Study on the Benefit Evaluation of System Operation and Market Operation After the Participation of Electric-Gas-Heat Multi Energy in the Market

Han Zhang[1(✉)], Xun Dou[2], Song Xue[1], and Li Ma[1]

[1] State Grid Energy Research Institute, Changping District, Beijing, China
{zhanghan,xuesong}@sgeri.sgcc.com.cn
[2] Nanjing University of Technology, No. 30, Puzhu South Road, Jiangbei New District, Nanjing, China

Abstract. The remarkable effect of multi energy system coordinated operation on improving the reliability, economy and cleanliness of energy system has attracted extensive attention. Multi energy coupling utilization and collaborative trading are important to ensure energy security, improve energy supply capacity, promote clean and low-carbon transformation of energy, and enrich new use models and new business types. They are also the development trend of comprehensive and efficient energy utilization in the future. China needs to build a multi energy collaborative trading market mechanism and regulatory system according to local conditions, and constantly innovate business models and new business formats for terminal energy use. This paper analyzes the impact of multi energy participation in the market on system operation and market operation from the perspective of economic, social and environmental benefits. The key factors and indicator system for measuring the construction effect of the electricity sales market have been systematically established from six aspects, including enriching the new mode and new business type of energy utilization, improving the trading and operation efficiency of the energy market, increasing the overall market dividend, ensuring the safe and reliable supply of energy, improving the efficiency of terminal energy utilization, and helping energy conservation, emission reduction and energy transformation, to effectively identify the deficiencies in the construction of the multi energy market, We will promote the sustainable and healthy development of the multi energy market.

Keywords: multi energy · electric-gas-heat · system operation

1 Introduction

The global energy structure is in the stage of accelerating the transformation from oil and gas to non-fossil energy. China's energy is also in the stage of diversified development of fossil and non-fossil energy, and the transformation to non-fossil energy. The

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process of energy development and utilization of green low-carbon is further accelerated. This has provided a strong driving force for achieving high-quality and sustainable economic and social development. The remarkable effect of multi energy system coordinated operation on improving the reliability, economy and cleanliness of energy system has attracted extensive attention. First, the coordinated operation of multiple energy systems can enrich the means of energy system operation and regulation, enhance the flexibility of the energy system, reduce the impact of the price and supply and demand uncertainty of a single energy system, reduce the risk of energy system operation, and improve the security and reliability of the energy system [1]. Secondly, the coordinated operation of multiple energy systems can realize the cascade utilization of energy, tap the complementarities and substitutions between different types of energy production and consumption, improve energy efficiency, reduce emissions and energy costs, and improve the utilization rate of energy infrastructure. Finally, the coordinated operation of multiple energy systems can make full use of the complementary and alternative characteristics of different energy sources in time and space, compensate the uncertainty of renewable energy, and promote the full consumption of renewable energy [2].

Multi energy coupling utilization and collaborative trading are important to ensure energy security, improve energy supply capacity, promote clean and low-carbon transformation of energy, and enrich new energy use models and new business types. They are also the development trend of comprehensive and efficient energy utilization in the future [3]. As a large energy utilization country, China must follow the trend of the times, take serving the dual carbon goals and building a new energy system as the core, reduce the dependence on foreign energy and provide energy security and stable supply capacity as the theme, vigorously promote the research and development of technology and equipment for efficient conversion and utilization of electric heat and multi energy, develop comprehensive energy services and multi energy supply industry chain, and combine the energy resource endowment and economic development level of various regions [4–7], We will build a market mechanism and regulatory system for multi energy collaborative trading in line with local conditions, constantly innovate business models and new business formats for terminal energy use, and improve users' sense of access to and satisfaction with diversified and personalized energy use [8–10].

2 Analysis of Key Factors Influencing System Operation and Market Operation When Multiple Energy Sources Participate in the Market

To assess the impact of multi energy participation in the market on system operation and market operation, first of all, it is necessary to reasonably determine the key influencing factors of multi energy participation in the market on system operation and market operation, systematically and completely divide the major issues affecting analysis into several small issues, and enhance the rationality, effectiveness and operability of the evaluation while reducing the difficulty of analysis.

Based on the multi-dimensional benefits such as economic benefits, social benefits and environmental protection benefits, the impact of multi energy participation in the

market on system operation and market operation is analyzed. This research systematically establishes the key factors to balance the construction effect of the electricity sales market from six aspects: enriching new energy utilization models and business types, improving the trading and operating efficiency of the energy market, increasing the overall market dividend, ensuring the safe and reliable supply of energy, improving the efficiency of terminal energy utilization, and helping energy conservation and emission reduction and energy transformation. The details of the six key factors are as follows.

2.1 Enrich New Modes and Business Types of Energy Utilization

Multi energy participation in the market can effectively promote the continuous innovation of energy utilization models, encourage comprehensive energy service providers to actively cultivate and fully tap the energy demand of users, actively cultivate and develop new models and business formats, promote the coordinated development of multi energy planning and design, construction, operation and maintenance, marketing services and other links, improve the modernization level of the energy industry chain supply chain, and strengthen the support of renewable energy innovation chain. Meet the diversified and personalized energy demand of energy and power users, provide users with more options and value-added services, and improve people's needs for a better life.

2.2 Improve Energy Market Transaction and Operation Efficiency

Multi energy participation in the market promotes the improvement of the market mechanism, promotes the coupled trading and coordinated operation of power, natural gas, heat and other multi energy markets, improves the overall operating efficiency and trading level of the multi energy market, reduces the energy cost of the whole system, cultivates multiple market players, enhances the enthusiasm of various market players to participate in the market, continues to promote the expansion of the market scale The diversified market entities represented by integrated energy service providers and large energy users have brought necessary competitiveness to the construction of the multi energy market.

2.3 Increase Overall Market Dividend

Under the environment of multi energy participation in the market, energy supply entities must improve customer satisfaction if they want to maintain the stability and sustainability of their own operations. Enhance customer stickiness, expand incremental customers, and avoid customer churn. When users' feedback and choices are made, various market entities can be guided to make adjustments. At the same time, in order to fully adapt to market competition, the energy supply and demand parties must continue to optimize their business strategies, improve their trading ability, increase customer stickiness, and strengthen innovation, which will effectively promote market competition, reduce user costs, and increase overall market dividends.

2.4 Ensuring Safe and Reliable Energy Supply

Multi energy participation in the market can effectively promote the cleaning of traditional fossil energy and the scale and effectiveness of renewable energy. At the same time, it can promote the multi energy complementation of traditional energy and new energy, give play to their respective endowment advantages, and integrate to form a safe, stable and reliable energy supply guarantee system. Multi energy participation in the market is bound to promote the coupling, coordinated and complementation development of the energy system, as well as improve the flexible regulation capacity of the energy system.

2.5 Improve Terminal Energy Utilization Efficiency

Multi energy participates in the market, conforms to the development trend of energy consumption efficient electrification, meets the diversified energy demand of users, and accelerates the efficient use of energy in key areas. We will help scientifically and orderly implement electric energy substitution, give play to the coupling and complementary effects of multiple energy systems, promote the transformation and upgrading of terminal energy consumption, and improve the energy efficiency of the whole society. Multi energy coupling promotes the efficient cascade utilization of energy recycling, creates a low-carbon competitive industry, widely uses energy-saving products (such as variable frequency air conditioner, LED and solar heater), and forms a reasonable energy use habit.

2.6 Assist in Energy Conservation, Emission Reduction and Energy Transformation

Multi energy collaborative participation in the market effectively helps to achieve carbon peaking, carbon neutralization, promote the comprehensive green transformation of economic and social development, promote green energy use models in key areas and even the whole society, and promote the substitution of non fossil energy in key industries and fields such as industry, construction, transportation, and change of energy use methods. We will help develop green energy consumption models such as new energy vehicles and building photovoltaic integration, promote energy substitution in heating and cooking, improve the level of electrification in the whole society, and effectively promote energy conservation, emission reduction and energy transformation.

3 Benefit Evaluation Method System of Electric Heat Multi Energy Participating in the Market

3.1 Basic Principles of Market Benefit Evaluation System for Multi Energy Participation

In the research and design of the market benefit evaluation system for multi energy participation, the following five basic principles are mainly followed:

First, the principle of combining quantitative and qualitative analysis. It not only conducts quantitative analysis on tangible and quantifiable economic and social benefit indicators, but also conducts qualitative analysis on intangible and difficult to quantify indicators. Quantitative and qualitative analysis are organically combined to comprehensively evaluate the market transactions of multiple energy sources.

The second is the principle of adaptability. The indicator system of China's multi energy participation in market transactions must first fully adapt to the characteristics of China's energy industry and the construction needs of the current energy market system. According to the functional positioning of the multi energy participation market, as well as the characteristics and requirements of different development stages of the multi energy participation market, targeted evaluation indicators are designed.

The third is the scientific principle. The content of China's multi energy market participation index system should be scientific and reasonable, and the form should be concise and easy to understand, without violating objective laws; Be able to conduct a systematic and accurate assessment of the multi energy participation market to ensure that the assessment results are comprehensive and complete; It also takes into account the micro and macro benefits of the market, short-term and long-term benefits, local benefits and overall benefits, reflecting the development trend of the spot market.

The fourth is the systematic principle. The indicators of the indicator system are interrelated and mutually restricted. Therefore, a systematic approach should be adopted in the design of the indicator system, which reflects the overall consideration of various relationships among indicators through the organic contact way and reasonable quantitative relationship between indicators, so as to achieve the optimal overall function of the evaluation indicator system.

The fifth is the principle of practicality. The principle of practicality refers to practicality, feasibility and operability. In order to meet the requirements of practicality, the following points should be achieved: firstly, the indicators should be simplified and the methods should be simple; Secondly, the data should be easy to obtain; Third, the meaning, units and corresponding calculation methods of each evaluation index should be standardized; Fourth, the accuracy of data should be strictly controlled.

3.2 Multi Energy Participation in the Market Benefit Evaluation Index System

This project mainly constitutes a multi energy participation market benefit evaluation indicator system by enriching new energy utilization models and business types, improving energy market trading and operation efficiency, increasing overall market dividends, ensuring safe and reliable energy supply, improving terminal energy utilization efficiency, helping energy conservation and emission reduction and energy transformation, and other six first level indicators, 19 s level indicators, and 51 third level indicators, as shown in Table 1.

Table 1. Multi energy participation in the market benefit evaluation index system (owner-draw)

First level evaluation indicators	Second level evaluation indicators	Third level evaluation indicators
Enrich new energy utilization models and business types	Development of new energy consumption formats	Abundance of new energy consumption business types and models
		Development speed of new energy consumption business type and new mode
	Multi energy industry chain coordination level	Business coupling degree of different energy systems
		Information sharing degree of different energy systems
	Cultivation of emerging entities	Scale of comprehensive energy service entities
		Scale of comprehensive energy service industry
Ensure the safe and reliable supply of energy	Multi energy market construction	Perfection of single energy market trading mechanism
		Perfection of trading mechanism of multi energy coupling market
		Perfection of regulatory mechanism of multi energy market
	Operation and development of comprehensive energy service enterprises	Industry operating income
		Total industrial profit
		Industry net profit
		Industry revenue profit margin
		Return on industry net assets
		Market concentration
		Type and number of independent service providers
	Multi energy system development	Multi energy system coupling operation level
		Intelligent and digital development level of multi energy system

(*continued*)

Table 1. (*continued*)

First level evaluation indicators	Second level evaluation indicators	Third level evaluation indicators
	Customer service capability	Service customer scale
		Universal service level
		Diversity of service packages in the market
		Customer satisfaction
	Corporate governance capability	Compliance and risk control level
	Brand value	Comprehensive value of industry enterprise brand
Increase overall market dividend	Promotion level of economic and social development	Surplus of multi energy producers
		Multi energy consumer surplus
		Multi energy market drives GDP growth
		Elastic coefficient of energy production
	Profit and loss of market entities	Profit and loss of energy production enterprises
		Revenue from decreasing user energy cost
		Comprehensive energy service enterprise profit and loss
Ensure the safe and reliable supply of energy	power supply	Power supply reliability
		Quality of power supply
	Natural gas supply	Natural gas supply reliability
		Quality of power supply
	Heat supply	Reliability of heat supply
		Heat supply quality
	Comprehensive supply	Multi energy coupling supply reliability
		Multi energy coupling supply quality

(*continued*)

Table 1. (*continued*)

First level evaluation indicators	Second level evaluation indicators	Third level evaluation indicators
Improve the efficiency of terminal energy utilization	Regional energy efficiency level	Regional energy consumption per unit GDP
		Overall efficiency of regional energy system processing and conversion
		Regional energy efficiency decline level
	Energy burden level	Energy cost per unit output value
		Proportion of user energy cost in total operating cost
Improve the efficiency of terminal energy utilization	Promote energy conservation and emission reduction	Proportion of regional fossil energy use
		Regional pollutant emission intensity
		Regional carbon emission intensity
		Carbon emission intensity per unit GDP
	Promoting energy transformation	Proportion of regional green electricity in electric energy use
		Proportion of regional natural gas in energy use
		Proportion of regional electric energy in terminal energy consumption

4 Conclusion

This study analyzes the impact of multi energy participation in the market on system operation and market operation from the perspective of economic benefits, social benefits, environmental protection benefits and other multi-dimensional benefits. The key factors to measure the construction effect of the electricity sales market have been systematically established from six aspects: enriching new energy utilization models and business types, improving the trading and operation efficiency of the energy market, increasing the overall market dividend, ensuring the safe and reliable supply of energy, improving the efficiency of terminal energy utilization, and helping energy conservation and emission reduction and energy transformation. Six first level indicators, 19 s level

indicators and 51 third level indicators have been formed to form an indicator system for evaluating the benefits of multi energy market participation and effectively promote the construction of multi energy market mechanism.

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