will send it to the platform operator for mediation or ruling.

(6) Credit information

Credit information includes two modules: credit information management and credit transaction behavior management. Contains user credit information, as well as credit transaction behavior, and provides a basis for users to select transaction objects before conducting transactions.

(7) Data service

The data service consists of four modules: historical user data, market transactions, power consumption forecast for industrial and commercial users, and deviation power analysis.

(8) System settings

The system setting includes four modules: basic parameter setting, credit amount setting, transaction rule setting, and data synchronization setting.

(9) Demand response management

Demand response management includes four modules: user energy flow diagram, equipment energy consumption analysis, energy saving scheme design, and comprehensive benefit evaluation. The user energy flow diagram mainly shows the composition and flow of energy consumption by users, which helps users understand their own energy consumption; the analysis of equipment energy consumption can provide users with detailed energy consumption of equipment, and on this basis, design energy-saving schemes. Comprehensive benefit analysis of energy saving.

3.4. Function design and system architecture design of electricity retail platform

The system architecture design introduces the interactive design concept of the e-commerce platform, which can enable market participants to complete power transactions independently, including package or auction release, consultation, product search, invitation, quotation, comparison, contract negotiation and contract signing. Autonomous interaction without direct intervention from the platform operator. The platform mainly includes six parts: system specification, retail trading platform, operation management platform, data resources and statistical analysis, docking system and basic service components, as shown in Figure 5.

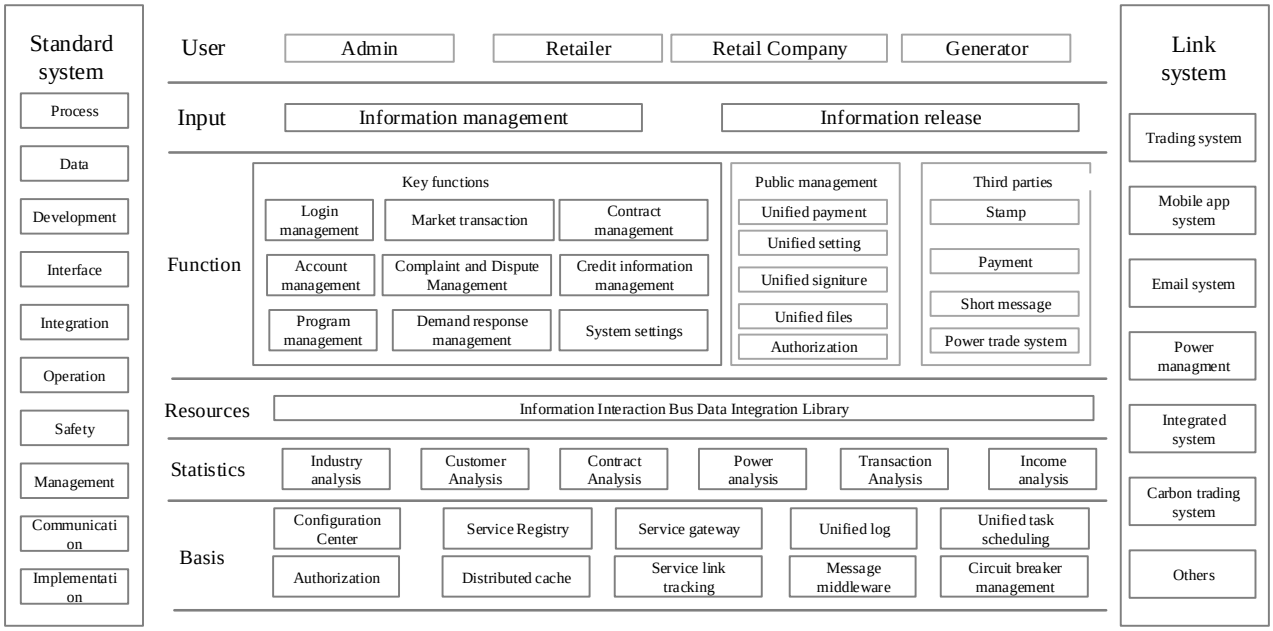


Figure 2. System architecture of the electricity retail platform

(1) System specification

The system follows the process, data, development, management, operation and other specifications.

(2) Retail trading platform

The retail trading platform is mainly responsible for the front end, with functions such as login management, market transactions, and contract management.

(3) Operation management platform

The operation management platform is mainly responsible for the back end, including public management modules and third-party management modules.

(4) Data resources and statistical analysis

Data resources mainly include market transaction data, product price changes, etc. All kinds of data resources on the platform are integrated into the database, and then fed back to platform users through statistical analysis to assist in transaction decision-making.

(5) Docking system

The electricity retail platform needs to be connected with the trading center system, power production management system, and carbon trading system to complete data synchronization and related transactions.

(6) Basic services and components

The basic services of the platform are subdivided into ten parts, including the configuration center, service registration center, etc., to provide sufficient data protection for record analysis and supervision of the occurrence, negotiation, and completion of electricity retail transactions.

4. Trading mode design of electricity retail market platform under full access of industrial and commercial users

4.1. Retail package design

Through the connection between the retail platform and industrial and commercial users, the corresponding price signal is introduced in the retail electricity market, and the transaction price and incentive mechanism are jointly formed to guide the product price of the retail electricity market, and to enhance the enthusiasm of industrial and commercial users to participate in the retail market competition. The types of retail packages set are mainly divided into fixed price packages, proportional sharing packages and market price linkage packages.

The fixed price package means that when the electricity sales company and the industrial and commercial retail users sign the contract, they agree on a fixed transaction settlement price, and at the same time, the electricity price remains unchanged during the contract period. Due to the fixed transaction settlement price stipulated in the contract period, this kind of trading package bears different risks when the wholesale market price rises or falls. When prices in the wholesale market rise, industrial and commercial users do not need to bear the risk of price increases, but when prices fall, they cannot enjoy the benefits of price cuts. In this transaction package, the cap price can be set according to the user's needs, and the corresponding cap price ratio can be implemented, so as to meet the user 's needs for different power settlements.

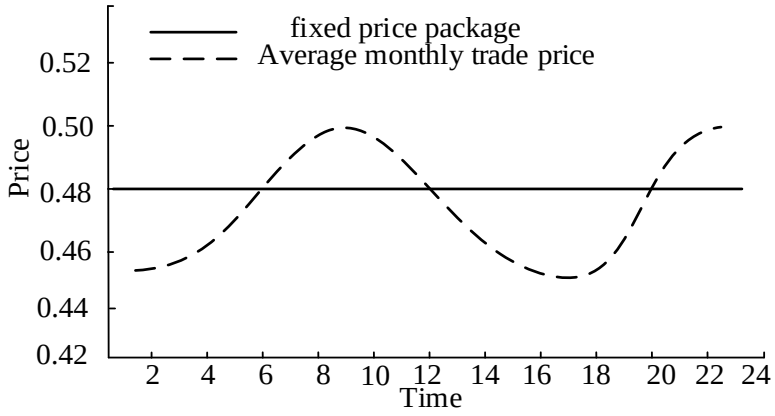


Figure 3. fixed price package illustration

The proportional sharing package refers to the package that the convergence company and the industrial and commercial retail users share the risks and benefits based on the agreed benchmark price and sharing ratio when signing the contract. The average price of this package is settled according to the average monthly transaction price. This package can also set a capped price, and the settlement will be made according to the set capped price. When prices in the wholesale market rise, users bear part of the risk of price increases, and enjoy part of the benefits of price reductions when prices fall. This package can realize the sharing of price reduction benefits and price increase risks in different proportions according to user needs. In the final transaction settlement, the electricity price is related to the user sharing ratio and the transaction benchmark price.

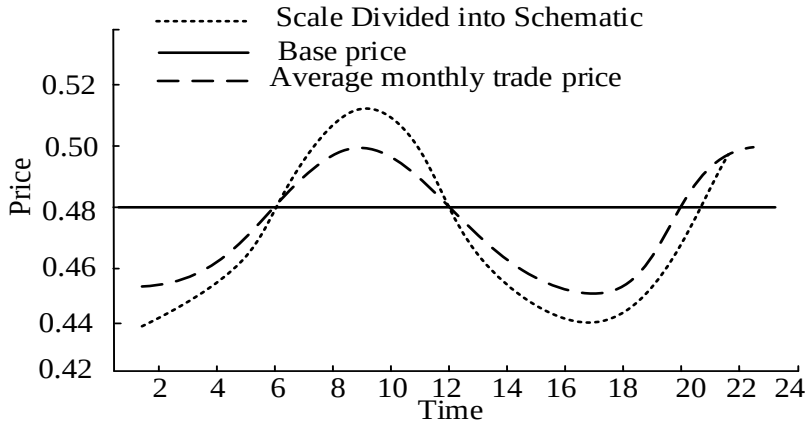


Figure 4. Scale Divided into Schematic

The market price linkage package means that when the electricity sales company and the industrial and commercial retail users formulate the transaction contract, the average transaction price is used as the basis, and the agreed upward or downward fee is determined in combination with market price changes, and finally the final linkage price is used as the transaction settlement price. This kind of transaction package is closely related to the fluctuation of electricity price in the electricity market, and users need to bear the risk of market price fluctuation accordingly.

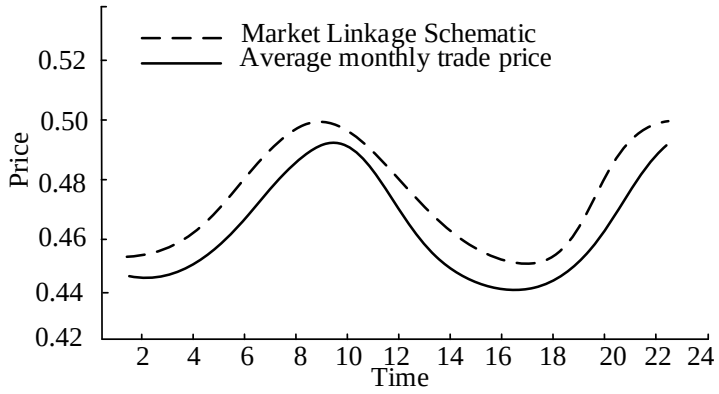


Figure 5. Market Linkage Schematic

4.2. Retail transaction design

The electricity retail trading market methods in which industrial and commercial users participate mainly include clearly marked price methods and negotiated price methods. The clear price marking method means that the electricity sales company lists the various products in the above three retail packages, specifies the parameters of the packages, lists them on the designed retail trading platform, and completes the transaction by placing an order for settlement. This method of clearly marking prices is mainly suitable for retail users with lower voltage levels. The main transaction process is shown in the figure below.

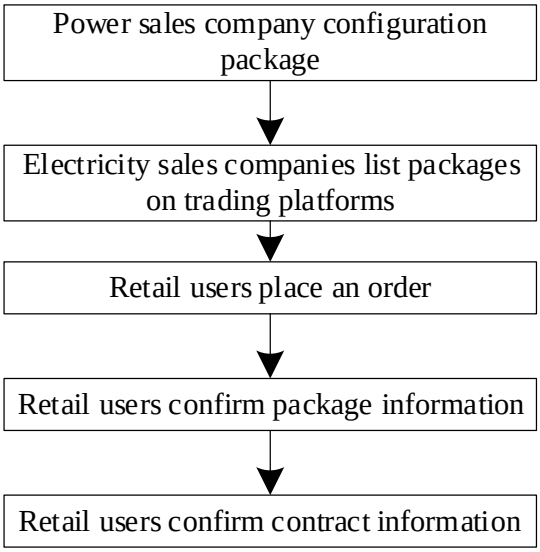


Figure 6. Schematic diagram of the price tagging process

Negotiation and bargaining means that electricity sales companies and industrial and commercial users negotiate and determine various parameters according to one of the above three retail packages, and complete the transaction after submission on the retail platform. This method is suitable for retail users of all voltage levels. The transaction flow is shown in the figure below.

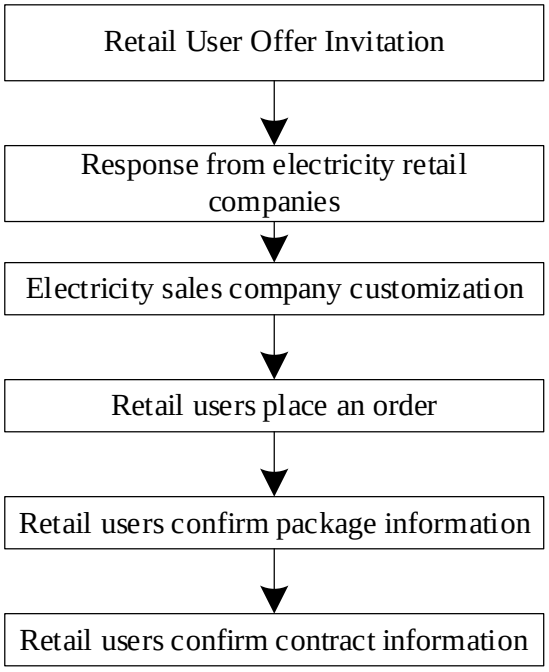


Figure 7. Negotiation and bargaining methods

4.3. Deviation assessment mechanism

The deviation assessment mechanism is applicable to various voltage levels, but for electricity retail market transactions involving industrial and commercial users, the voltage level of 35 kV is generally used as the boundary, and users of voltage levels above 35 kV are encouraged to negotiate to determine the deviation assessment, while 35 kV and below Users generally do not conduct deviation assessment, but can also be determined through negotiation. Industrial and commercial users who participate in the agreed deviation assessment need to report the electricity demand for the next month on the retail trading platform, and can modify the reported electricity demand after negotiating with the electricity sales company.

4.4. Transaction Settlement Mechanism

Industrial and commercial users sign retail packages and electricity sales contracts with power retail companies within the agreed time, and then publish the volume and price parameter information of the retail packages on the retail trading platform within the agreed time, and the power grid company checks the validity of the retail contract. For invalid retail contracts, it needs to be publicized on the power platform. After confirming the validity of the contract, the power grid enterprise can push the market-oriented electricity tariff information of retail users to the electricity sales company for verification and confirmation. After the electricity sales company completes the review and confirmation within the agreed time frame, the retail transaction will be concluded, and the transaction settlement will be finally realized.

4.5. Smart contract

With the development of the electricity retail platform, the transaction process is bound to move closer to transparency and speediness, especially as time changes, when the platform data shows a big data trend, smart contracts can greatly reduce the load of big data processing, and more Conveniently complete the transaction contract, analyze the electricity consumption habits and patterns of power users, and better understand the data fluctuations of all parties on the platform. At the same time, it can simplify the contract signing and transaction process, which greatly liberates manpower. Prevention and control provide effective information.

In the process of electricity trading, the electricity retail package refers to a display that stipulates the electricity price standard provided by the electricity sales company to provide electricity sales services to electricity users. The electricity package lists electricity in detail with clear quality, energy level, electricity, electricity price and other parameters, so that electricity, a non-traditional commodity, has a value carrier, and through a variety of parameter configurations and business ideas , turning the intangible power that cannot be stored into a variety of online commodities to meet the daily needs of different users. The electricity package needs to specify the available time period, date, quality, and corresponding fees of electricity. The electricity bill of retail users should indicate in detail the basic electricity purchase fees, agency fees of electricity sales companies, transmission network fees and distribution network fees covered by this electricity transaction. For network fees, the platform regulator will supervise the overcharging of unknown fees in electricity transactions.

4.6. Risk prevention and control mechanism and supervision mechanism of electric power retail platform

When formulating risk management strategies for electricity retail platforms, there are many problems that have to be faced. On the one hand, due to the non-storage of electricity, changes in electricity prices and the randomness and complexity of user loads are usually performed in real time, making transactions in the electricity retail market accompanied by On the other hand, how to balance and allocate the power purchases in the spot market and the futures market, in view of the two situations in which market risks are caused by price fluctuations and non-price fluctuations, different risk prevention and control mechanisms should be formulated. Although Value-at-Risk (VaR) is the de facto standard for risk compliance regulation in the financial sector, it is not a consistent risk measurement, so it may not be able to correctly capture the diversification benefits of investment portfolios. Conditional Value at Risk (Conditional Value-at- Risk, CVaR) as a consistent risk measurement index can overcome this defect, and it has good monotonicity, uniformity and translation invariance, etc., which is easier to calculate and has been commonly used In the risk assessment of electricity retail business.

As the rear of the electricity retail platform, the regulatory mechanism plays a vital role in protecting the orderly competition of the electricity retail platform from a third perspective and protecting the effective and comprehensive power supply information and consumer privacy information of the electricity retail companies. The setting of the supervision mechanism should follow two principles: independent and centralized. Setting up an independent regulatory mechanism can not only enable the regulatory agency to perform long-term and stable regulatory duties, but also ensure the neutrality and impartiality of the regulatory mechanism during its operation. The centralized supervision mechanism requires the State Electricity Commission to formulate national unified operating standards and management principles for electric power retail platforms. The supervision agencies of electric power retail platforms in all provinces and cities should implement a unified strategy. Apply for registration, and only after approval can small individual improvements be made on the basis of the national unified principle.

4.7. Case analysis

Taking an industrial and commercial power user in the Zhejiang power market as an example, select its power consumption from October 2020 to September 2021 for analysis, use the power retail market trading platform proposed in this paper to select packages and determine contracts, and realize retail sales. market transactions. It can be seen from Figure 8 that the total cost of electric power users has dropped significantly compared with before, from 1044.6 million yuan to 948.07 million yuan, which effectively reduces the power consumption cost of electric power users. And the power consumption of users has also been greatly improved, with a total increase of 147.9 million kWh in annual power consumption, which effectively promotes the substitution of electric energy.

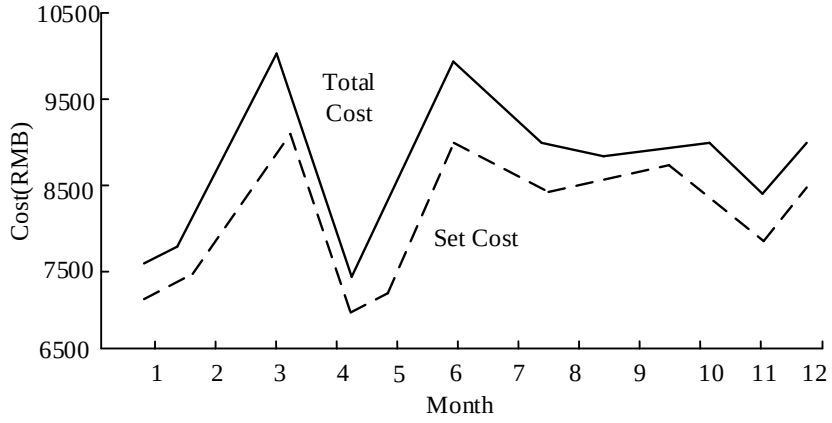


Figure 8. Comparison of total cost of electricity users

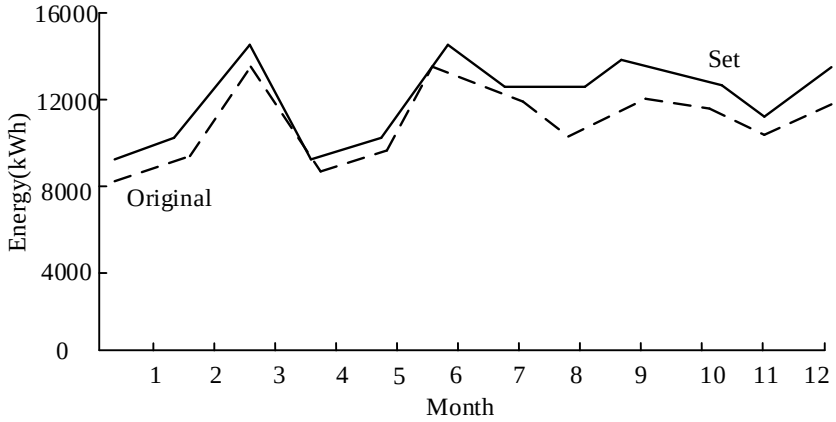


Figure 9. Comparison of Power Consumption by Power Users

5. Conclusion

In the context of deepening power reform, in order to solve complex problems such as transactions, prices, settlements, and risk management that restrict the development of the retail market, this paper proposes the design concept of a retail platform for the power market driven by carbon neutrality, and proposes a power-based retail platform. The transaction mode of the retail platform. The article first expounds the necessity of the construction of the electricity retail platform according to the transaction situation of the retail market in Zhejiang; then, combined with the requirements of carbon neutrality for the electricity sales platform, it proposes the design structure of the electricity retail platform, trying to realize its goal of promoting "two substitutions" function, to overcome the problems of information asymmetry and high transaction costs in offline transactions; then design a transaction model based on retail platforms, introduce carbon signals to design low-carbon clean substitution mechanisms, electric energy substitution mechanisms, and electricity -carbon medium and long-term transactions and spot transactions mechanism to realize the low-carbon operation of the electricity market, and at the same time design smart contracts; finally, the effectiveness of the transaction model is illustrated through an example, which not only realizes clean energy substitution on the power generation side, but also effectively reduces pollutant emissions and promotes the consumption of renewable energy. It also greatly reduces user costs on the power consumption side, greatly increases user power consumption, and effectively promotes power substitution.

Acknowledgment

Fund project: Science and technology project of State Grid Zhejiang Electric Power Co., Ltd. (2021ZK53).

References

[1] Kiesling L, Munger M, Theisen A. From Airbnb to Solar: Towa - rd A Transaction Cost Model of a Retail Electricity Distribution Pl - atform. 2018.

[2] B. Çolak, MA Gökmen and H. Kiliç, "A Web-Based Auction Pl - atform for Electricity Retail Markets," 2015 IEEE 14th International Conference on Machine Learning and Applications (ICMLA), 2015, pp. 1148-1152, doi: 10.1109/ICMLA.2015.17.

[3] Wang Bei, Wang Gangjun. Analysis and research on the realization of electricity sales platform based on micro-service architecture [J]. power information and communication technology, 2019, 17(4): 34-39.

[4] Xie Jingdong, Zhou Xuemei, Wang Shiyao etc. Research on distributed electricity market trading platform based on block chain technology [J/OL]. Electrical measurement and instrumentation: 1-8[2021-09-09].

[5] Zhao Chunzhang, Shang Jingfu, Yang Shengchun. New electricity sales model: design of P2P electric energy trading platform based on microgrid[J]. Journal of North China Electric Power University (Social Science Edition), 2018, (4): 30-36.

[6] Qi Bing, Zhai Tianyi, Li Bin, wait . Research on interactive mode of intelligent power consumption based on industrial internet cloud platform[J]. Measuring and instrumentation, 2019, 56(19): 46-52.

[7] Song Jianjing, Chen Yonghua, Yang Dongmei, et al. Research on the operation mechanism of the new electricity sales market after the electricity sales side is released [J]. Power demand side management, 2018, 20(5): 20-24.

[8] Kou Yan, Liu Yuming, Guo Liang. Ideas for the construction of electricity retail market under the spot market model [J/OL]. Power grid technology: 1-7[2021-09-09]. https://doi.org/10.13335/j.1000-3673.pst.2021.0393.