

<sup>1</sup>Shasha Zhao<sup>1</sup>Yakui Zhu

# Liberalization of Electricity Sales Side for Electricity Market-Oriented Transaction Mode



**Abstract:** - The market-oriented reform of the energy sales side is currently having a considerable impact, and in the economically developed regions, the electricity sales industry has evolved a competitive trend. Power grid corporations now compete in the market rather than serving as the traditional dominant force in electricity sales. After a new round of electrical reform, a key concern for the growth of firms is how to better integrate into the reform and increase their core competitiveness. The dangers associated with power market-oriented trading are examined in this study, and three risk mitigation strategies are suggested: the creation of a big data power trading platform, an information management system, and a blacklist system. The findings demonstrate that the optimal trading approach can successfully reduce the risk of variation in electricity assessments and generate significant revenue from electricity usage for power users. Additionally, we develop a multi-objective combination optimisation profit model and advise positioning and defences for businesses following the introduction of the power selling side.

**Keywords:** optimization, electricity, blacklist, management

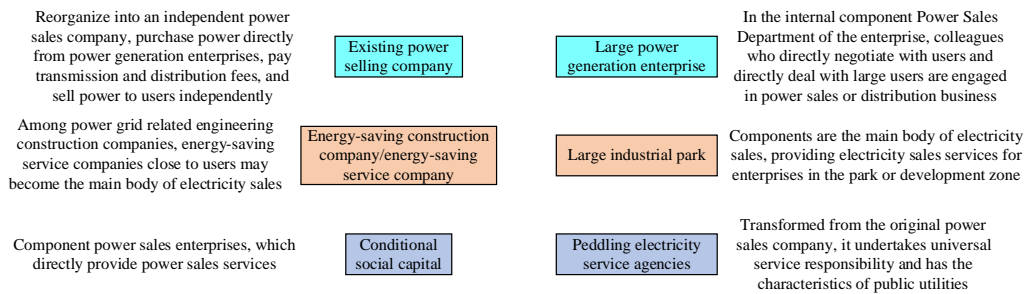
## I. INTRODUCTION

The primary concern in creating a particular power market is the way in which transactions take place. The construction of a competition mechanism has broken the initial system monopoly as a characteristic means of market-oriented reform, and further development is required to form a collection of free, equal, and transparent market trading mechanisms. As a result, several specialised market models have emerged as a crucial component of the research, which also covers questions related to market administration and even ownership. Additionally, the entire power industry structure was formed under law. The programmatic document for the power sales side reform, or document No. 9, was published in March 2015. The national development and Reform Commission released a number of supporting documents, the electricity price reform plan, and new rules on electricity trading to standardise the electricity price and trading system in order to put the spirit of the agreement into practise. Following the liberalisation of the power selling sector, a sizable number of power selling businesses will have an impact on the original power grid businesses' position as the primary power sellers, and these businesses will emerge as new market players by offering power selling or power distribution services. Its primary business strategy is to buy electricity from businesses that generate it, buy power on the market for trading power, buy power from other businesses that sell power, and finally sell power to consumers. The electricity market is highly competitive as a result of the liberalisation of the power sales industry. Five categories can be used to categorise the electricity sales

<sup>1</sup>State Grid Hebei Electric Power Co., Ltd. Marketing Service Center, Shijiazhuang Hebei, 050000, China

\*Corresponding Author: Shasha Zhao

companies competing in the Chinese market: power grid enterprises, power generation enterprises, engineering construction companies, energy conservation service organisations, and industrial parks.



**Figure 1 Participating entities of China's electricity sales companies**

The best possible operation of the market and resource allocation depend on the development of DSM in a competitive electricity market, which is what DR is. It primarily competes in the market based on its built-in user retention, real-time communication, and reciprocal interaction. The primary focus of this paper is on the optimal trading strategy of electricity sales companies in the electricity market through the DR design scheme, and it makes use of DR characteristics to help these companies fully open up users' rights to choice, offer a variety of electricity sales services, and prevent the assessment risk of electricity deviation. Furthermore, they proposed the interruptible load and electricity repurchase DR scheme to absorb the deviation, built the profit models for the electricity sales company and the best trading strategy taking DR into account, and then completed the verification analysis through the simulation comparison of four different trading strategies.

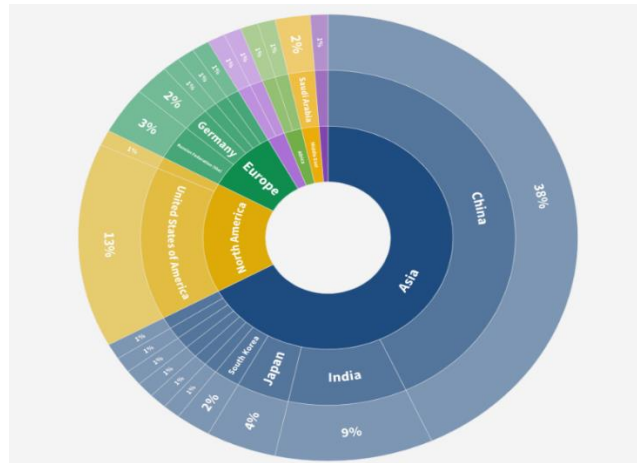
## II. RELATED WORK

### 2.1 Research on electricity market transaction mode

[2] The system examines the power bank mode (unilateral transaction), the bilateral transaction mode, and the exchange mode of the electricity market using economics as a foundation. The bilateral transaction mode needs to be extensively expanded in order for the long-term power market to thrive. [3] Based on the partial equilibrium analysis method used in economic theory, the bilateral transaction mode and the power pool mode were examined. The idea that the design of the power transaction mode had a direct bearing on the development of the power market structure was advanced, and that the power bank mode's monopoly power was stronger than that of the bilateral transaction mode was also advanced. [4] It is considered that economic relationships are the core of the market.

### 2.2 Domestic and foreign research status of electricity sales companies participating in the electricity sales market

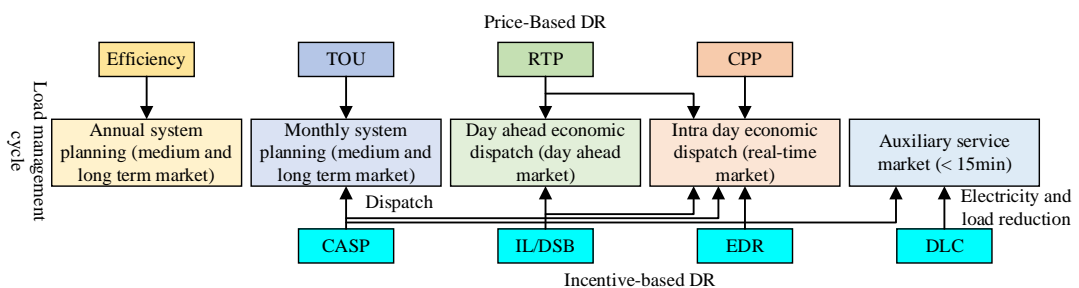
The publication of "Document No. 9" in March 2015 and "Trading Rules" in December 2016 represented a significant advancement in the marketization of energy and encouraged thousands of power sales enterprises to list and make their presence known in regional trading hubs. According to insufficient data from December 2017, there were 7,216 electricity sales companies registered and established in various provincial and municipal industrial and commercial bureaus, more than 3,000 of which had been announced in Beijing and Guangzhou, the two largest trading hubs in China. Figure 2 depicts how electricity sales companies are currently distributed across my country's major regions.



**Figure 2 Proportion of the distribution of national electricity sales companies**

### 2.3 Demand Response (DR) Technology

Electricity consumers who engage in DR change their innate electricity consumption patterns in response to price signals or incentive methods so as to take part in system scheduling activities or market transactions [25]. Based on various DR implementation strategies, existing DR technologies can be categorised into price-based DR and incentive-based DR. Pricing-based DR In order to encourage the full utilisation of demand-side response resources, price-based DR plays a crucial role in market transactions through the pricing mechanism by developing varied price plans under various circumstances. (2) DR Incentive The subject implements incentive DR by developing incentive plans or incentive strategies with various reward levels and execution tactics that electricity customers can select at their discretion. The expansion of user stickiness and the diversification of the electricity sales industry are crucial indicators of how competitive the company is in the market. Figure 3 illustrates the function and pricing incentive mechanism of energy consumers taking part in various forms of DR in the management of the power system.



**Figure 3 Time span and price incentive mechanism for users to participate in the operation of DR in the power system**

## III. METHODOLOGY

### 3.1 Considering DR, the electricity sales company optimizes the transaction plan design

This paper chooses interruptible DR contracts to make it easier for electricity sales companies to sign and implement

DR contracts with electricity customers given the early stage of the liberalisation of the electricity sales market in my country and the immature trading environment of electricity price mechanism, spot market, and real-time market. Plans for electricity consumption are created using the interruptible load (IL) and demand buyback (DB) DR techniques. In order to reduce the possibility of biased electricity assessments, the scheme increases user stickiness, which boosts the market competitiveness of electricity sales companies.

### 3.1.1 Interruptible load (IL) DR scheme design

An effective tool for implementing load regulation and risk management in the project's main body is interruptible load. By negotiating with the power customer regarding criteria such the quantity of electricity for a single load interruption, the total number of monthly load interruptions permitted, and the advance notice period, the implementing entity creates a diversified DR power consumption plan. The varied DR strategy has different criteria. In order to fully liberalise the user's right to choice, customers can freely declare the DR plan's specifications based on variables like the monthly production condition and market demand. When the electrical sales company participates in the monthly market transaction and there is a positive deviation, the DR scheme can regulate the deviation of power, successfully avoiding the risk of market positive deviation evaluation. In this paper, the DR scheme of interruptible load is implemented to eliminate the electric quantity of the positive deviation assessment part. Therefore, the compensation cost  $E_{IL}(t)$  of the DR scheme of interruptible load implemented by the electricity sales company in the  $t$  month is set as:

$$E_{IL}(t) = \sum_{i=1}^N (n_{IL}(i,t) \cdot Q_{IL}(i,t) \cdot P_{IL}(i,t)) \quad (1)$$

In the formula:  $n_{IL}(i,t)$  -the number of interruptions that the agent customer  $i$  of the power sales company implements the interruptible load DR scheme in the  $t$  month;  $Q_{IL}(i,t)$  -the power sales company agent customer  $i$  in the  $t$  month Interrupted power consumption of the interruptible load DR scheme implemented in a single month;  $P_{IL}(i,t)$  -the unit electricity compensation price of the power sales company's agent customer  $i$  implementing the interruptible load DR scheme in the  $t$  month;  $N$  - the total number of power customers .

1) Upper and lower limit constraints on the number of monthly interruptions of interruptible load:

$$0 \leq n(i,t) \leq n_{IL,max}(i,t) \quad (2)$$

2) The upper and lower limits of the electricity compensation price per unit of interruptible load:

$$P_{IL,min}(t) \leq P_{IL}(i,t) \leq P_{IL,max}(t) \quad (3)$$

In the formula:  $n_{IL,max}(i,t)$  -the maximum allowable number of interruptions that the agent customer  $i$

implements the interruptible load DR scheme in the  $t$  month;  $P_{IL,min}(t)$  -the power sales company implements the  $t$  month The minimum unit electricity compensation price provided by the interruptible load DR scheme;  $P_{IL,max}(t)$  -the maximum unit electricity compensation price provided by the electricity sales company implementing the interruptible load DR scheme in month  $t$ .

### 3.1.2 Demand Buyback (DB) DR Scheme Design

Repurchasing electricity is a useful option for project implementation companies to manage load and reduce risks. The implementing entity negotiates the time of the electricity repurchase, the number of repurchases, and the amount of electricity repurchased at one time with the electricity client before signing the contract. The power repurchase DR scheme will encourage customers to increase power consumption and offer discounts on the actual total power consumption of power customers when the power consumption declared by the implementing entity in the monthly market transaction and the actual power consumption trend in the middle and late months of the month are in excess. To benefit customers, use pricing or compensation. Customers' increased electricity usage can be used to produce and store energy storage devices ad hoc. The adoption of this plan will not only assist energy sales organisations in minimising risks but will also support the market's supply and demand equilibrium. In this study, the negative deviation assessment component of the electricity is eliminated using the DR scheme of electricity repurchase. Therefore, the compensation fee  $E_{DB}(t)$  for the electricity sales company to implement the DR scheme of electricity repurchase in the  $t$  month is set as:

$$E_{DB}(t) = \sum_{i=1}^N (n_{DB}(i,t) \cdot Q_{DB}(i,t) \cdot P_{DB}(i,t)) \quad (4)$$

In the formula:  $n_{DB}(i,t)$  -the number of times of electricity repurchase DR scheme implemented by the electricity sales company's agent customer  $i$  in the  $t$  month; DB  $Q_{DB}(i,t)$  -the electricity sales company's agent customer  $i$  in the first month. The electricity repurchased for a single implementation of the electricity repurchase DR scheme in month  $t$ ;  $P_{DB}(i,t)$  -the unit electricity of the electricity sales company's agent customer  $i$  who implements the electricity repurchase DR scheme in the  $t$  month compensation price.

1) The upper and lower limits of the repurchase times of the electricity repurchase scheme:

$$Q_{DB,max} \leq n_{DB}(i,t) \leq n(i,t);$$

2) The price constraint of unit electricity compensation in the electricity repurchase scheme:

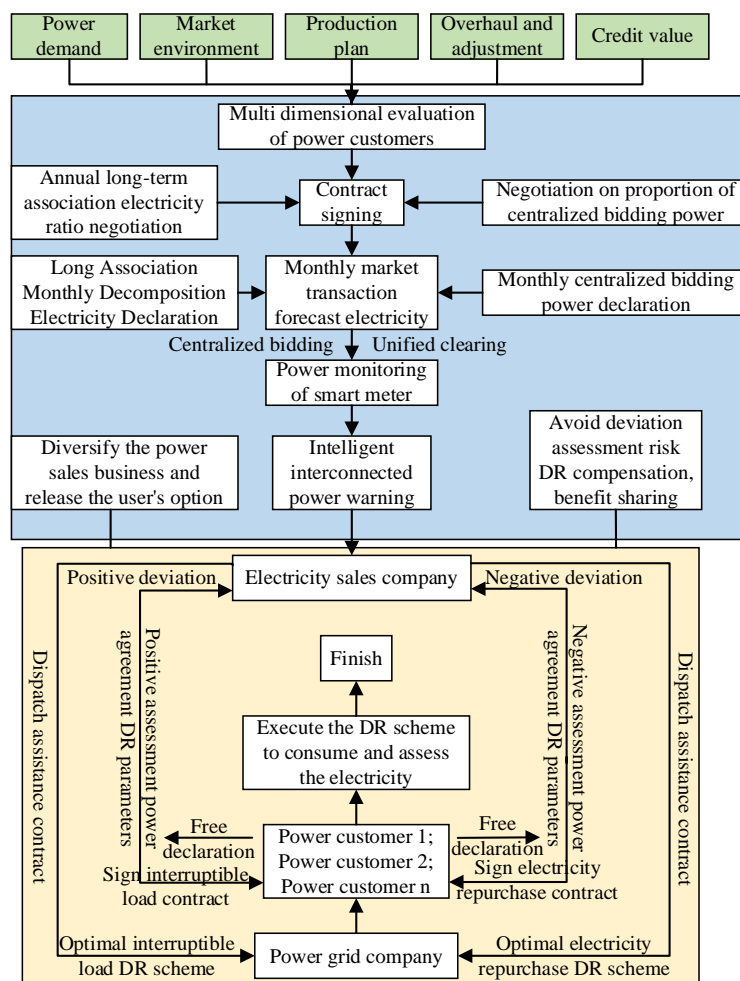
$$P_{DB,min}(t), P_{DB,max}(t) \leq P_{DB}(i,t) \leq P(t). \text{ In the formula: } n_{DB,max}(i,t) \text{ -the maximum allowable repurchase}$$

times of the power repurchase DR scheme implemented by the agent customer  $i$  in the  $t$  month;  $P_{DB,min}(t)$  -

the minimum unit power compensation price provided by the power sales company implementing the power repurchase DR scheme in the  $t$  month;  $P_{DB,max}(t)$ -the maximum unit electricity compensation price provided by the electricity sales company implementing the electricity repurchase DR scheme in month  $t$ .

### 3.2 Electricity sales companies considering DR optimize the transaction operation process

The position of DR is gradually changing as a result of the liberalisation of supply and demand in the electrical market, the "interconnection of all things" in the energy Internet, and the thorough optimisation of smart grids. Marketization has emerged as the dominant trend in the reform of the power system among them, and DR will play a crucial role in maximising resource allocation and achieving supply and demand balance through market-oriented measures. Through the DR power consumption plan, electricity sales companies can invite power customers to take part in market transactions. As part of a market-oriented approach, DR resources will be considered equally with the supply side and take part in system operation, opening up new possibilities for energy sales businesses to indirectly control loads through power grid companies. technological techniques. In order to control the demand-side resources' ability to participate in electricity market transactions, this study proposes the operating strategy of the electricity sales company utilising the DR scheme, as shown in Figure 4 below.



**Figure 4 Optimized transaction operation process of electricity sales companies considering DR**

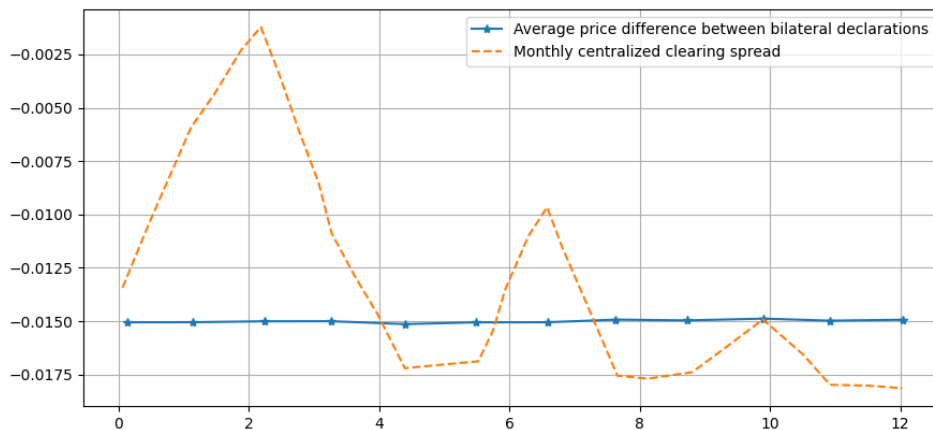
Following the processes shown in the flow chart above, the power sales firm implements the optimal benefit and

risk sharing trading operation strategy with the power customers: First, the power sales organisation analyses the production schedule, the demand for electricity, the market environment, the upkeep and adjustment of the power consumers, etc. Perform multi-dimensional customer evaluations based on various criteria, agree on annual, long-term, and monthly electricity distribution ratios, profit-making plans, etc., and sign contracts with customers. After that, take part in monthly centralised transactions based on the reported electricity forecast for the following month; Step 2: The electricity sales firm tracks and records the real monthly electricity consumption of the electricity consumers using the monitoring feature of the smart metre, and sets the alarm threshold of the deviation electricity. The early warning of electricity sales to the electricity sales firm in the middle and end of the month is made possible by clever interconnected communication technologies; Step 3: Analyse the electricity warning to determine the positive and negative deviations as well as the pre-assessed electricity. The energy sales business chooses the best DR plan and sends it to the power grid company for scheduling assistance, and the electricity customer executes the DR plan consumption evaluation. The electricity sales company optimises and solves the DR parameters that the client has freely specified. In order to realise the avoidance of risk assessment for electricity sales firms, electricity. It is anticipated that the electricity sales company's transaction operation strategy, which takes DR into account, will be the value growth point and innovation point of the electricity sales company in the market-oriented environment, and it will be a means of enhancing market competitiveness.

#### IV. EXPERIMENTS

##### 4.1 Data sample design

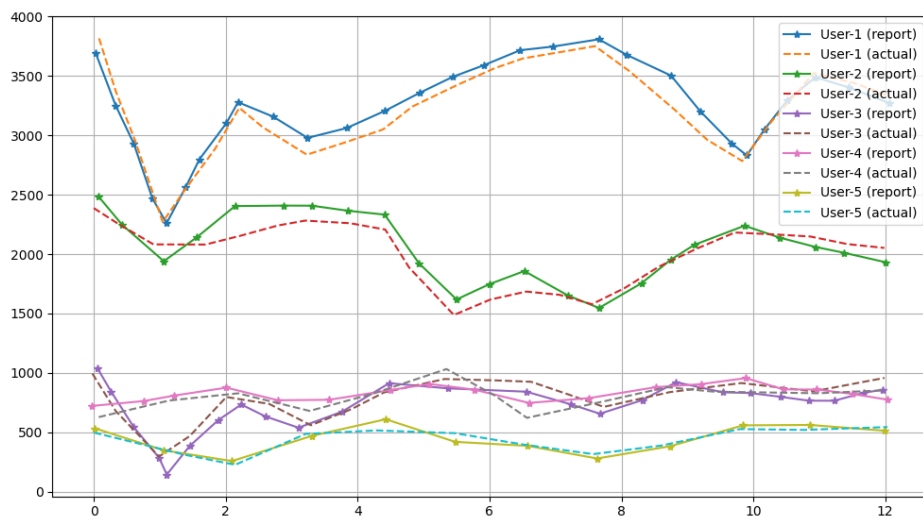
The trading regulations made it clear that a customer's total electricity demand may only be disclosed to one electricity sales business. This study makes the assumption that the demand for electricity consumption put forth by the electricity sales firm is fully satisfied in order to streamline the computation and comparison, and selects the annual long-term average price difference of  $-0.0645$  yuan/  $kW \cdot h$  announced by the Guangdong Electric Power Trading Center in 2017 as the average price difference of bilateral transactions. At the same time, the average clearing price difference in January from each month's centralised auction in 2017 was chosen as the monthly centralised auction clearing price difference; the precise amount is displayed in Figure 5.



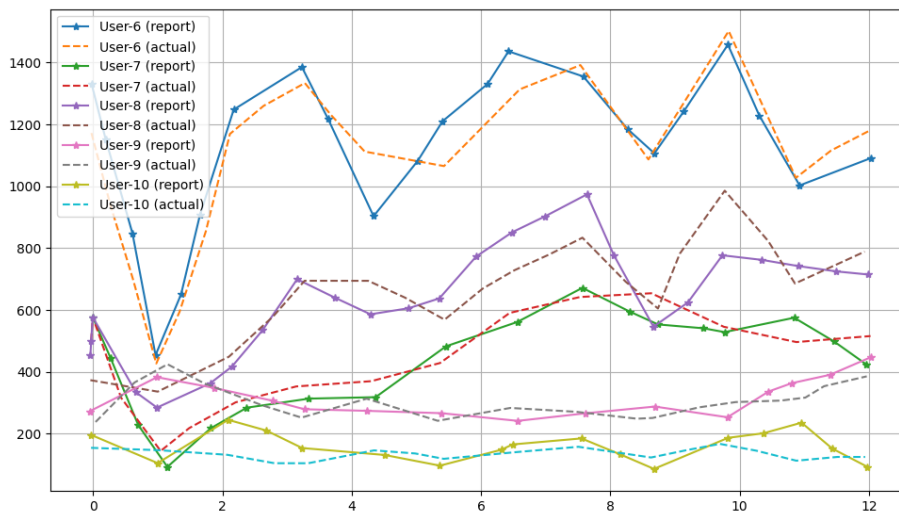
**Figure 5 Values of different types of price differences in each month**

### 4.2 Simulation parameter settings

The monthly power deviation of electricity users is unavoidable because of numerous unpredictable factors such as climatic change, market demand, and changes in the price of raw materials. By running a Monte Carlo stochastic simulation on the forecast data (declared electricity volume), which is the data produced by random simulation and used as the actual electricity consumption in accordance with the monthly electricity mean and standard deviation of various types of electricity customers, the effectiveness of the profit model is assessed. In particular, Figures 6 and 7 compare the monthly stated electric amount of commercial users with the real electric quantity and the monthly declared electric quantity of industrial users with the actual electric quantity using numbers.



**Figure 6 Monthly declared power and actual power of industrial users**



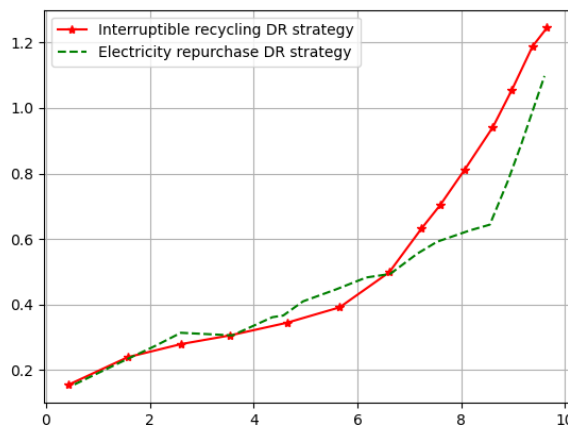
**Figure 7 Monthly declared electricity consumption and actual electricity consumption of commercial users**

The electrical sales firm establishes the top and lower bounds of each parameter, as given in Table 2. The penalty spread factor is set to 3 if the electrical client fails to implement the DR plan as planned.

**Table 2 The upper and lower limit parameters of the DR scheme of the electricity sales company**

Parameter	Interruptible load DR scheme			Electricity repurchase DR scheme		
	Upper and lower limits of interrupt times	Upper and lower limits of single interruption power (10000 $kW \cdot h$ )	Upper and lower limits of unit power compensation price (yuan / $kW \cdot h$ )	Upper and lower limits of repurchase times	Upper and lower limits of single interruption power (10000 $kW \cdot h$ )	Upper and lower limits of unit power compensation price (yuan / $kW \cdot h$ )
Numerical value	[0,5]	[10,80]	[0.6 $P_c(t)$ , 0.92 $P_c(t)$ ]	[0,5]	[10,60]	[0.6 $P_c(t)$ , 1.5 $P_c(t)$ ]

Among them, for the interruptible load unit electricity compensation price parameter  $P_{IL}(i, t)$  and the electricity repurchase unit electricity compensation price parameter  $P_{DB}(i, t)$  of the DR scheme, when the electricity customer pays when the compensation price is reported to the electricity sales company with low price parameters, it shows that the electric power customer has a strong enough willingness to participate in this type of DR scheme. The willingness to take part in this kind of DR programme is comparatively low, or even nonexistent. When there is a variance in the total transaction electricity volume in the monthly bidding of a particular electricity retail company, the electricity retail company will be based on the unit electricity declared by the electricity customer. This is because the electricity sales company will prioritise in accordance with the unit electricity compensation price parameters declared by various types of electricity customers. Electricity consumers with low declared prices are given preference in order to eliminate the deviation of electricity, and the price curve is constructed from low to high compensation price.



**Figure 8 Quotation curve of electric power customers' unit electricity compensation price**

4.3 simulation results and comparative analysis

Figures 8 and 9 display, respectively, the total declared electricity quantity for monthly bidding and the monthly bilateral electricity quantity broken down by long-term cooperation of various types of power consumers. The declared electricity quantity of each monthly centralised bidding is the absolute value of the difference between the two, as shown in Table 3.

**Table 3 The deviation assessment results of unified customer electricity participation in monthly market transactions**

Month	Clearing price difference $P_c(t)$ (yuan / $kW \cdot h$ )	Deviation electricity / 10000 $kW \cdot h$	Assessment free electricity / 10000 $kW \cdot h$	Assessment power / 10000 $kW \cdot h$
January	-0.0787	458.26286	272.4	185.86286
February	-0.1455	-286.57179	-205.2	-81.37179
March	-0.18945	464.97945	253.4	211.57945
April	-0.1015	-1.57531	-252.4	0
May	-0.045	-323.09812	-264.8	-58.29812
June	-0.04815	406.39773	253.8	152.59773
July	-0.115	197.65315	267.8	0
August	-0.0405	26.27948	266.2	0
September	-0.0426	-396.32574	-265	-131.32574
October	-0.065	-245.64059	-273.6	0
November	-0.037	262.19751	266.8	0
December	-0.0365	-196.07962	-270.6	0

Table 3 shows that positive deviations occurred in January, March, and June under the mode of unified customer electricity consumption of electricity sales businesses to participate in monthly transactions, and negative deviations happened in February, May, and September. The monthly electricity's deviation portion falls outside the purview of the exemption. Using the fundamental tenet of Strategy 3 and the free declaration constraints for power users taking part in the DR scheme as indicated in Table 3. Entering the formula (1)) in the MATLAB 2014 simulation platform will yield the execution results of the strategy 3 DR scheme as shown in Tables 4 with reference to the assessment findings of the deviation power in each month.

**Table 4 Execution results of interruptible load DR scheme**

Interruptible load DR - avoids positive deviation									
Custo mer	February			May			June		
	Number of interrupt	Total power interrup	DR compens ation	Number of interrupt	Total power interrup	DR compens ation	Number of interrupt	Total power interrup	DR compens ation

	ions	tion / 10000 <i>kW · h</i>	fee/10,00 0 yuan	ions	tion / 10000 <i>kW · h</i>	fee/10,00 0 yuan	ions	tion / 10000 <i>kW · h</i>	fee/10,00 0 yuan
1	4	120	6.615	4	120	15.914	4	120	4.045
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	2	40	2.205	2	40	5.305	1	20	0.674
6	0	0	0	0	0	0	0	0	0
7	1	10	0.472	1	10	1.137	1	10	0.289
8	1	25	1.457	1	25	3.505	0	0	0
9	1	15	0.768	1	15	1.847	1	15	0.469
10	0	0	0	1	40	5.987	0	0	0

Tables 4 show that strategy 3 is based on the importance of the customer's DR parameter quotation to execute complete deviation power consumption to avoid the danger of assessment. power customers. The annual compensation revenue of each customer adopting the DR system in Figure 10 may be calculated by using the compensation fee income of electric power customers implementing the DR scheme in various months in the table.

## V. CONCLUSION

The market's traditional trading tactics struggle to keep up with the evolving requirements of the electrical market-oriented trading model in the contemporary setting. First, using the additional constraints of the DR scheme and the power consumer default penalty model, we simulate the proposed optimisation transaction strategy of electricity sales organisations that takes into consideration DR. The simulation results of numerical examples demonstrate that our technique performs much better in transaction operation than the prior method strategy. Additionally, the compensation expense of the DR scheme surpasses the assessment cost of the deviation power when it is used to absorb the power consumption of the deviation assessment, resulting in a lower final income than our technique. It perfectly exemplifies the significance and potency of our approach in maximising the operating income of the trading model based on the electricity market under the liberalisation of the energy sales side.

### Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

### Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

### Funding Statement

There is no specific funding to support this research.

## REFERENCES

- [1] Cui, J., Li, Y., He, C., Zhang, Z., Wang, H., Tang, J., ... & Yang, L. (2021). Optimal Electricity Allocation Model Under China's Planning-Market Double-Track Mechanism Considering Bidding Game of Generation Companies. *Frontiers in Energy Research*, 9, 673228.
- [2] Sun, B., Wang, F., Xie, J., & Sun, X. (2021). Electricity Retailer trading portfolio optimization considering risk assessment in Chinese electricity market. *Electric Power Systems Research*, 190, 106833.
- [3] Xin-gang, Z., & Shu-ran, H. (2020). Does market-based electricity price affect China's energy efficiency?. *Energy Economics*, 91, 104909.
- [4] Chen, Y., Zhang, L., Xu, P., & Di Gangi, A. (2021). Electricity demand response schemes in China: Pilot study and future outlook. *Energy*, 224, 120042.
- [5] Lei, N., Chen, L., Sun, C., & Tao, Y. (2018). Electricity market creation in China: Policy options from political economics perspective. *Sustainability*, 10(5), 1481.
- [6] He, Y., Liu, Y., Li, M., & Zhang, Y. (2022). Benefit evaluation and mechanism design of pumped storage plants under the background of power market reform-A case study of China. *Renewable Energy*, 191, 796-806.
- [7] Hu, J., Xia, C., Li, H., Zhu, P., & Xiong, W. (2020). Properties and structural analyses of USA's regional electricity market: a visibility graph network approach. *Applied Mathematics and Computation*, 385, 125434.
- [8] She, Z. Y., Meng, G., Xie, B. C., & O'Neill, E. (2020). The effectiveness of the unbundling reform in China's power system from a dynamic efficiency perspective. *Applied Energy*, 264, 114717.
- [9] Gómez-Navarro, T., & Ribó-Pérez, D. (2018). Assessing the obstacles to the participation of renewable energy sources in the electricity market of Colombia. *Renewable and Sustainable Energy Reviews*, 90, 131-141.
- [10] Yin, S., Wang, J., Li, Z., & Fang, X. (2021). State-of-the-art short-term electricity market operation with solar generation: A review. *Renewable and Sustainable Energy Reviews*, 138, 110647.
- [11] Gu, H., Yan, R., & Saha, T. (2019). Review of system strength and inertia requirements for the national electricity market of Australia. *CSEE Journal of Power and Energy Systems*, 5(3), 295-305.
- [12] Djørup, S., Thellufsen, J. Z., & Sorknæs, P. (2018). The electricity market in a renewable energy system. *Energy*, 162, 148-157.
- [13] Hasankhani, A., & Hakimi, S. M. (2021). Stochastic energy management of smart microgrid with intermittent renewable energy resources in electricity market. *Energy*, 219, 119668.
- [14] Yang, W., Wang, J., Niu, T., & Du, P. (2020). A novel system for multi-step electricity price forecasting for electricity market management. *Applied Soft Computing*, 88, 106029.
- [15] Lüth, A., Zepter, J. M., del Granado, P. C., & Egging, R. (2018). Local electricity market designs for peer-to-peer trading: The role of battery flexibility. *Applied energy*, 229, 1233-1243.

- [16] Zhang, Z., Li, R., & Li, F. (2019). A novel peer-to-peer local electricity market for joint trading of energy and uncertainty. *IEEE Transactions on Smart Grid*, 11(2), 1205-1215.
- [17] Hakimi, S. M., Hasankhani, A., Shafie-khah, M., & Catalão, J. P. (2021). Stochastic planning of a multi-microgrid considering integration of renewable energy resources and real-time electricity market. *Applied Energy*, 298, 117215.
- [18] Lin, J., Kahrl, F., Yuan, J., Liu, X., & Zhang, W. (2019). Challenges and strategies for electricity market transition in China. *Energy Policy*, 133, 110899.
- [19] Prol, J. L., Steining, K. W., & Zilberman, D. (2020). The cannibalization effect of wind and solar in the California wholesale electricity market. *Energy Economics*, 85, 104552.
- [20] Jafari, A., Ganjehlou, H. G., Khalili, T., & Bidram, A. (2020). A fair electricity market strategy for energy management and reliability enhancement of islanded multi-microgrids. *Applied Energy*, 270, 115170.
- [21] Dvorkin, Y. (2019). A chance-constrained stochastic electricity market. *IEEE Transactions on Power Systems*, 35(4), 2993-3003.
- [22] Jiang, S., Wan, C., Chen, C., Cao, E., & Song, Y. (2018). Distributed photovoltaic generation in the electricity market: status, mode and strategy. *CSEE Journal of Power and Energy Systems*, 4(3), 263-272.
- [23] Khaloie, H., Abdollahi, A., Shafie-Khah, M., Siano, P., Nojavan, S., Anvari-Moghaddam, A., & Catalão, J. P. (2020). Co-optimized bidding strategy of an integrated wind-thermal-photovoltaic system in deregulated electricity market under uncertainties. *Journal of Cleaner Production*, 242, 118434.
- [24] Le Cadre, H., Jacquot, P., Wan, C., & Alasseur, C. (2020). Peer-to-peer electricity market analysis: From variational to generalized Nash equilibrium. *European Journal of Operational Research*, 282(2), 753-771.
- [25] Peng, D., & Poudineh, R. (2019). Electricity market design under increasing renewable energy penetration: Misalignments observed in the European Union. *Utilities Policy*, 61, 100970.