

Standard Mechanism for Market Operation and Value Evaluation of Energy Storage Systems Under High Proportion of New Energy Access

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Abstract

Under the tide of new energy Internet, power energy storage has become one of the important supporting technologies for the development of energy Internet, and while paying attention to the technological innovation and development of energy storage systems, its business model is also an important factor to determine whether the energy storage industry can flourish. First of all, the relevant policies to support the development of energy storage are combed and their impact on the development of energy storage industry is discussed. Secondly, it summarizes and analyzes the current development of business models in many application areas such as supporting new energy, microgrid and auxiliary services at home and abroad, and finally puts forward the potential feasible commercial operation mode of energy storage in the light of the actual situation in China.

Keywords

New energy; Energy storage systems; Market operations; Evaluation criteria.

1. Introduction

As a product of energy development process, the energy Internet has been widely concerned by the global energy industry and gradually entered a period of rapid development. In order to adapt to the new pattern of future energy consumption, solar, wind, biomass, water and other clean renewable energy in the energy production sector is playing an increasingly important role, this trend is irreversible, and even in the near future, renewable energy will completely replace fossil fuels as the source of energy for human survival. Energy storage technology has emerged in this environment, and the rapid development of energy storage has become an important driving force for energy Internet from conception to reality [1]. The energy storage makes the rigid power system flexible, breaks the barrier that the power system needs real-time balance, and suppresses the volatility caused by the access of a large number of renewable energy sources to the power grid, which makes the safety, economy and flexibility of the power grid operation be improved. The research on energy storage system planning explores the economies of scale of energy storage in the power system and even in the environment of energy Internet, which is also the basis of the energy storage from demonstration to commercialization. However, there is less literature on the energy storage business model in the current research on energy storage planning, which is limited to physical planning and less on feasible business models based on policy and market environment. The development of energy storage not only depends on the maturity of energy storage technology, but also needs active and friendly policy support and market environment. This paper first briefly summarizes the current situation of various energy storage technologies and their applications, makes a detailed analysis of the research progress in the solution of new energy grid-connected problems in energy storage systems, and then focuses on the optimization and allocation methods of energy storage systems, and summarizes the control strategies of the energy storage system in different health conditions, and finally, the research direction and application prospects of energy storage technology [2].

At present, China's power system reform is still in its infancy, the existing power grid operation and business model curing degree is high, storage capacity in the process of commercial operation lack

of application research and demonstration guidance, and the degree of electricity marketization is limited, lack of corresponding policy support, to a certain extent, hinder the commercial promotion of energy storage system [3]. Starting with the application of energy storage and energy Internet, this paper studies the existing energy storage system business model, analyzes the feasibility of different energy storage application strains, and paves the way for the large-scale promotion of energy storage in the future [4].

2. Business model for energy storage technology market operations

Power energy storage has become one of the important support ingress of smart grid technology, in the context of the development of energy Internet, the function and positioning of energy storage has been further expanded. The technology forms of energy storage are different, including electrochemical energy storage, compressed air storage, flywheel energy storage, supercapacitor energy storage, superconducting magnetic energy storage, hydrogen storage, heat storage, etc. , establishing a coupling relationship between electricity, heat, hydrogen and other energy sources, playing an important role in energy transit, matching and optimization. Energy storage provides power and energy services to the power grid, and its application on the load side improves the flexible adjustment capability of the load [5]. At present, there are a large number of energy storage on-body technology, energy storage planning and design, energy storage control technology research, this article is not repeated here. In addition, the energy storage business model is another key factor to break through its development, it clarifies the business logic of a particular entity, but also the energy storage industry can be healthy and orderly construction and growth of an important prerequisite. The success or failure of the business model determines the success or failure of the enterprise, which is defined as the overall solution to achieve the maximum customer value, to integrate the internal and external elements that enable the enterprise to operate, to form a complete and efficient operating system with unique core competitiveness, and to meet the customer's needs and realize customer value through the most realized form, while making the system achieve the overall goal of sustained profitability. At present, some scholars have carried out research work in this field. Recently, China's distributed power generation, electric vehicles, renewable energy and other emerging industries rapid development, and jointly promote the rise of the energy Internet [6]. As a way of energy time-space transfer, energy storage plays an important role. However, at this stage, there is a contradiction between the economics of energy storage and the urgency of application needs. On the one hand, the cost of energy storage system is still higher than traditional power equipment, considering that its full life cycle after the profit space is not large, resulting in its marketization process is slow, from the project landing demonstration to commercial operation of the driving force is insufficient; In this case, the business model of energy storage will become the key to break through the development of energy storage. In this paper, we will first analyze the current situation of energy storage commercial operation according to different energy storage application scenarios from the policy point of view.

Looking at the whole world, countries in the planning and layout of energy storage strategy is very different, the development of energy storage involves the characteristics of power load, economic level, market openness, related policies, subsidy mechanism and so on. Further subdivide the field of energy storage applications, for the storage of energy and new energy supporting the construction of operation, different countries of the development focus and business model sits different [7].

The United States has been leading the world in the field of new energy and energy storage, with Sunrun, Tesla and other companies driving the application of home light storage products, for example. Prior to Tesla's acquisition of SolarCity, the two had been partners in the U. S. optical storage market, focusing on the commercial and civil sectors, successfully introducing energy storage in photovoltaic systems to provide users with a greener, cheaper, more stable and secure power supply. Tesla's acquisition of SolarCity has reduced investment costs in optical storage, shut down dozens of SolarCity solar power plant installations and ended retail partnerships with HomeDepot due to lack of capacity, lack of capital and poor profitability in the optical storage sector. Sunrun is a leader in the industry as the industry is in decline, offering users a BrightBox package with higher value and

profit margins. The business model in the field of optical storage is typically in the following three categories [8]:

(1) Equipment buy-out mode. That is, the user buys light storage equipment at once, spontaneously self-use, self-maintenance.

(2) Photovoltaic leasing model. Refers to the user does not need to buy equipment, only need to save from the monthly electricity cost to the company according to a certain rental rate to pay a certain amount of equipment rental costs, not only save a large amount of equipment investment costs, but also can enjoy cheap green electricity. The NetMetering policy in the United States provides a good policy environment for this model [9].

(3) Power Purchase Protocol Mode (PPA). For large commercial projects, the model refers to third-party agreements between optical storage system providers and commercial users and power companies, companies such as Tesla, which build and maintain optical storage systems and sell electricity to power companies and charge electricity; For small commercial and residential projects, the model is similar to the photovoltaic leasing model, in which the company sells cheap electricity directly to its users. In addition to optical storage, Tesla is also committed to large-scale energy storage projects using vertical integration models, such as its 100MW/129MWh Powerpack energy storage system for South Australia in 2017. Tesla, in partnership with Neoen, a French renewable energy supplier, uses wind power from all of its Holmesdale wind farms to recharge its storage capacity and discharge it during peak hours, providing stable, safe and adequate electricity to more than 30, 000 homes [10]. As shown in Figure 1.

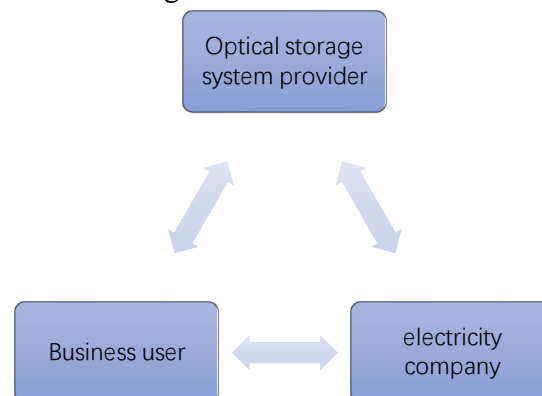


Figure 1 PPA mode for large commercial projects

Domestic research and practice in this regard started late, has been put into operation of the supporting new energy storage system to demonstration projects, the relevant projects are mainly by the power grid companies or power generation enterprises responsible for the project funds are generally by the enterprise's own funds, scientific and technological project stake funds, bank financing and other ways, through the cost of electricity recovery, low economy. Such as the use of user investment model of "Zhangbei landscape storage and transmission demonstration project", the use of contract energy management model of "Wuxi Singapore Industrial Park intelligent distribution network energy storage system" and so on. In the future, China needs to formulate electricity price policy, preferential tax policy, subsidy policy, etc. to provide a good policy environment for the development of "energy storage and new energy", to tap the various benefits of energy storage, to build a reasonable income model, the use of various financial means to realize future earnings, forming positive cash flow. On June 1, 2018, the National Development and Reform Commission, the Ministry of Finance and the State Energy Administration jointly issued the Notice on The Related Matters of Photovoltaic Power Generation in 2018, which has unprecedented control over the photovoltaic industry, covering measures such as limiting the scale of new construction, reducing the intensity of subsidies and electricity prices, which makes the photovoltaic industry face a dilemma, and also foreshadows the huge development space of the combined energy storage of "pv and energy storage".

3. Energy storage to participate in the business operation of ancillary services

Pumped storage power station is a strong guarantee to ensure the safety, stability and economic operation of the power system, and bears the important tasks of system backup, peak fm, peak filling and filling.

(1) Foreign pumped storage power station business model look at the world, pumped storage power station construction and operation mode is relatively single, most of them are power grid enterprises wholly-owned construction operation or power grid company holding / equity investment construction, a very few use independent power generation companies investment and construction model. Table 1 briefly summarizes the operating mode of a typical national pumping power station.

Table 1 Typical national pumping power plant operation mode.

Countries	Operation mode of pumped storage power station
United States	Power grid company construction and operation, power marketization to promote independent power production plant construction pumping power station
United Kingdom	The initial reform was managed by the State Grid Corporation, and the reduction of pumping power plants deeply managed by the state was reformed
France	The French power company has a national monopoly.
Germany	Independent power generation company can be independent construction
Japan	Unified construction and operation by regional power companies

(2) China's pumped storage power station business model because the service target of pumped storage power station is the power grid, whether it is before or after the electricity reform, the power grid companies have the responsibility and obligation to plan the pumped storage power station in a unified manner. However, because pumped storage power station is a heavy asset, the independent investment of power grid enterprises in the construction of pumped storage power station is limited by the shortage of funds and other factors, which in turn hinders the development process of pumped storage power station construction. Therefore, through the formulation of a reasonable electricity price mechanism, clear the functional benefits of pumping power station, the designation of a reasonable distribution of interests of the relevant beneficiaries, to determine a reasonable return on investment, is conducive to attracting power generation companies and local governments to jointly invest in the construction of pumped storage power station. At present, China has built two main types of pumped storage power stations: the construction of power grid enterprises and power grid enterprises holding construction.

(1) Power grid enterprise-owned construction: pumped storage power station in the early stage of development mostly use this model, such as Panjiakou pumped storage power station, Gangnan pumped storage power station.

(2) Power grid enterprise holding construction: currently under construction and planning of pumped storage power stations mostly belong to this type, and because the regions and provinces power companies are wholly owned subsidiaries of the State Grid Corporation, so most of the pumped storage power stations are controlled by the State Network Corporation.

It is worth mentioning that there are also individual pumped storage power stations are invested by power generation enterprises, such as the Three Gorges Group to participate in investment in the construction and independent operation of the Hohhot pumped storage power station, by the CLP Group (now the National Electric Power Investment) responsible for the Hunan Black Peak pumped storage power station, but because of the continued loss of operation by the State Network New Source Company. Despite the setback, power generation companies are still keen on pumped storage business, the Three Gorges Group, Huadian, China Nuclear and other enterprises have a layout in this field. The development of capital market, bonds, stocks and other financial means of continuous improvement, enriched the financing means of enterprises, is conducive to solving the problem of the initial shortage of funds for the construction of pumped storage power station.

Foreign already has extensive experience in electrochemical storage to participate in the auxiliary service market, but also has a good policy environment, such as the 2011 FERC issued on the "wholesale power market FM compensation mechanism", the introduction of two compensation system, emphasizing the FM effect, such as energy storage and other high-quality FM resources to provide a favorable policy environment. China is also constantly trying to participate in auxiliary services in the area of electrical storage energy. In June 2016, the State Energy Administration issued a Notice on Promoting the Participation of Electricity Storage Energy in the Pilot Work of the "Three Norths" Regional Power Auxiliary Services Compensation (Market) Mechanism" to determine the status of the market participants in the peak FM auxiliary service market, and did not restrict the identity of the energy storage, the following parties are likely to participate in: 1 power generation enterprises. New energy power station supporting energy storage; Energy storage alternatives or bundled with traditional units to participate in ancillary services; Through energy storage to improve the quality of electricity, to build core competitiveness; Provide unified scheduling resources to obtain revenue.

4. Conclusions

Based on the above discussion and analysis, energy storage technology has occupied a place in many scenarios of power system, in addition to the above several areas, storage energy in the field of electric vehicles is also widely used, limited to space no longer repeated. China's power system reform started late, so we should learn more mature and advanced business models abroad, and combined with their own characteristics fully internalized. China's power system reform has just started, in the market environment and policy environment is still unstable, the energy storage industry needs to constantly break through their own technical bottlenecks, reduce technology costs, improve service quality at the same time, explore the market development trend, relying on the energy Internet development of the general situation, explore suitable for their own business operation model.

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