

# Research on development status and index system of electricity sales industry under the background of energy Internet

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**Abstract.** Energy development has entered the era of energy Internet. As the core link of power system, the development of power sales industry is affected by energy Internet. This paper first interpreted the connotation and architecture of energy Internet, then analysed the current situation of power sales industry and the changes in the context of energy Internet. On this basis, this paper constructed the development index system of power sales industry from four aspects of national society, power sales market, power users and innovation development, which provided a method for the development of power sales industry. Finally, it pointed out the challenges faced by the electricity sales industry and the government under the background of energy Internet, and put forward some suggestions.

## 1 Introduction

Excessive use of fossil energy has led to energy shortage, environmental pollution and other problems. Energy development is facing a challenge of using energy more safely, efficiently and environmentally friendly. At present, Internet technology and renewable energy have been gradually integrated, resulting in a new energy utilization system called energy Internet [1]. Electricity is an important support for China's current social production and residents' life [2]. Electricity sales industry is the core of the electricity industry chain, which plays an important role in connecting electricity production and consumption. The development of energy Internet not only increases the openness and interconnection of power system, but also changes the traditional mode of power sales. It is of great significance to study the electricity selling mode under the background of energy Internet for the electricity sellers to cope with the new market impact, build a reasonable electricity market mode and promote economic and social development.

At present, the research on the electricity sale industry focuses on the development status, problems and future development direction of the electricity sales side Reform [3], the opportunities, challenges and countermeasures of the electricity sale side in the new electricity reform [4], the marketing strategy innovation of the electricity sale enterprises [5], and the choice decision of users on the electricity sale companies [6], etc. On the whole, most of China's current research on electricity sales industry focuses on electricity sellers, but there is not enough attention paid to the object of the electricity sales transaction, electricity energy, and the information communication in the electricity sales link. Therefore, this

paper analysed the development of electricity sale industry in the context of energy Internet.

## 2 Connotation and architecture of Energy Internet

### 2.1 Connotation of Energy Internet

Energy Internet is a new energy ecosystem that takes the power system as the core and link, builds a variety of energy Internet, uses Internet ideas and technology to transform the energy industry, realizes the horizontal multi-energy complementary, vertical "source-networked-load-storage" coordination, and highly integrates energy and information [7]. Source refers to various types of primary energy such as coal, water energy and natural gas, and secondary energy such as electricity. Network covers the natural gas and oil pipeline network, the electricity network, as well as the railway, road and other transportation networks. Load and storage refer to various energy needs and storage facilities [8]. The coordination and interconnection among various elements of the energy Internet enables the rational distribution and consumption of renewable energy, contributes to the balance of energy supply and demand and the optimal allocation of resources.

Energy Internet is renewable, distributed, interconnected, open and intelligent [9]. Renewable energy is the main energy supply source of energy Internet, which has intermittent and fluctuating characteristics. It is necessary to establish a network for on-site collection, storage and use of energy. These micro energy networks are small in scale and widely distributed, which constitute the nodes of energy Internet and are interconnected to exchange energy and balance energy supply and demand.

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Openness means that the energy Internet should be a peer-to-peer, flat and bidirectional energy sharing network. Generation, transmission, conversion and use of energy in energy Internet should have certain intelligence.

## 2.2 Architecture of energy Internet

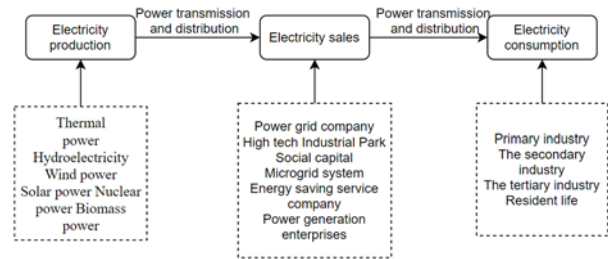
The architecture of energy Internet includes multiple energy layer, energy router, active load and multiple energy market [10]. Multi-energy layer is formed by the coupling of different levels of energy networks, including power transmission network, natural gas network, hot/cold air network, hydrogen energy network, etc. Energy router can realize energy network interconnection, scheduling and control, and is the core device of energy Internet [11]. Active load includes cold, hot and electric loads as well as distributed generation, electric vehicles and energy storage devices. With the support of open platform, multi-energy market realizes a variety of new businesses, such as electricity trading, new energy quota trading, distributed power supply, monitoring, operation and maintenance of electric vehicle charging facilities.

## 3 Electricity sales industry under the background of energy Internet

### 3.1 Current situation of electricity sales industry

Electricity sales industry is the core of electric industry chain. The upstream of electricity sales link is production electricity link, and the downstream is consumption electricity link [2]. According to different production modes, electricity production can be divided into thermal power, hydroelectricity, wind power, solar power, nuclear power and biomass power. Electricity consumption mainly includes the electricity application in the production of three major industries and the use of residents' life, among which the secondary industry consumes the largest amount of electricity. The three links of power production, sales and consumption are connected through power transmission and distribution, which are mainly carried out by power grid companies.

China's electricity system reform proposes to open up the electricity market. In addition to the traditional power grid companies, five categories of qualified market players have been added: ①qualified high-tech industrial parks or economic and technological development zones; ②the main body of electricity sales established by social capital investment; ③users with distributed power supply or micro-grid system; ④water supply, gas supply, heating and other public service industries and energy saving service companies; ⑤electricity selling entities invested and established by qualified power generation enterprises. The industrial chain of electricity sales industry is shown in Figure 1.



**Figure 1.** Industrial chain of electricity sales industry.

The traditional power grid companies and five new electricity sellers have different business models and advantages and disadvantages, as shown in Table 1.

**Table1.** Comparison of business models of 6 electricity sellers.

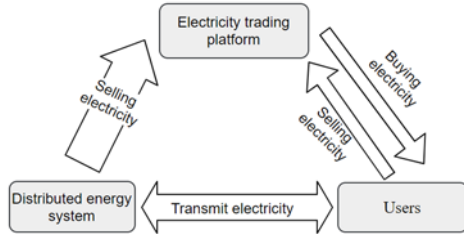
Electricity sellers	Business model	Advantage	Disadvantage
Power grid company	Purchase electricity from power generation enterprises and sell electricity to consumers	Perfect power transmission and distribution network and customer resources, experience in distribution	Huge structure, lack of flexibility; insufficient attention to small and medium-sized users
High tech Industrial Park	Generate electricity in the park and sell it to enterprise users in the park	With regional customer resources, strong competitiveness in the region	Resources are relatively concentrated, not conducive to expansion
Social capital	Buy electricity from wholesale market, sell it to consumers, earn a price difference	Flexibility and innovation, advanced and scientific organizational form, high operational efficiency	Lack of power generation and customer resources, unstable power sources, poor ability to resist risks
Microgrid system	Generate electricity through new energy and sell clean energy to customers	Realize the integration of "source, network, load and storage", providing integrated energy services	Small scale
Energy saving service company	Purchase electricity from power generation enterprises and provide comprehensive energy services	Relying on water network, heat network and gas network to realize the monopoly operation in the region, policy support	Without its own power generation resources, the power source is unstable
Power generation enterprises	Power generation enterprises sell electricity directly to customers	Abundant capital, rich power generation resources and customer resources	Lack of sales experience, limited customer types

### 3.2 Electricity sales industry reform under the background of energy Internet

#### 3.2.1 Integration of consumption and sales

In the environment of energy Internet, users are not only power consumers, but also power sellers. Users can generate electricity by themselves, and the generated

electricity can be used by themselves, or the surplus can be transmitted to the electricity trading platform for sale, forming a structure of electricity sales and consumption, (Figure 2). The energy Internet will change the way of one-way electricity sales into two-way electricity sales with strong interaction, which is conducive to stimulating the flexibility of electricity sales market, and promoting the marketization of electricity pricing.



**Figure 2.** Integration of electricity consumption and sales

### 3.2.2 Internet economy of electricity sales

Energy Internet introduces the concept of Internet on the basis of traditional energy network, integrates information and communication technology with energy, and improves the intelligent level of energy system [12]. Electricity selling enterprises have produced the Internet Economic format, forming a communication platform for power information, which enables the electricity sellers to better identify power generation resources and electricity demand, break the information barrier, improve the intelligent level of electricity selling service and provide more targeted services for power users.

### 3.2.3 Developing integrated energy services

The efficiency and controllability of the energy Internet promote the organic integration of a variety of clean energy with electricity as the medium [12], and better meet people's basic needs for energy supply adequacy and cleanliness. After identifying the characteristics of users' needs, electricity sellers can develop targeted and efficient solutions to provide comprehensive energy services for users [13], which is conducive to improving the service quality of power sales industry, optimizing the structure of power sales industry, and effectively coping with climate change and energy resource crisis.

## 4 Index system for the development of electricity sales industry

### 4.1 Index system construction

Based on the characteristics of the power sales industry and stakeholders, this paper designs three first level indicators of the country and society, electricity sales industry and electricity users. As the power sales enterprises are in the new background of energy Internet, they need the support of academic research and innovation, so the first level indicators of innovation and development are also added. Specific indicators are shown in Table 2

**Table2.** Electricity sales development industry index system.

First level indicators	Second level indicators	Third level indicators
Country and society	Industrial policy	Number of government documents in electricity sales industry
		Number of electricity sales industry standards
	Investment and construction	Infrastructure construction of electricity sales industry
		Construction of pilot demonstration project of electricity sales industry
	The public	News report on electricity sales industry
		Search heat of electricity sales industry
Electricity sales industry	Electricity market structure	Number of different types of electricity sellers
		Herfindahl-Hirschman index
		TOP-m index
	Competitive efficiency of electricity sales	Types and differences of products and services
Electricity users	Exercise of user's option	Proportion of customers who change the electricity selling scheme in the same company
		The proportion of customers who change the selling companies
		The convenience of users to change the selling company
	User service	Number of user complaints
		Customer satisfaction
Innovation and development	Innovation and development	Number of research institutions in the field of electricity sales
		Number of papers published in the field of electricity sales
		Personnel training in the field of electricity sales

### 4.2 Explanation of index system

#### 4.2.1 Country and society

Country and society indicator include industrial policy, investment and construction and the public as secondary indicators.

The third level indicators of industrial policy indicator are as follows.

1) Number of government documents in electricity sales industry. The government documents related to the macro strategy, laws and regulations, industry standards, departmental rules and incentive policies of power sales industry can reflect the overall development of power sales industry. Generally speaking, the more the number of government documents, the better the development and standardization of the industry.

2) Number of electricity sales industry standards. The industry standard is the standard which has no national

standard and needs to be unified in a certain industry. The formulation of industry standards means the standardization and maturity of an industry, which provides the necessary basis for the development of the industry.

The third level indicators of investment and construction are as follows.

1) Infrastructure construction of electricity sales industry. It includes power infrastructure such as power generation facilities, power transmission and distribution facilities, infrastructure related to energy Internet, and information technology such as the 5th generation mobile communication technology and Internet technology. The infrastructure construction of power sales industry is the material basis for the development and reform of power sales industry.

2) Construction of pilot demonstration project of electricity sales industry. Through the pilot demonstration project, we can explore new models and methods, and promote the experience gained in the pilot project in the industry. The construction indicators of pilot demonstration projects can predict the future development trend of the reform of power sales side.

The public index can be divided into two three levels: the news report on electricity sales industry reflects the attention of news media to the power sales industry, and the search heat of power sales industry reflects the attention of power users to the power sales industry, which can reflect the public's attitude towards the power sales industry.

#### 4.2.2 Electricity sales industry

Electricity sales industry indicator include electricity market structure and competitive efficiency of electricity sales as secondary indicators.

The third level indicators of electricity market structure indicator are as follows.

1) Number of different types of electricity sellers It can intuitively judge the structure of the electricity sellers who participate in electricity trading.

2) Herfindahl-Hirschman index. It refers to the sum of the square of the market share of all the electricity selling companies. The smaller the HHI value is, the better the market competitiveness is. Generally speaking, the market with  $HHI < 1800$  can be regarded as fully competitive<sup>[14]</sup>.

3) TOP-m index. It refers to the sum of the market shares of m power sales companies with the largest market share<sup>[15]</sup>. For a specific m, the larger the TOP-m index, the higher the market concentration. In the industrial field,  $m = 4$  is generally taken. When the top-4 index is greater than 65, it indicates that the market has the nature of oligopoly<sup>[16]</sup>.

The third level indicators of competitive efficiency of electricity sales are as follows.

1) Types and differences of products and services. With the maturity and perfection of the power sales market, the power sales companies will change from price competition to service competition, which can reflect the

intensity of market competition and the maturity and perfection of the power sales market<sup>[16]</sup>.

2) Electricity selling companies share the proportion of price reduction in wholesale market. It refers to the proportion of the self reserved part of the price reduction bonus obtained by the power selling company when the electricity price in the wholesale market drops. The smaller the proportion is, the less the power selling company gets and the more full the competition is.

#### 4.2.3 Electricity users

Electricity users indicator include exercise of user's option and user service as secondary indicators.

The third level indicators of exercise of user's option are as follows.

1) Proportion of customers who change the electricity selling scheme in the same company. It refers to the proportion of users replacing the original electricity selling scheme in the same electricity selling company, which reflects the positive degree of electricity users to the competition of electricity selling.

2) The proportion of customers who change the selling companies. It refers to the proportion of customers who give up their original cooperation and choose other competing companies, which can directly reflect the fierce competition in the electricity market.

3) The convenience of users to change the selling company. This index examines whether consumers encounter barriers when replacing the power selling companies, and whether the replacement time and process are reasonable, which reflects the circulation degree of the power trading market and the perfection degree of the rules of the power selling market.

The third level indicators of user service are as follows.

1) Number of user complaints. It reflects the situation that the power sales company fails to meet the requirements of power users and fails to fulfill its commitments, and the number of user complaints has decreased, indicating that the company gradually attaches importance to user service.

2) Customer satisfaction. It reflects the overall judgment of electricity users on the content and service level of the products and services sold by the electricity sales company, and indirectly reflects the innovation ability of the electricity sales company.

#### 4.2.4 Innovation and development

It can be divided into three levels: academic research can guide the development direction of the future power sales industry, solve the practical problems at this stage, and inject new vitality into the development of the power sales industry through personnel training, which can measure the innovation and development of the electricity sales industry<sup>[17]</sup>. These three indicators reflect the importance of the development of electricity sales industry in the academic and practical application field.

## 5 Results and conclusions

Based on the era background of energy Internet, this paper explores the reform of electricity sales industry, and designs 4 first level indicators, 8 secondary indicators and 19 tertiary indicators, and finally constructs the development index system of power sales industry. The conclusions are as follows.

1) Under the background of the energy Internet, the electricity sales industry has produced the transformation of the integration of electricity consumption and sales, the economic format of electricity sales Internet, and the development of comprehensive energy services.

2) There are four primary indicators in the development index system of electricity sales industry, which are country and society, power sales market, power users and innovation and development. The country and society indicators include three secondary indicators: industrial policy, investment and construction, and the public. The index of electricity sales market includes two secondary indexes: market structure and competition efficiency. The index of electricity users includes two secondary indexes: the situation of users' exercise of options and the situation of users' service.

In the context of energy Internet, electricity sales enterprises are facing many challenges. More diversified electricity sellers enter the market, which intensifies the market competition. The traditional B2C electricity sales mode changes, and the C2C two-way electricity sales system begins to appear. Users' demand is more diversified. This requires the electricity sales enterprises to improve and innovate technology, pay attention to information resources, provide intelligent services, pay attention to user needs, and provide comprehensive energy services and customized services. In the face of the new pattern of electricity sales market, the government should also innovate regulatory thinking, promote the formation of a reasonable market pattern, and make good use of the ability of macro-control to organize and coordinate.

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