Practices and Enlightenment of Domestic and Foreign Demand Response in Electricity Market

Shuai Han*, Wanlu WU, Xiaoxuan Guo, Leping Sun
Electric Power Research Institute of Guangxi Power Grid Co., Ltd, Nanning, Guangxi, 530023, China
*Corresponding author’s e-mail: 492285848@qq.com

Abstract. With the increasing proportion of intermittent power supplies and large capacity generator set, demand response based on excitation and price is widely concerned for improving the flexibility of system operation scheduling. The development of demand response in the electricity market is in the ascendant in the world, and the market mechanism can be better designed by fully drawing on existing experience. This paper comprehensively analyses the released relevant policies, technical standards and implementation of existing pilot projects of domestic and foreign demand response in electricity market, summarizing the research focus in recent years, learning the experience of the existing demand response project and combining the current situation of the power market revolution, then put forward some suggestions to develop the mechanism of demand response in electricity market.

1. Introduction
With the further development of economy, the problems of weak grid structure and uneven distribution of power supply are further exposed. The problems of large peak-to-valley difference and insufficient peak-capacity capacity affect the safety and reliability of the power grid, which restricts the development of society to a certain extent. The introduction of demand response (DR) in the electricity market can cope with possible surges in the future and intermittent energy sources such as electric vehicles and wind power, which can alleviate the impact of grid congestion in extreme cases, improve system flexibility, achieve comprehensive energy efficiency configuration, and delay generator capacity increase and line investment. In the process of promoting the new round of power market reform in China, the national policy clearly pointed out that it is necessary to adhere to energy conservation and emission reduction, actively implement DR, and give full play to the market adjustment mechanism, so as to promote the power balance between the supply side and the demand side of the system, and ensure the reliable and economic operation of the power system. Under the situation that the country vigorously promotes demand-side management (DSM) and power market reform, it is urgent to design a reasonable and effective DR resource trading mechanism based on the actual development status and trends of the actual power market, to lay the foundation for the widespread promotion of DR, support for R&D and pilot construction.

Based on the analysis policy mechanism, the implementation of standards and industry present situation of DR in recent years in the US, EU, Japan and China, this paper summarizes the exploration direction of DR, and selects typical pilot project to study the effect. Then combined with the current development status and trend of DR marketization, the future development of DR market-oriented trading model design and key technology research in China is prospected.
2. Status of foreign research and development

2.1. Management policy and industrial development

The main body of foreign power DSM is basically the power companies, responsible for formulating relevant strategies and implementing corresponding technologies. As a legislator, the government focuses on the supervision and incentives of power companies. Although some large foreign power companies are also public-owned enterprises, their management models are quite different from those in China, and they have their own characteristics in implementing DSM.

Table 1. DR development status in various countries

| Supportive policies | the United States | European Union | Japan |
|---------------------|------------------|---------------|-------|
| **The Energy Policy Act of 1992:** Demand-side power investment is equal to the traditional supply-side investment, and DR participates in the wholesale market. | | | |
| **Order No. 888 of the Federal Energy Regulatory Commission in 1996:** Unbundling of electricity, power generation wholesale markets and transmission services. | | | |
| **The Energy Policy Act of 2005:** Encourage the timing of pricing and other forms of DR, eliminate barriers to entry, and incorporate DR into national policy. | | | |
| **Energy Independence and Security Act of 2007:** An assessment of the country's DR potential and policy recommendations. | | | |
| **Federal Energy Management Commission Order No. 719 of 2009:** Allows DR to bid directly on the wholesale market. | | | |
| **Federal Energy Regulatory Commission Order No. 755 of 2011:** affirms that DR can be a cost-effective option in balancing energy supply and demand. | | | |
| **Federal Energy Regulatory Commission Order No. 745 of 2015:** Allows DR to enjoy local wholesale market prices in the real-time market and electricity market. | | | |
| **Through the formulation of energy law and energy tax law, the EU has stipulated the role, rights and obligations of the government, various departments, intermediary and research institutions, and energy users in DSM. The directive on “Enhancing Energy Efficiency and Promoting Energy Services” provides recommendations and regulations for energy DSM, and its obligations include important energy suppliers (distributors and retailers) and end users. The "white certificate” mechanism means that the energy use process has achieved the level of energy conservation stipulated by the EU program. Energy suppliers should pay a certain number of "white certificates” every year, with fewer penalties and more awards. This policy promotes the energy supply enterprises' consideration of the user's energy supply and the interactive sharing of information. The three European 2020 climate and energy targets issued by the European Commission indicate that DR is an important means to help achieve the goals. | | | |
| **The 4th Energy Basic Plan in 2014:** Introducing new DR models, maintains a reasonable scale of power generation capacity through DSM to achieve stable power supply. | | | |
| **2015 “Negative Watt Market”**: Increase people's enthusiasm for saving electricity. | | | |
| **2016 “Japan Rejuvenation Strategy”**: It is proposed to achieve the goal of DR accounting for 6% of total electricity demand by 2030, and clearly propose a policy to promote virtual power plants (VPP). | | | |
| **2016 “Energy Innovation Strategy”**: Formulates government subsidy plans to support enterprises in implementing VPP technology. | | | |
| **The 5th Energy Basic Plan in 2018:** Accelerate the promotion of technologies such as low-cost energy storage batteries, V2G (Vehicle to Grid), and electricity-to-gas (P2G), and strengthen the research and development of low-power wide-area network technology (LPWA) and M2M and P2P. | | | |
| Standards of implementation | Industrial Development status |
|-----------------------------|-----------------------------|
| Developed by the DR Research Center at Lawrence Berkeley National Laboratory, OpenADR uses dynamic electricity prices to improve the economics and stability of the grid. In 2012, OpenADR 2.0a was released as a national standard in the United States; in 2014, the IEC approved OpenADR 2.0 as a publicly available specification and included in the standard catalog of the Smart Grid Interoperability Panel (SGIP). | The state governments have played a leading role in the DR work and established energy management departments at all levels; the US power companies are fully competitive in all aspects such as generation and distribution, and the degree of market-oriented reform is high; third-party energy service companies are mature and the American people have a good understanding of DR. There are three typical DR operating modes in the United States: 1) intermediaries-led mode of operation 2) government-led mode of operation 3) power company-led mode of operation. The implementation of DR project can be roughly divided into three stages: first, manual stage; second, semi-automatic stage; third, fully automatic stage. At present, DR in the US is still in the transition period of the second and third stage. |
| The DSM-related standards promoted by the EU's Smart Grid Standardization Organization include: TC57 WG21 is responsible for the grid side of the smart grid user interface, TC205 is responsible for the smart grid connection to the home and building electronic systems, and TC59 is responsible for user-side equipment such as washing machines and refrigerators. | According to the different project financing modes and recycling modes, the DR commercialization operation modes in European countries can be roughly divided into the following categories: comprehensive resource planning mode, public benefit fund model, government investment mode, and participant fund raising mode through special funds. The EU has two main focus areas for energy management use: the Sixth Framework Programme and Pilot Project (FP6) and the EU Smart Energy Initiative (IEP). FP6 has launched a number of large-scale projects that are energy efficient, such as the Concerto Initiative and the Eco-Building Project. The DR in Europe is still in the second stage. |
| Japan adopted OpenADR 2.0 as the basis for its automatic DR standard, and the Ministry of Economy, Trade and Industry established the DR Action Group to draft a communication between Japanese energy suppliers (electric power companies) and energy consumers (independent service providers and end consumers). Technical specification, this transitional specification is called "Japan DR Interface Specification 1.0". | Japan's DSM system: the top is the Ministry of Economy, Trade and Industry and the local economic and industrial bureaus, the middle is a professional energy-saving organization, and the bottom is the energy-saving designated factory and energy-saving product manufacturers and distributors. The vertically integrated Japanese energy efficiency management model makes a series of targeted rules and regulations for key energy users, and the external organizations can promote the R&D, demonstration and guidance of energy conservation and new energy industry technologies. At present, Japan's DR is still in the second stage. |

2.2. Research focus in recent years
Research on DR started early abroad, and the basic work such as demand side load modeling, measurement, control mode and communication architecture has matured. Practical applications is now the focus. The following is a summary of the current research hotspots by collecting and analyzing papers published in high-level journals in the past three years.

2.2.1. Multi-scene multi-energy complementary strategy. Literature [4] studied the application potential of DSM based on optimization of electricity consumption in the industrial field by utilizing cold storage and off-grid solar photovoltaic to reduce and transfer peak demand of electricity consumption. Literature [5] studies the demand side flexibility benefits of smart appliances and passenger cars. The analysis shows that demand side control increases the flexibility of the system, enabling the integration of efficient low carbon power (such as nuclear and wind energy) to reduce
storage requirements. Literature [6] studied the behavior of multi-energy enterprises and multiple energy carriers to maximize profits and reduce operational risks, and established a decision-making conflict model between power companies and other energy companies in the electricity demand market. In [7], for the characteristics of rotating standby, DR resources and battery storage in hybrid energy systems, an optimal sequential dynamic emergency standby scheduling and activation scheme is proposed.

2.2.2. Automatic demand response technology. Literature [8] studies the DSM load redistribution optimal fitness function based on genetic algorithm, which can effectively allocate the available power in the peak period to minimize the power consumption in the peak period. Literature [9] proposed an electricity consumption DSM scheme that maximizes user satisfaction within the scope of user budget, studied the introduction of user satisfaction factor in automatic demand response, and maximized user satisfaction under pre-determined user budget. Literature [10] studied DR of electric water heater based on heuristic automatic dynamic programming, which can minimize energy consumption during peak load. Literature [11] studies the participation of TCLs in the real-time retail power market in the agent-based mode, and develops a simple and effective DR control scheme for TCLs, which can adjust the power consumption of aggregated TCLs in real time.

2.2.3. Market optimization model. Literature [12] proposed a distributed resource management method for load aggregators, including resource scheduling, aggregation and reward. The influence of the formation of salary tariffs is analyzed by using the combination of fixed and exponential tariffs. Literature [13] proposed a mathematical model for the energy bidding problem of virtual power plant (VPP) participating in conventional power market and intraday demand response exchange (DRX) market. The model takes into account the different system uncertainties of retail customer demand and electricity price.

2.3. Typical engineering case analysis
North America is the leading region of DR market, accounting for more than 80% of the global market share, followed by Europe and asia-pacific. The United States has developed a relatively mature DR market, and European Union countries have shown great interest in the broad DR market recently. Japan has been trying to establish a stable power supply system since the earthquake in tohoku, and has conducted various demand response project tests. The following is an analysis of typical demand response pilot projects in various countries.

Table 2. foreign power demand response projects and implementation patterns [14-15]

| Region   | Project type           | Implementation model                                                                 |
|----------|------------------------|--------------------------------------------------------------------------------------|
| California | Direct load control    | Remote control of intelligent devices of residential end users. If the                |
|          | Interruptible load     | response of DR events causes inconvenience to users, the Settings can                |
|          | Demand side bidding    | be restored manually. Provide a series of DR plans for large                        |
|          | Peak price             | customers, such as peak day pricing, basic interruptible plan, demand                |
|          |                        | bidding plan, scheduled load reduction plan, etc.                                   |
| Texas    | Emergency demand       | Provide emergency response service plans in the event of grid                        |
|          | response                | emergencies; design load-reduction projects for commercial and                      |
|          | Interruptible load     | industrial users; install control equipment for intelligent temperature-             |
|          | Direct load control    | controlled terminal users free of charge, control load by controlling               |
|          | Peak price             | temperature settings; provide for customers who are willing to                       |
|          | Time-of-use price      | participate Fully free electricity at night or on weekends, provided                |
| Britain  | Time-of-use price      | they receive a higher day or workday electricity price.                               |
|          | Interruptible load     | Provide a variety of time-sharing tariff rates; interruptible load forms             |
|          |                        | include: short-term operational backup, fast standby, stable grid                   |
|          |                        | frequency response, frequency control.                                              |
Generator capacity profit is used to compensate interruptible load; load cutting projects are divided into two categories: real-time and advance notice. There are many types of time-of-use electricity prices, new time-of-use tariff plans. According to the new time-of-use tariff plans, electricity price is expensive from 8:00 AM to 7:00 PM from Monday to Friday, while the rest of the electricity price is cheap.

Tokyo Electric Power and Schneider, Kansai Electric Power and Kanghui jointly launched a demand response plan to deploy demand response management technology Intelli SOURCE Enterprise to the grid network, install energy-saving systems in participating devices, and use the Internet for remote communication. Send signals to heating systems and equipment in commercial buildings to reduce energy use.

According to the US Department of Energy, the current interruptible load is the largest DR project in the United States. With the development of foreign power DSM technology and the mature market mechanism, the direct load control and the reduction of interruptible load projects have shown the trend of catching up with DR projects that are gradually being operated by other wholesale markets. The price-type DR has risen rapidly in market-oriented transactions.

3. Status of R&D in China

3.1. Manage policy and industry development
DSM was introduced in China in the 1990s to deal with the shortage of electricity and the serious shortage of investment in electricity. DSM began to be introduced to China through technical literature in 1992, and the government gradually attached importance to it. Under the pressure of the prominent contradiction between supply and demand, DSM has been vigorously promoted. In recent years, continuous supportive policies have well clarified China's determination to develop the DR resource market.
**2010**

**Power Demand Side Management Measures**

Determine the power demand side management definition and the responsible body and implementation body of the power demand side management work, and put forward 16 management measures and incentive measures for the power demand side management work.

**2015**

**Notice on Improving the Electric Power Emergency Mechanism and Doing a Comprehensive Pilot Work on the Power Demand Side Management City, Guidance on Promoting the Development of Smart Grids**

The main tasks are identified as network source coordination, technical support, absorption of new energy, multi-energy complementarity, power grid security, strengthening DSM, electricity replacement, diversified electricity consumption, equipment research and development, standard internationalization, etc. Put forward organization and coordination, investment support, electricity price mechanism, business model and other safeguard measures.

**2017**

**Notice on Deepening the Structural Reform of the Supply Side and Doing a Good Job of Power Demand Side Management under the New Situation, Electricity Demand Side Management Measures**

(Revised Edition)

In the notice, the focus of DSM's work has shifted to diversified targets. It is necessary to promote the reform of electric power system to implement electric energy substitution, promote the consumption of renewable energy, and improve the level of intelligent electricity use. The revised “Power Demand Side Management Measures” has carried out major reforms on DSM, and proposed to gradually form a demand-side mobile peak-shaving capability that accounts for about 3% of the annual maximum power consumption.

**2019**

**Industry Demand Side Management Work Guide**

Put forward the work plan of guiding energy consuming units to independently participate in and implement DSM, and make it clear that energy consuming units can participate in unilateral market bidding and sign demand response agreements under the guidance of power authorities and power grid enterprises, and can also participate in providing auxiliary services to obtain corresponding benefits if they are qualified.

**2004**

**Guiding Opinions on Strengthening Power Demand Side Management**

It is clear that peak-to-valley and time-of-use electricity prices, and flood season-dry season prices can be implemented; research on interruptible load and high-reliability electricity price policies can be promoted; and technical measures such as cold storage and heat storage transfer load are promoted.

**2012**

**Interim Measures for the Administration of Central Financial Incentive Funds for Comprehensive Pilot Work of Power Demand Side Management Cities**

The reward amount for demand response is clarified, which reflects the role and partial connotation of DR in the initial stage, and indicates the government's transformation from administrative means to guiding and motivating policy tools required by DR in electric power DSM.

**2016**

**Special Action Plan for Power Demand Side Management in the Industrial Sector (2016-2020)**

(2016)

Set the overall target, the deployment of the main tasks, including establishing industry electric power demand side management guidelines, the construction industry electric power demand side management system platform, promote industry electric power demand side management demonstration promotion, support, power demand side management technology innovation and industrialization of application, speed up cultivating power service industry, etc.

**2018**

**Guiding Opinions on Improving the Regulating Capability of Power Systems**

It is proposed to enhance the adaptability of the receiving network, develop the interruptible load such as the microgrid, develop various types of flexible power load, promote the reform of the power selling side, and guide the user to use the peak power through the price signal to achieve a fast and flexible demand side response. Carry out demonstrations of power demand response and user interaction projects in smart communities and smart parks. Conduct pilot projects for energy efficiency power plants. Encourage all types of high-energy-consuming enterprises to provide auxiliary services such as interruptible load and controllable load for the system.

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Figure 1. Key supporting policies of China's demand response

In terms of standard formulation, the IEC PC118 Smart Grid User Interface Project Committee was formally established in September 2011. This is the second IEC technology (project) committee that
was independently proposed by China and set up the secretariat in China after IEC TC115. The PC118 international standard mainly involves the information interaction interface and demand response of the smart grid user domain. Firstly, it supports the energy service information interaction and demand response of the smart grid and traditional buildings such as commercial buildings and residential households. With the deepening of smart grid construction, it will also support two-way interactive services with new user facilities such as distributed power supplies, electric vehicle charging and discharging, and energy storage devices. PC118 will also work with ISO/IEC-related TCs to coordinate and standardize power user service standards such as energy efficiency management and pre-payment[16].

3.2. Research focus in recent years

3.2.1. Improved in policies, regulations and industrial standards. Literature [17] focuses on the power DSM policy, uses dynamic evolutionary game model to analyze the game behaviour between government-grid enterprises and government-power users in DSM process, and optimizes the design incentives for DSM policies. Literature [18] analyzes the positive role of government regulation in the implementation of power DSM, and proposes suggestions for improving DSM. Literature [19] based on the status quo of DR development at home and abroad, gives some suggestions from the aspects of policy, information reform and organization and implementation. The literature [20] describes the main content of the OpenADR2.0 standard, and introduces the application cases of OpenADR and the research progress of domestic standardization work.

3.2.2. Exploration of market participation mechanism. Literature [21] proposed a two-layer optimization model for DR bidding, using the closed shadow price function of total load demand to maximize the total profit of the service provider. Literature [22] proposed a multi-energy DR response model to determine the multi-energy user time-of-use (TOU) electricity price by the interior point method. Literature [23] proposes a dynamic pricing DR model for energy management in a hierarchical electricity market that considers both service provider profit and customer cost, which can adaptively determine retail electricity prices and ensure the flexibility of wholesale electricity prices. Literature [24] proposes to adopt an adaptive DR dynamic optimization scheme in the power spot market to maximize the long-term profit of the electricity seller.

3.2.3. Scheduling utilization strategy. Reference [25] considers the coordination of the power generation side and the flexible load, and establishes a multi-objective optimization of the safety constraint unit commitment model considering the flexible load. Literature [26] developed a two-way framework to solve the DSM problem in a distributed manner, using the Newton method to accelerate the centralized coordination of the DSM strategy to minimize the peak-to-average ratio, and the double fast gradient method and the convex relaxation method to alleviate the user's load transfer/Discomfort caused by the interruption. Literature [27] proposed a multi-price multi-time DR model, and introduced a DSM strategy to achieve joint planning with energy storage systems. In [28], a multi-objective multi-target optimization scheduling model based on new energy generation is proposed. Considering the randomness of DR, an adaptive weighted and approximate dynamic programming optimization problem is proposed.

3.3. Typical engineering case analysis

Under the strong promotion of national policies and power companies, some power DSM pilot cities and provinces, such as Beijing, Jiangsu and Guangdong, have carried out DR pilot projects and achieved good results. The selected key pilot projects are described as follows.
Region | Project type | Implementation model
---|---|---
Beijing | Interruptible load | Load integrators are used to scale up and systematically integrate power user resources, and demand response is implemented through six steps: agreement signing, event release, load distribution, response feedback, implementation and monitoring, certification and identification. According to the 0.5/4/24h notice in advance, the project will be given incentives of 120/100/80 yuan /kW respectively.
Jiangsu | Peak price | The dynamic seasonal peak price policy was implemented. When the maximum temperature exceeded 35 °C on that day, select 1 hour in the afternoon to implement the peak price of 0.1 yuan per kWh on the basis of the peak electricity price for the large industrial users of 315kVA and above. The implementation of "valley filling" power DR for many times has verified the important role of DR resources in improving the power load at valley level, and it is the first bidding mode in China.
Foshan, Guangdong | Interruptible load | According to the load characteristics of the participating enterprises, formulate load reduction strategies, such as temporary shutdown of production equipment, temporary adjustable shutdown of production load, adjustment of production equipment parameters, shutdown of non-production equipment, etc. In 3 years, the cumulative response times are not less than 10 times, and the response load is generally not more than 15% of the total load of the enterprise. The subsidy is 130 yuan /kW.

China has initially explored the market-oriented trading of DR through pilot projects. However, compared with the mature foreign market mechanism, the gap in the construction of DR resources in China is obvious, the trading mode is single and weak, lacking sufficient development of price-based DR such as real-time electricity price and time-of-use electricity price, as well as incentive DR market model such as emergency demand, capacity market and auxiliary plan.

4. Experience enlightenment and development prospects
Analysis of the above materials shows that the pace of China's DR marketization is accelerating, showing the following characteristics: 1) policies are issued intensively; 2) the electric power economy enters the new normal development period under the new round of electricity reform; 3) the demand-side resource market has been built and implemented, and the incentive DR model has become a hot spot for exploration; 4) the development of DR resources focuses on increasing the permeability of renewable energy; 5) attach importance to the combination of top-level design and industry consensus. Compared with the more mature DR market construction in foreign countries, especially in the United States, the market trading mechanism for DR in China is still in the exploration period, and the relevant supporting policies and incentive measures to promote the development of power DSM are still not perfect. It can be seen from the development experience of DSM in foreign countries that its development relies on policy support at the beginning, and the scale and maturity depend on the construction of the electricity market and the improvement of the electricity price system, as well as the financial system that provides rich financing channels. The existing DR systems in domestic pilot cities are simple in structure and weak in function, lack of coordination and management experience of multiple loads, and lack of overall grasp of regional DR resources, so they cannot fully mobilize the full participation of DR resources. According to the actual situation of China's power grid, future DR work can be improved from the following aspects:

1. Improve and refine relevant policies and regulations
Throughout the development process of foreign power DSM, relevant policies and regulations are not only accompanied by it, but also often legislated before practice, and there are almost no statements of principles, but specific and detailed provisions on the subject, rights and obligations, rewards and punishments. At present, it is urgent to establish and improve the key policies and
systems of Chinese power grid, including the establishment of DSM special fund and the power pricing mechanism adapted to DSM. The method of using the electricity bill or explicitly identifying the DSM part in the existing special funds or funds may be adopted. The fund use and management methods shall be formulated, and the sources of funds, expenditure items, use and supervision and management shall be clarified. Many successful experiences abroad also prove that only by establishing special funds can we solve the problem of original driving force of DSM and step into the track of virtuous cycle and sustainable development.

2. Accelerate the pilot project construction to support standards
The lack of exploratory results in the relevant fields of the domestic industry and the support of corresponding industry standards will make the country in a passive position in the formulation of international standards, because the important way to establish international standards is to upgrade mature industrial standards to international standards, and any theoretical concepts, ideas and methods lacking the support of industrial applications cannot be established in international standards. The focus of DR market-oriented transactions in the coming period should be to comprehensively promote the pilot construction. In this process, local autonomy should be respected and diversity, difference and particularity should be emphasized, so as to form the national standards required by domestic industry as soon as possible, which will be the basis for our promotion of Chinese standards in the field of international standards.

3. Broaden the DR dimension and create a multi-complementary pattern
Foreign research and construction of the DR field started early and took the lead in marketization. From table 2, it can be seen that the United States involves almost all price-based and incentive DR market participation models, which enables it to fully mobilize DR resources. Various resources with different properties can choose appropriate DR projects according to their own characteristics. From the perspective of China's pilot projects in Table 3, most of them focus on the simple incentive DR market model. With the continuous advancement of new power reforms, the power market has gradually changed from medium- and long-term transactions to a market-based power balance mechanism based on medium- and long-term transactions and spot transactions. China should gradually establish and improve the types of DR projects, set up a variety of DR projects such as response and real-time response, combine DR projects with the wholesale electricity market, and guide users to use electricity in real time through the spot price of electricity to improve the system's efficiency.

4. Introduce multi-participation to fully mobilize market vitality
The construction of DR market-oriented transactions should attract multiple social capital to participate in competition. The role of bridge integrators and power-selling companies in multi-capital construction should be fully affirmed and supported. In DR projects, load integrators and power selling companies sign project contracts with different users, aggregate different DR resources and sign contracts with power grid companies, or auction them in the wholesale market, so as to make DR resources circulate. They can also provide users with relevant technical services and promote to potential participants to support their participation in DR projects.

5. Strengthen public awareness and establish a platform for sharing information and experience
At present, China's energy demand side energy awareness has not been popularized, which restricts the implementation of some DSM measures and policies. While formulating policies, optimizing the market, and developing technologies, it is necessary to promote the public's concept of energy use through publicity and education. The change of public awareness can make various demanders such as life energy and industrial energy more receptive to DSM and saving measures, which is conducive to the better development of energy DSM in China.

5. Conclusion
The rapid development of social economy makes it difficult to avoid the energy dilemma, countries actively develop the power DR resources into the market to alleviate the rapid growth of power demand. DR market trading in China has policies and measures to start, pilot projects are also in
progress, however, in general, the domestic marketization of DR is still in its infancy. This paper systematically introduces the development of power DR market-oriented transactions at home and abroad from the aspects of support policies, implementation standards and typical pilot projects, and summarizes the future exploration directions of all parties; by referring to the practical experience of DR projects at home and abroad, five related suggestions on establishing the market-oriented trading mechanism of power DR in China are put forward, which can provide reference for the follow-up DR construction of China's power system.

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