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A Review of the Power Metering Systems in Australia, Britain and Guangdong Electric Market

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Abstract. With the development of electric market reform, electricity spot market pilot is about to be launched in China. However, facing more complex settlement process in a competing environment, the existing power metering system may not meet the requirements of modern power market. Thus, it is an urgent problem to determine the improvements performances based on the existing power metering system. This paper will focus on this problem and propose suggestions based on the experience of domestic and foreign electricity market. In this paper, electric power metering systems of Australia, Britain and China (Guangdong Province) is firstly studied and presented in five significant aspects, including market participants, market structure, metering point, acquisition cycle and business managements. Then, their commons and differences will be further analysed and compared as reference of Chinese practice. Finally, suggestions of power metering system construction are proposed in China' electric power market reform.

1. Introduction

Since 2015, a new round of electric market reform has been launched in China [1]. Till now, many provinces, such as Zhejiang Province, electric power system has already experienced transmission-and-distribution tariffs reform and direct trading pilot. With the expansion of electric power trading scale, electricity spot market pilot is the key of next step for China's electric market construction, which is about to be launched in 2019.

Electricity spot market, including day-ahead and real-time auxiliary service trading markets, is one of significant part of modern electric power market. Unlike the existing electric power operating mode, spot market not only provides competing environment for electric power trading, but also serves as a supplementary part of market-oriented electricity balance mechanism. It makes power settlement process much more complex and definitely puts forward a higher requirements of metering system both in accuracy and real-time. Meanwhile, to guarantee the steadiness and security of market (e.g. avoiding generation companies rigging market by market power), the existing metering scheme may not be suitable for market environments [2], [3].

Many western countries have already completed the improvements of electric power metering system supporting the power market [4]-[7]. The existing power market such as Britain, Australia are markedly market-oriented while the domestic electricity market is mainly managed by the power grid companies. Guangdong Province has already started a spot market pilot, but it is still in exploration



stage and faces many problems [8], [9]. Therefore, how to improve the metering system for supporting China's electric market reform needs to be discussed and studied.

This paper will focus on this problem and propose exact requirements based on the experience of domestic and foreign electricity market. In this paper, electric power metering systems of Australia, Britain and China (Guangdong Province) is firstly studied and presented in five significant aspects, including market participants, market structure, metering point, acquisition cycle and business managements. Then, their commons and differences will be further analysed and compared as reference of Chinese practice. Finally, suggestions of power metering system construction are proposed in China's electric power market reform.

The remaining of this paper is organized as follows. Section 2 analyses the existing power metering system including Australia, Britain and Guangdong Province, and make comparisons between those markets. Section 3 proposes suggestions of power metering system construction are proposed in China's electric power market reform. Section 4 concludes the paper.

2. Overview of power metering systems in existing electric market

The electric power metering system in this paper is a system responsible for storing, collecting and processing energy data in different time periods, including market participants, organizational structure, metering point setting, data acquisition cycle and the management system. It involves power generation side, power gateway, user side, main stations and metering management systems. This chapter will introduce the metering systems of Australia, the United Kingdom and Guangdong Province from the above aspects.

2.1. Australia

Australia has established a complete metering system to ensure the operation of the electricity market. Australian Energy Market Operators (AEMO) is responsible for managing the whole process including metering, while the metering system management is the responsibility of the employed company.

2.1.1. Market participants

- AEMO: Responsible for managing the operation of wholesale market and the safety of power system;
- Generators: Market access capacity of at least 30 MW;
- Market users: Including retailers or end users, retailers buy electricity from wholesale markets on behalf of their privileged users. (electricity demand greater than 10MW, who can freely choose to buy electricity from retailers or from spot markets) and non-privileged users (electricity demand less than 10MW, who must participate in retail transactions); end users consume electricity in their factories, offices and households.
- Power Grid Service Institutions: Owning (or leasing) and operation of transmission and distribution networks.

2.1.2. Organizational structure. Figure 1 shows the relationship of metering institutions in the Australian Spot Electricity Market.

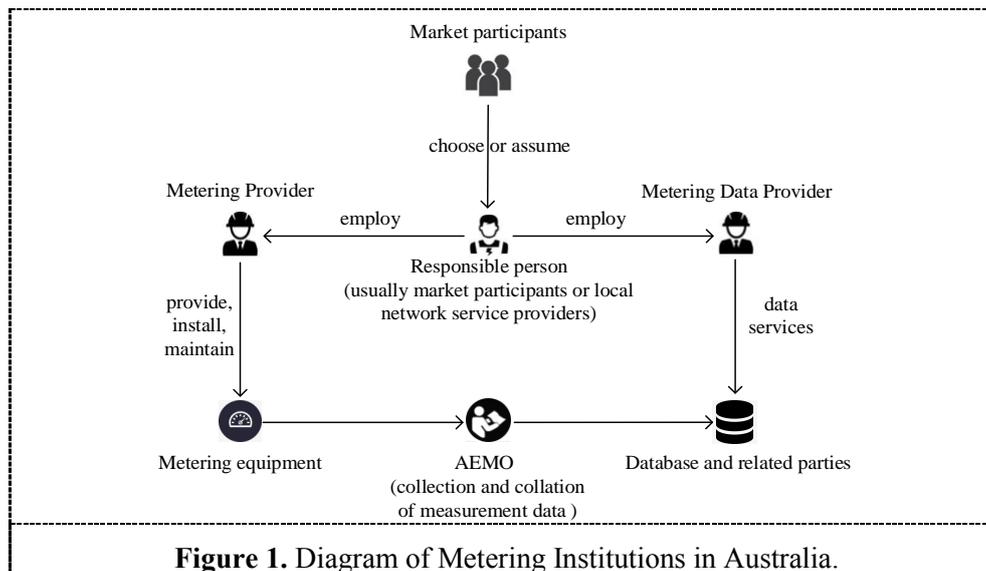


Figure 1. Diagram of Metering Institutions in Australia.

Market participants can choose or act as the head of the metering device, which is generally assumed by market participants and local network service providers.

Responsible person needs to employ metering providers to provide, install and maintain metering devices. Responsible person also needs to employ metering data providers to provide data services and transmit data to databases and parties.

In the process of data transmission, AEMO should be responsible for the collection and collation of metering data. The difference between AEMO and metering data providers is that metering data service providers are responsible for specific implementation, while AEMO are only responsible for responsibility without specific operation.

2.1.3. Metering Points. The metering point of the power plant is usually installed at the outlet of the power plant, and the users' metering point is usually set at the user side.

2.1.4. Acquisition cycle. The period of collecting electricity data is usually 15 minutes.

2.1.5. Business management. When AEMO fail to verify the metering data in the process of preparing the settlement preparation data and the replacement calculation data cannot be obtained within the time required for settlement, the AEMO must prepare an alternative value according to the metering procedure. The supplier of metering data must arrange for *responsible person* to obtain the relevant metering data.

2.2. Britain

The metering system in the UK adapts to the development of the UK electricity market. Comparing with Australia's system, the popularity of smart meters is low, and the metering and settlement cycle is longer.

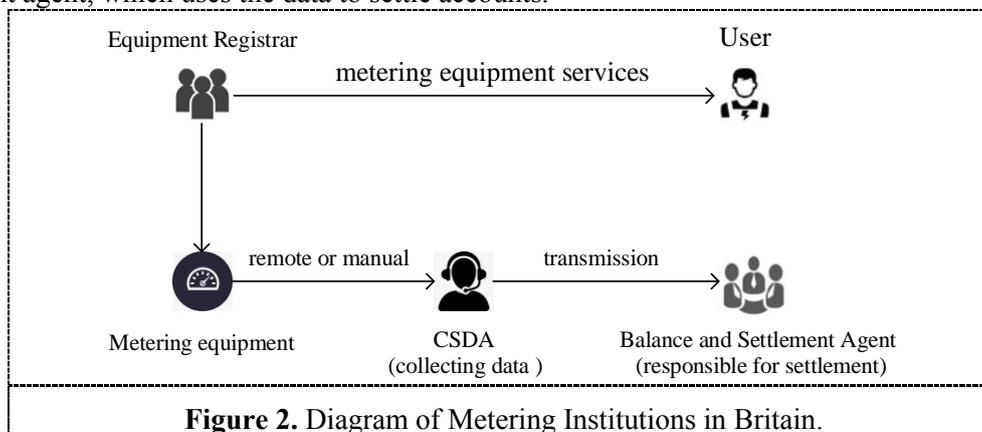
2.2.1. Market participants

- Transmission providers: The UK State Grid is the only transmission system operator and dispatcher responsible for the dispatch and control of the UK-wide power system.
- Generators: There is no minimum capacity limit in the UK electricity market. There are more than 400 power producers in the country. The top six power producers account for more than 70% of the total market share and the top ten more than 85%.
- Market users: includes retailers and end users. The UK has more than 20 retailers nationwide, with the market share of the top six companies exceeding 90%. British power producers and retailers

are vertically integrated. Retailers have their own power generation assets, that is, retailers are also power producers.

- Distribution providers: There are seven distributors in the UK, which operate distribution services in 14 districts.
- Power exchange: The UK has established two power trading centres, APX and N2EX, to provide a platform for short-term spot contracts and contract management for both parties.

2.2.2. Organizational structure. Figure 2 shows the relationship of metering institutions in the UK Spot Electricity Market. The equipment registrar is responsible for installing, operating and maintaining the metering equipment, providing metering equipment services for users. The central data collection agent (CDCA) obtains the user's electric energy information through remote acquisition or manual meter reading, and then sends the relevant information to the balance and settlement agent, which uses the data to settle accounts.



2.2.3. Metering Points. For large-scale units, the unit of measurement is usually a single unit; for small-capacity units, such as wind power plants, it is generally chosen to trade through user aggregators to reduce risk. For these small units, the total outlet of multiple units will be measured.

2.2.4. Acquisition cycle. Generally, the period of half an hour or more is used to collect electricity data.

2.2.5. Business management. If the settlement result of this stage is inconsistent with that of the previous stage, the deviation part needs to be adjusted. Settlement system adjusts the settlement repeatedly based on the update of user data, and gradually improves the target value of accurate settlement for non-half-hour metering users. Finally, more accurate metering and settlement can be achieved.

2.3. Guangdong Province

Guangdong Province took the lead in reforming the electricity market. Its metering system adapts to the current development stage of China's electric power system reform and it is a meaningful attempt for Chinese electric market reform.

2.3.1. Market participants

- Generators: They should meet the government's requirements, which have the technical ability to submit the market parameter information before the day of submission.
- Electricity Suppliers: They meet the government's requirements, which have the technical support system for electricity management and have the technical ability to submit the next day's hourly load forecasting curve as required.

- Market users: According to the requirement of settlement, their power data should be measured and transmitted per hour and the accuracy and reliability of data must meet certain standards.

2.3.2. *Organizational structure.* The power grid company provides the data of the generators' power production, the user's power consumption, the deviation of production and consumption, etc. The trading center is responsible for the maintenance of settlement algorithm, the development of settlement module, the calculation and review of electricity charges. The power grid company is responsible for the unified settlement and payment of wholesale and retail markets.

2.3.3. *Metering Points.* The metering points of the unified power plant are located at the high-voltage side of the main transformer; the metering points of non-unified power plant are generally located at the gateway of the line side of the transformer substation. The metering points of large users are set at the substation side and ordinary users' metering points are set at the user side.

2.3.4. *Acquisition cycle.* The data of generators and users will be frozen per hour.

2.3.5. *Business management.* When the power data is unavailable, the power metering and testing center confirms the reason and issues a report, and the settlement of electricity is negotiated by the relevant market entities of the power trading organization.

2.4. Analysis and comparison

Table 1. Comparison of the existing power metering systems

Items	Australia	Britain	Guangdong
Market participants	AEMO; Generators; Market users; Power Grid Service Institutions.	Transmission providers; Generators; Market users; Distribution providers; Power exchange.	Generators; Electricity Suppliers; Market users.
Organizational structure	Figure1	Figure2	The trading center is responsible for the maintenance of settlement algorithm, the settlement module, the calculation and review of electricity charges. The power grid company is responsible for the unified settlement and payment of wholesale and retail markets.
Metering Points	Usually installed at the outlet of the power plant and at the user side.	For large-scale units, the unit of measurement is usually a single unit; for small-capacity units, the total outlet of multiple units will be measured.	Usually located at the high-voltage side of the main transformer, at the substation side and at the user side.
Acquisition cycle	15 minutes	Half an hour or more	An hour

Business management	AEMO prepares an alternative value according to the metering procedure. The supplier of metering data arranges for responsible person to obtain the relevant data.	The settlement system adjusts the settlement repeatedly based on the update of user data, and gradually improves the target value of accurate settlement for non-half-hour metering users.	The power metering and testing center confirms the reason and issues a report, and the settlement of electricity is negotiated by the relevant market entities of the power trading organization.
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Table 1 shows the comparison of typical foreign electricity market and Guangdong spot market construction pilot projects. We can see that the measurement systems in Australia and Britain are generally outsourced to specialized measurement companies, which are responsible for the measurement devices. This shows that the marketization of measurement system in foreign countries is obvious. Power market management organizations realize indirect management of measurement system by signing contracts. On the contrary, in Guangzhou electric power market, measurement services are mainly undertaken by the grid companies, because the existing measurement system is established and managed by the grid companies, and the power market is still in its infancy, so it is not necessary to fully realize measurement outsourcing.

3. Suggestions of power metering system construction in electric market reform

3.1. Give full consideration to the current situation of metering system and rationally design market system

In the future, China should fully consider the overall status of the domestic metering system when designing the trading rules in the spot electricity market, take the security and stability of the power grid and the market as the premise, give full play to the resources and performance advantages of the current metering system, seize the key points, make full use of strengths and avoid weaknesses, tailor-made power trading rules and regulations suited to the national conditions, and avoid copying foreign and unnecessary duplication of construction.

3.2. Overall planning and step-by-step implementation of the transformation and upgrading of the metering system

The transformation of metering system involves a wide range and has great influence. The implementation of phased transformation strategy is not only a more stable and feasible scheme under the current situation of metering system, but also a reasonable measure to ensure the steady progress of market construction. From the analysis of the phased task path proposed by the market construction scheme, there are certain time series differences in the participation of power plants and users in the market. The transformation scheme of the metering system should also be considered as a whole, and the implementation suggestions of phased transformation should be put forward.

3.3. Focus on the setting of metering points on the power side

Generally speaking, the metering Settings of large power plants such as thermal power plants are basically measured by units, while those of small power plants are relatively flexible. At present, China's unified power plant settlement adopts three metering methods. The unified metering point can refer to the experience of foreign and Guangdong pilot projects. However, the unified transformation of power plant metering involves the property rights of power producers and power grids, the division of management responsibilities of dispatching and marketing specialties, and the impact of power plant downtime transformation on power grid security. It is necessary to make full study and consideration, put forward reasonable reform plan and implementation plan, and do a good job of response measures.

3.4. Attention to Abnormal Treatment of Metering Faults

Typical power markets at home and abroad have different treatment methods for metering faults[10]. Supplement for missing data and change the method of foreign typical electric power market mainly by the lack of specialized estimation procedures to estimate a numerical participate in the settlement, at last, through the scene in the late filling real data collection and other way, and Guangzhou electric power market clearing power by electricity trading organization relevant market main body to talk things over solve. At the initial stage, China can learn from the mature experience of other countries and choose the appropriate scheme for abnormal metering processing and data completion to carry out pilot projects. On this basis, we can actively carry out research and put forward more scientific and reasonable technical scheme.

3.5. Actively Optimize the Metrology Management System Guided by Market Demand

From the perspective of marketization, the metrological system management system, technology and service standard originally designed around the internal management objectives of enterprises are quite different from the marketization operation and cannot fully meet the market demand. Therefore, it is necessary to take market demand as the guide, actively optimize and adjust management strategies, timely revise relevant metering technical standards, improve management and execution efficiency, and give certain institutional flexibility to ensure that the metering system can effectively support the market operation.

4. Conclusion

This paper has analysed the difference of existing power metering system, and proposed suggestions based on the experience of domestic and foreign electricity market.

Comparing typical electricity market of Australia and Britain with Guangdong spot market construction pilot projects, we can see that foreign measurement systems are generally outsourced to specialized measurement companies, which shows that the marketization of measurement system in foreign countries is obvious. On the contrary, in Guangzhou electric power market, measurement services are mainly undertaken by the grid companies.

As for the power metering system reconstruction in China's electric market reform, this writer suggests that not only the current situation should be given full considerations based on the design of the market system, but also the upgrading the metering system should be implemented step by step. Besides, there are two recurrent technical problems, which are the setting of metering points and the treatments of metering faults respectively, that need to full studies and consideration to put forward a reasonable plan. In addition, an active metrology management system is the foundation of an efficient market operation, which is supposed to be focused on and give certain institutional flexibility.

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References

- [1] Shao C, Ding Y, Song Y, et al. Experiences of Power System Deregulation in Typical Emerging Market Countries and Its Reference Value for China. *Southern Power System Technology*, 2015.
- [2] Zeng N. The metering of electric energy had be developed to suit the reform of electric power market. *Electrical Measurement & Instrumentation*, 2003, 40(9).
- [3] Han X, Yao Li, et al. Reflection on Development Trend of Electric Energy Metering in Competitive Electricity Market . *Zhejiang Electric Power*, 2017(3).
- [4] Zhang X, Li J, Fu H. UK Retail Electricity Market Reform and Challenges. *Automation of Electric Power Systems*, 2016,40(11):10-16.
- [5] State Electricity Regulatory Commission. *Electricity Market in Europe and Australia* [M]. China Power Press, 2005.

- [6] Yang Y, Bao M, Ding Y, Song Y, Lin Z, Shao C. Review of Information Disclosure in Different Electricity Markets. *Energies* 2018, 11, 3424.
- [7] Horlyck B. Metering and the contestable electricity market in Australia// *International Conference on Metering & Tariffs for Energy Supply*. IET, 1999.
- [8] Song Y. Discussion on Guangdong Electricity Market Reform and Electricity Sale Strategy . *Modern Manufacturing*, 2017(6):89-90.
- [9] Su K, et al. Design and Implementation of Guangdong Electric Power Market Trading System . *Southern Power System Technology*, 2015, 9(8):52-56.
- [10] Yingjun H U , Li Y , Xing W U , et al. Main Faults Analysis and Countermeasures for Smart Meters. *Zhejiang Electric Power*, 2015.