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Research on Constructing Integrated Energy System

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Abstract. The current situation of energy supply and demand is severe. To solve a series of problems, the target energy system, with the typical characteristics of supply effectivity and synergistic transformation between supply and demand, needs to be constructed. The target energy system, that is, integrated energy system makes full use of supply and demand resources on both sides, and organically combines integrated services and integrated energy to form a coordinated supply subsystem, so as to meet the new energy demand and realize the effective supply of energy. Finally, the paper puts forward three concrete measures to improve integrated energy system construction.

1. Introduction

In the wave of supply-side reforms, China's energy industry has undergone major changes, and many problems have arisen. Whether it is coal, natural gas, crude oil or electricity, there is the disequilibrium of supply and demand. In terms of oil and natural gas, import dependence is further increased, and national energy security is seriously threatened. In addition, environmental pollution caused by energy consumption is increasingly serious. Based on the problems, in order to cope with the pace of supply-side structural reforms in the entire economic sector, structural reforms in the energy supply side are imperative. In order to smoothly implement the reform of the energy supply side, we must first abandon the mindset of isolated operations in energy, and turn to integrated energy governance. Integrated energy governance refers to the formulation of rules for all energy operating systems related to the economy, the environment and society, mitigating conflicts, balancing and coordinating and ultimately achieving a win-win situation. The ultimate goal is the sustainable development of energy. The emphasis should shift from focusing on the single operation of energy production, conversion and distribution, to the overall management of energy, we will dilute energy production supply and strengthen energy service supply [1]. Therefore, whether the overall balance of energy supply and demand can be obtained through reform of the energy supply side still needs to be implemented into the improvement and development of integrated energy service planning.

2. Energy supply side reform

The supply-side reform is based on the original economic policy that stimulates demand in China. The focus is on the supply side. On the one hand, through the adjustment of the supply structure, the excess capacity of traditional consumption is reduced to meet the upgrading demand and emerging demand; On the other hand, through the transformation of the economic development mode, the original extensive economic growth mode based on resource consumption is abandoned, and a new fine economic growth mode focusing on quality and efficiency is developed. The supply side is not a narrow production



process, but all the production, transportation, distribution and other aspects before reaching the consumer. The organic combination of all the links on the supply side forms a supply subsystem that circularly operates and continuously interacts with other systems. In addition, the true supply-side management cannot separate the demand side, but the overall system optimization with the demand side. To sum up, the supply-side structural reform refers to the effective supply through the adjustment of supply structure and the transformation of economic growth mode, with emphasis on the effectiveness of supply and the dynamic balance between supply and demand [2]. Now, the energy industry urgently needs to further push the supply-side reform to the depth. There are two main reasons for this:

First of all, the energy industry, as a basic industry and pillar industry in China's national economy, also faces common problems in economic activities. Because of excessive coal production capacity, and dependence on imports for crude oil and natural gas, supply-side reforms are needed to achieve effective energy supply. By docking, optimizing and utilizing energy supply and demand side bilateral resources, we can maintain supply and demand balance and solve energy problems [3].

Second, energy is an indispensable intermediate input and means of production for all industries. The supply structure, price and included service of energy products have an important impact on supply-side structural reforms in the overall economic sector. Therefore, it is necessary to support the supply-side reforms of other industries to pay more attention to comprehensive services for energy-demand customers in energy supply-side reforms, and to meet the new demands of service consumption, and to strengthen the management of demand-side resources. Though the above, it leads reforms, and guides the energy supply structure adjustment [4].

The energy supply side reform refers to the integration of energy production and transportation, conversion, and consumption systems, including energy services and docking energy consumption. There are only two changes in the focus of attention (Figure 1): one change is from the original supply quantity to the supply effectiveness, that is, the supply structure adjustment and change that effectively satisfies the demand; the other change is from the original splitting of the supply and demand side resource management to the collaborative management of the bilateral resources through energy service[5] These two transformations are not a one-time process, but a long-term process. The ultimate goal is to break the old energy system, change the old ideas of expanding supply, that is, simply increase the supply quantity to meet the demand, and change the operation status of the system that the production side is separated from the demand side. On the basis of the above, it creates the target energy system with two typical characteristics. One is to improve the supply efficiency to meet the demand, and the other is the synergistic transformation between the production side and the demand side. The fundamental solution to the energy problem lies in achieving the above two changes.

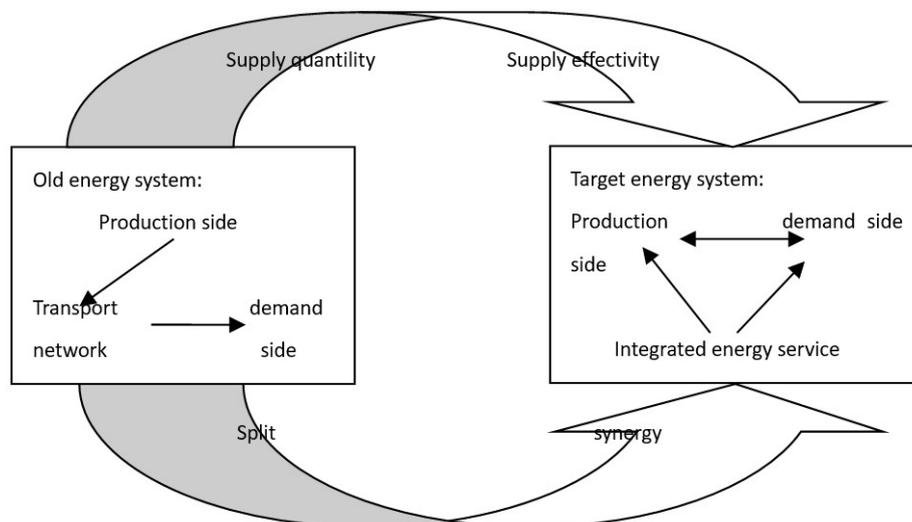


Figure 1. Two changes in energy supply side reform

Therefore, through the energy supply side reform, we can establish a long-term mechanism to link supply and demand with services to adjust China's energy supply structure, change China's energy utilization way.

3. Integrated energy services

The integrated energy service initially appeared in the form of energy-storage services. The main business is to provide the customers with the services of choosing when to use energy, in order to reduce costs for customers, also called demand side response, is more common in the power industry. With the diversification and complication of customer needs, integrated energy services are no longer limited to demand side responses in power systems, but rather to integrated energy and integrated services distributed across all energy industry. As shown in Figure 2, integrated energy covers electricity, oil, natural gas, cold, and heat. Integrated services include distribution services, energy saving services, operational services, information services, etc. [6]. As an energy service provider, the integrated supplier not only provides planning, information, and operation services for energy suppliers, but also provides energy saving, information, and distribution services for the final users of energy. Therefore, energy suppliers and energy demand customers act as The service demand side exists harmoniously in the target energy system and interacts with each other to form a coordinated operation system.

With the development of new energy, energy companies that have been operating relatively independently have experienced inter-industry and intra-industry integration, breaking the boundaries between primary and secondary energy, energy producers and consumers. For example, thermal power enterprises invest in photovoltaic power generation and wind power generation, which is the integration of different primary energy and secondary energy in the power industry. energy-storage service companies invest in incremental distribution network, which is the integration of energy distribution service and energy-storage service; micro-grid operators build distributed energy and electricity, heat, cold and other networks, which is integration of the energy transmission service and energy production. the connection between the micro network and the main network, enables the micro network to change the role between the producer and the consumer at any time according to the needs of its own balance, and so on. in the above integration of any energy industry, it can be seen that integrated energy service is playing a role in linking all, the emergence of integrated energy service providers has thus become a natural outcome and powerful driving force of industry development.

As shown in Figure 2, the foundation of integrated energy services lies in the mutual conversion of various energy sources on the energy exploitation and production side. For example, electricity can be converted into heat and cold energy, and coal is converted into electricity, heat, cold energy, etc., so that energy not only flows from the energy supplier to the end user, but also flows in the supply subsystem where the supplier participates collectively; secondly, on the energy demand side, the use form, time, place, quantity, etc. of different energy demand can be adjusted, transferred, reduced, and defused; The third is the mutual transformation between the energy production side and the demand side. For example, energy storage can be used as energy load to input and store energy, when the energy supply is greater than demand or there is a low price signal; when the energy supply is less than demand or there is high price signal, it is used as an energy supply to output and use energy[7].

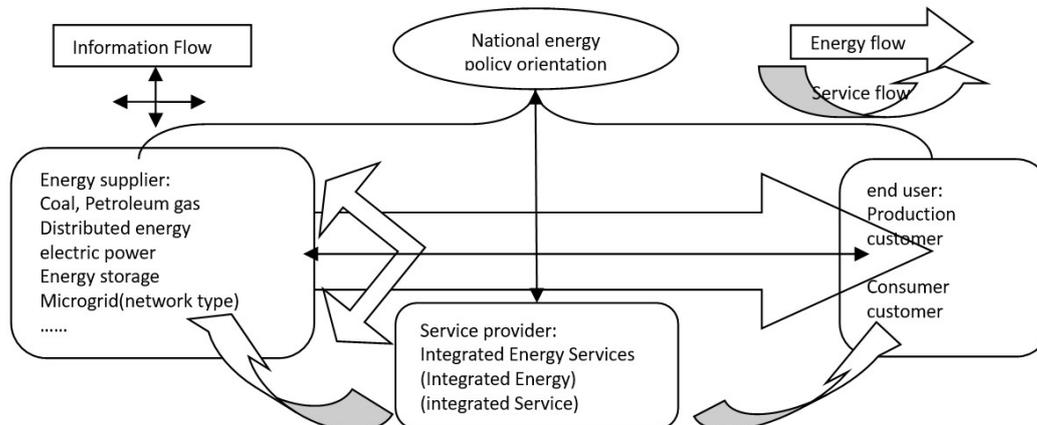


Figure 2. Target energy system with integrated energy service providers

Based on this, integrated energy services can promote two transformations in energy supply-side reforms, forcing changes in energy supply side, driving energy structure adjustment and development patterns transformation, and ultimately embodied in environmental governance and economic development. As shown in Figure 2, the main reasons are as follows:

First of all, the service supply is also part of the supply system. It complements the energy supply and combines all the energy production, transmission and distribution before reaching the consumer into a whole, and builds a harmonious operation supply subsystem, thus forming an effective supply guided by the new service demand. In the current era of service economy, service consumption is the representative of new consumption patterns. The emergence of service demand means that there must be service supply to meet demand, and energy service demand is concentrated on how to obtain a cost-effective energy use experience. Therefore, effective energy supply can only be achieved through effective service supply [8].

Second, integrated energy services can organically link supply and demand by providing services to energy suppliers and energy demanders. On the one hand, the service suppliers provide energy planning services for the demand side customers and lead them to take part in demand side management, utilizing the time shifting and quantity changing ability of the customer demand, combined with the price signal, thus reducing energy costs and improving energy efficiency. At the same time, the consumption change in energy demand side leads the supply side to adjust the energy structure, promotes the refinement of supply management by market means, concentrates limited resources, and improves energy efficiency. The connectivity of this kind of bilateral resources has been concentrated in the demand side response of electric energy. The demand side responds to reduce or transfer the peak load, which can save energy for customers while also leading power plants to adjust production plan, reducing peaks and filling valleys together, thus improving the safety of system operation and ensuring effective energy supply. On the other hand, the service suppliers provide information services such as big data for energy suppliers. These big data obtained from demand side management, is used for the service suppliers to provide energy production and transmission, distribution planning services for supply side customers. The integrated energy service supplier even can invest in Distribution network, micro-network development and construction, responding to national policies and investment increments, and provide energy distribution services and network management services to improve energy production and transmission comprehensive efficiency. Through the above two-way service provision, the supply and demand can be maximized to meet the needs of customers, and the connection between supply and demand can be realized [8].

4. Development path

In the promotion and construction of integrated energy services, according to different service characteristics and comprehensive energy conditions, it is necessary to carry out fundraising activities,

project construction management, etc. After the establishment of the integrated energy service system, select the operating entity and operation mode to ensure the system smoothly. At the same time, in the process of system operation, an effective market incentive mechanism should be established to improve the effectiveness of integrated energy services, so that supply and demand can be truly connected. With all of those, the comprehensive balance of economic development, environmental improvement, and national security can be achieved. Details as follows:

4.1. Introducing multiple investment entities.

According to the power system reform policy, social capital is allowed to enter the incremental distribution network. This policy aims to gradually form market-based electricity prices through the introduction of competition in the transmission and distribution sector. It can be seen that the introduction of diversified investment entities can accelerate the construction of the energy market through competition and cooperation. In addition, in order to promote intermittent renewable energy consumption, and to build an Energy Internet platform that can be freely and independently accessed, the integrated energy service facilities such as distributed energy, transmission network, energy storage, and data processing platforms are large in scale, especially The micro-grid service construction project in remote areas lacks a reasonable investment return operation pattern. If a single economic subject investment will bear a large risk, instead adopting a diversified investment entity model, the risk will be greatly reduced, more and more investment will be attracted.

4.2. Encouraging cross-border integration operations.

Integrated energy services include integrated energy and integrated services, with a wide range of energy sources and diverse types of services. Therefore, integrated energy services cannot be realized with a single industry knowledge. Multi-energy integration on the energy production side, multi-network integration on the transmission side, and energy production, transmission, distribution and storage are required. On the basis of the integration of consumption and multi-links, cross-border operations are encouraged to achieve effective energy and service supply through knowledge sharing and resource integration.

4.3. Establishing market incentive mechanism.

Demand side response is a behavior in which users voluntarily and autonomously respond to price signals or economic incentives and adjust energy demand accordingly. First of all, it is necessary to establish a smooth price transmission mechanism, so integrated energy service suppliers can use the price signal to provide the right energy carrier and suitable energy use time and place to provide services for customers. Secondly, it is necessary to establish a coordinated and comprehensive incentive mechanism, including adjust and improve existing power demand side response incentive methods, including energy conservation subsidies, reduce peak power load incentives, etc., and also include orderly establishment of unique incentives for other energy sources, especially renewable green energy, so that integrated energy service providers promote the demand side resources actively to track the development and utilization of green energy, guided by the service direction of environment protection and sustainable development.

5. Conclusion

To solve the serious problem of the construction and operation of the energy system, it is necessary to carry out energy supply side reform. Based on the energy supply side problems and the characteristics of energy as a necessity in other industries, energy supply side reform need to promote two transformations: one is from supply quantity to supply effectivity, another is from split management to coordinated management of supply and demand sides. To achieve these two changes in the energy supply side reform, the foothold needs to be placed on integrated energy services that can effectively coordinate the supply and demand sides. Therefore, only by promoting integrated energy services, we can efficiently, economically and rationally integrate and utilize resources of supply and demand side,

promote energy supply-side reforms, and effectively address current energy issues. To effectively promote the development of integrated energy services, we must first introduce multiple subjects in the investment links to accelerate the construction of energy markets in an orderly manner. Secondly, we need to encourage cross-border integration operations in the operation links to realize multi energy production, transmission and utilization knowledge sharing, to play a multi-faceted comprehensive impetus. Finally, it is necessary to establish a market incentive mechanism in the policy links to guide the direction of integrated energy services through market means, to promote the prosperity of the integrated energy service market.

Acknowledgments

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