Research on Integrated Energy Value-added Services Based on Energy Consumption Data

[1st] Guoliang Li[1,a*] , [2nd] Yujiao Liu[1,b], [3rd] Yiqing Lin[1,c], [4th] Qingqing Chi[2,d], [5th] Liguo Zhang[2,e*], [6th] Yiwen Gao[2,f]

[1]Zaozhuang Power Supply Company of State Grid Shandong Province Electric Power Company, State Grid Corporation of China,Zaozhuang City, Shandong 277101, China
[2]State Grid Shandong Integrated Energy Services, State Grid Corporation of China, Jinan City, Shandong 250021

[a*]Corresponding author:guoliangli2023@163.com
[b]yujiao998@163.com
[c]skdlyq0525@163.com
[d]952363834@qq.com
[e*]191687517@qq.com
[f]891522376@qq.com

Abstract. Integrated energy services can optimise resource allocation and reduce energy consumption costs, and are an important development direction for the low-carbon transformation of energy consumption. Exploring the value-added integrated energy services based on the energy consumption data of the subject, the key issues of integrated energy services for the subject of energy consumption are explored from the analysis of energy consumption data of the users of the integrated energy system, the optimisation of energy consumption strategies of the users, the value-added services and their applications, etc., providing ideas to enrich the future development direction of the integrated energy system.

Keywords:integrated energy systems, integrated energy services, value-added data services

1 Introduction

China is in a critical period of energy transformation and modern energy system construction. In the context of alleviating energy supply shortage, realising efficient energy use and ensuring renewable energy consumption, integrated energy services can effectively shorten the energy industry chain, reduce energy costs [1-2] and achieve reasonable and optimal allocation of energy resources under the new power system [3], which is the preferred choice to support energy transformation and a reliable de-

A. Rauf et al. (eds.), *Proceedings of the 3rd International Conference on Management Science and Software Engineering (ICMSSE 2023)*, Atlantis Highlights in Engineering 20,
https://doi.org/10.2991/978-94-6463-262-0_21

velopment direction for the future energy system. The development direction of the future energy system.

Integrated energy systems include integrated energy and energy services [4]. Integrated energy includes different loads such as cooling, heating, electricity and gas, and can flexibly access and consume distributed energy and realise the coupling of multiple types of energy. Energy services include different types of business models such as distributed photovoltaic power generation, electrochemical energy storage, combined cooling, heating and electrical supply, and power demand-side management [5]. With the advancement of energy transformation and the abundance of user-side resources, the centre of the integrated energy system is gradually shifting towards the main energy-using side, and the massive amount of user data has posed new challenges to the traditional data processing methods [6-7]. With the diversification of energy consumption patterns and energy supply characteristics, the demand for personalised energy services is increasing[8-9]. By mastering and operating user data, further optimising energy consumption strategies and exploring and innovating energy service products have become the future development trend of integrated energy services[10], which are of great significance in helping users to reduce energy consumption costs and improve the energy efficiency of society.

This paper discusses the key issues of value-added services of integrated energy systems based on the energy consumption data of the subject in the context of energy transition, and elaborates on the analysis of energy consumption data of users of integrated energy systems, optimization of energy consumption strategies of users, value-added services of data and their applications respectively.

2 Analysis of users energy consumption data of integrated energy system

2.1 Basic architecture of integrated energy system

The integrated energy system is a new type of energy supply system with a high degree of integration and complexity, which contains a variety of energy supply systems such as electricity supply systems, cooling and heating systems, and natural gas systems. In addition, demand-side response resources are more abundant in the integrated energy park, and coordination and influence are generated between demand response objects and response subjects.

An integrated energy park is a new type of integrated district energy system. In the integrated energy system of the park, physical information technology and a rational management model enable coordinated planning, optimised operation and collaborative management between natural gas, electrical and thermal energy sources. In addition, integrated energy technology can meet the diverse energy needs of the system while effectively improving energy efficiency and promoting sustainable energy development. The integrated energy system of the park includes solar, wind, hydrogen and natural gas energy types. Through advanced technology, these different energy resources are co-ordinated to provide customers with a higher system energy efficien-

cy in the supply of cooling, heating and electricity loads. In practice, the various subsystems of the integrated energy system interact with each other to realise the functions of the integrated energy system in the park through the links of "development - conversion - transmission - storage - consumption". The system is designed to be used in a variety of ways, value added data services business model is shown as figure 1.

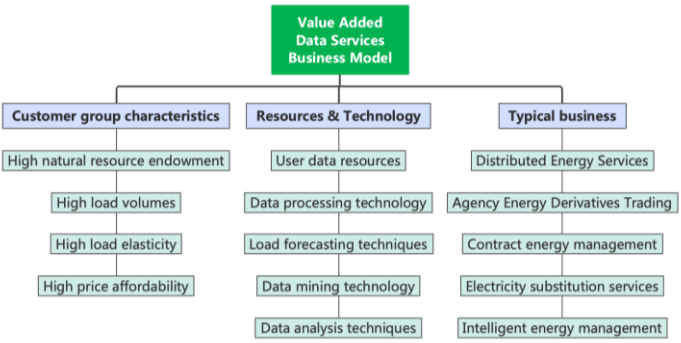

Fig. 1. Example of a figure caption. *(figure caption)*

2.2 Factors influencing the energy consumption characteristics in integrated energy system

The energy consumption load of park users is mainly influenced by the industrial structure and level of economic development, climatic conditions and power demand-side management. In the study of load characteristics indicators, the regional industrial structure and economic development level is a very important influencing factor, mainly reflected in: the better the economic development of the region, the higher the living standard of residents, the higher the degree of electrification, the load rate tends to decline, the system peak-to-valley difference increases; in the economic structure, if the proportion of heavy industry is larger, the annual load growth is faster, the load rate level is higher, the peak-to-valley difference is not large; If the proportion of tertiary industry is larger, the load level is lower and the peak-to-valley difference is larger; with the improvement of China's economic development level and industrial restructuring, the load of residential electricity and tertiary industry users will show a rapid growth trend, and in the absence of effective regulation means, the load rate level will continue to decline.

Differences in load characteristics between regions are largely caused by differences in climatic conditions between regions, for example, differences in load characteristics between northern and southern regions, with peak summer cooling loads greater in the south than in the north and heating loads greater in the winter than in the north. Typically, changes in climatic conditions have a greater impact on monthly loads, for example, where average temperatures are higher than in the summer months of the same period, monthly load rates are lower and peak-to-valley differences are greater. The impact of climatic conditions on load is also reflected in the impact on

agricultural irrigation electricity consumption, as irrigation electricity consumption is closely related to natural precipitation, and in months with more precipitation, irrigation electricity consumption is lower and the corresponding load rate levels are higher and the peak-to-valley differential is lower than for the same period.

Demand-side management is an artificially imposed influence aimed at achieving economy of supply and consumption while improving the reliability of system power supply. The main technical measures adopted in DSM are: peak shaving, valley filling, peak shifting, strategic power saving, strategic load growth and increasing flexible loads. The aim is to reduce customer demand during peak load hours on the grid and to keep the load relatively stable while the demand for electricity continues to grow. Effective demand-side management, such as guiding large consumers to shift their power consumption by adjusting their variable workflow and power consumption plans; providing technical guidance on power saving and energy conservation to help them use power rationally, so as to achieve strategic power saving and peak and valley reduction; and using price mechanisms to increase the proportion of new power using low valley power, so as to achieve the purpose of filling the valley and flexible operation while ensuring consumers' power consumption needs.

2.3 Methods for collecting energy consumption data

The main sources of energy consumption data of the park include the power management department of the region to which the park belongs and the government statistics and planning departments to collect the total amount of electricity consumption at the end of the year, the annual peak load of the park, the total population at the end of the year, the GDP of the park, the industrial structure of the park, the geographical location of the park, the traffic conditions around the park, the total area of the park, the area of the built-up area of the park, the energy consumption per unit of output value of each industry, the per capita living consumption level of the park, the planning of the park, etc. The objectives of the park, etc. The data of relevant factors that have an impact on the load density of the park are counted, and on the basis of the statistical collation of historical data of relevant influencing factors, the main influencing factors of each classification of load are determined, and the load density of each classification of the park in the historical year is also calculated. In addition, it contains various load characteristics analysis indicators to describe the changes of load characteristics in different cycles, such as annual, seasonal, monthly, weekly, daily, etc. Through the analysis and calculation of these specific indicators, it is possible to quantitatively describe the development and changes of load characteristics of end-users and the park as a whole, thus visually reflecting the operation of the park's energy system.

3 Types of value-added data services

The end-user body of integrated energy services mainly includes industrial, commercial and residential customers, whose consumption needs, according to their energy consumption characteristics, include

(1) Reliable services: energy security and stability are the basic needs of energy consumption, and the electricity, heat (cooling) and gas loads for production and living in the park must be met, while ensuring the necessary reliability and quality of energy supply.

(2) Cleaner services: for high pollution and heavy emission users in the park, the park should actively respond to climate change, improve the ecological quality of the park and achieve green harmony between energy and environment and sustainable development of the park.

(3) Efficient services: In response to the high energy consumption and crude energy consumption patterns in the park, energy laddering and recycling should be promoted to improve the efficiency of resource allocation and to form an economical and efficient energy consumption system in the park.

(4) Intelligent services: Internet, artificial intelligence and other technologies will profoundly change the production and lifestyle in the park, with new scenarios such as smart homes, smart buildings, smart factories and smart logistics emerging, and energy consumption will give rise to new demand accordingly.

(5) Economical services: effectively reduce the energy costs of end-users in the park, alleviate the economic burden and create a good economic development environment for industrial and commercial users.

The specific energy consumption demand and types of value added services are shown in the following table 1.

Table 1. Demand, type and content of integrated energy services.

Energy consumption demand	Types of Value Added Services	Services
Reliable	Reliability services	One-stop energy supply
		Specialised Professional Operations and Maintenance
Cleaning	Cleaning services	Distributed Energy Services
		Agency Energy Derivatives Trading
Efficient	Efficient service	Contract energy management
		Electricity substitution services
Smart	Intelligent Services	Intelligent energy management
		Big Data Information Services
Economy	Economical services	Integrated Energy Retail Package
		Agency energy purchase and sale transactions

4 Implications for the application of integrated energy value-added services

With the development of smart grids and the construction of advanced measurement systems, the power system has accumulated a huge amount of basic electricity consumption data, which contains a wealth of information, and it is important to make full use of the huge amount of power big data to analyse the useful information behind the data. Power consumers are an important part of the power system, and it is important to dig into the inner rules of power consumer load data for the planning and operation of the power system, so it has received extensive attention and research. The core purpose of data analysis is to extract and mine knowledge from massive amounts of data, while the electricity consumption data of customers conceals their electricity consumption habits. Studying and mining electricity consumption data can help understand the personalised and differentiated service needs of customers, thus further expanding the depth and breadth of comprehensive energy services.

Carrying out integrated energy services based on user data can, on the one hand, improve energy utilisation efficiency, select high energy-consuming and high-emission users in the park based on energy consumption data, promote fine energy management and recycling efficiency in the park through contract energy management and electrical energy substitution services, improve the efficient allocation of energy in the region and form an economical and efficient energy consumption scenario. On the other hand, it is able to optimise energy market trading services. Integrated energy service providers mainly act as bridging agents for internal and external energy transactions in the park's energy market, and realise the extensive circulation of energy commodities in the park and promote energy output and digestion through the development of value-added data service trading business models such as integrated energy retail packages and agency purchase and sale energy transactions.

5 Conclusions

Research on value-added services of the park's integrated energy system based on the subject's energy use data, optimising intelligent power consumption strategies under the conditions of customer-side energy interconnection, developing data value-added analysis modules and other energy services that are compatible with the new power system according to the potential data value-added service issues under customer-side energy interconnection, and promoting the development of energy transformation. At the same time, the research as well as application of integrated energy services with the core of user data deep mining has just emerged, and still faces many difficulties, from technology, operationally and at multiple levels of coordinated development, such as through the construction of a smart integrated energy services platform, actively exploring the development strategy and technical solutions of integrated energy services, providing an important guarantee to enhance the technical service level of integrated energy services and improve energy use efficiency.

Acknowledgment

Authors wishing to acknowledge assistance or encouragement from colleagues, special work by technical staff or financial support from organizations should do so in an unnumbered Acknowledgments section immediately following the last numbered section of the paper.

References

1. Li J.F, Liang X.M, Wu J, Wang Y.B, Pan F. Design of a low carbon oriented regional integrated energy service market trading mechanism[J]. Northeast Power Technology,2023,44(03):55-62.
2. Huang B.L, Li P, Xing Z, Gao B, Zhao J. Research on the construction path of integrated energy service platform for power generation enterprises under value chain reconstruction[J]. Comprehensive Intelligent Energy,2022,44(12):75-80.
3. Zhu Y, Ren L.Q, Zhou D.Q, Wang F, Yu Q, Gao Y, Chang Z.Y. The relationship between new power systems and integrated energy services and suggestions for future development[J]. China Soft Science,2022(11):20-25.
4. Li Y, Song T.L, Wang Z.J. Exploration of key issues of integrated energy services based on deep mining of user data[J]. Electricity demand-side management,2018,20(03):1-5.
5. Chen T, Chen K, Ye H.Z, Wen Y. Research on different types of integrated energy service business models[J]. Energy and Environment,2023(01):29-31.
6. Jin W.D, Jiang Y.B, Ding Y. Current status and outlook of research on key issues of user-centered integrated energy system optimization management[J]. Zhejiang Electric Power,2016,35(10):73-80.DOI:10.19585/j.zjdl.2016.10.016.
7. Wang X.L. Research on data application of integrated energy service platform based on big data analysis[J]. Electrical Times,2022(04):29-30.
8. Luo Y.T., Zhang L, Ding S.H Xing Z.H. Exploring the transformation of gas stations into integrated energy service stations[J]. International Petroleum Economics,2023,31(03):83-89.
9. Li N, Liao S.L, Pan C.C, Zheng B.Y, Gu Y.Q. Research on the technical route of standardization of integrated energy services[J]. China Standardization,2022(24):88-94+107.
10. Guo J.Y,Cheng D.S. Research on the intelligent management of integrated energy services based on cloud platform[J]. Rural Electrification,2022(12):31-33+37. DOI:10.13882/j.cnki.ncdqh.2022.12.008.