

Active Consumers in the Russian Electric Power Industry: Barriers and Opportunities



I. O. Volkova, E. A. Salnikova, and L. M. Gitelman

1 Introduction

Change in the technological basis of the electric power industry by the development of Smart Grid System leads to decentralization of economic decision-making, significant changes in industry management and rules of interaction between economic agents in the market especially households and companies which until recently were only consumers of services. The new technological basis creates conditions for a fundamental change in economic behavior of relevant market agents from “passive” to “active” accompanied by a change in functions and roles of consumer agents and from an agent accepting terms dictated by the electric power system to an “active” consumer who orders services. New roles manifest in demand management actions and the provision of additional system services for load management which gives the consumer an ability to compete with generation.

2 The Concept of Active Consumer in the Energy Sector

The main trend in the development of the Smart Grid is related to the fact that the level of network control and automation increases, technologies become available to a consumer; the consumer becomes not just a subject that consumes electric power

I. O. Volkova

National Research University Higher School of Economics, Moscow, Russia

E. A. Salnikova

Nonprofit Partnership “Market Council”, Moscow, Russia

L. M. Gitelman (✉)

Ural Federal University, Yekaterinburg, Russia

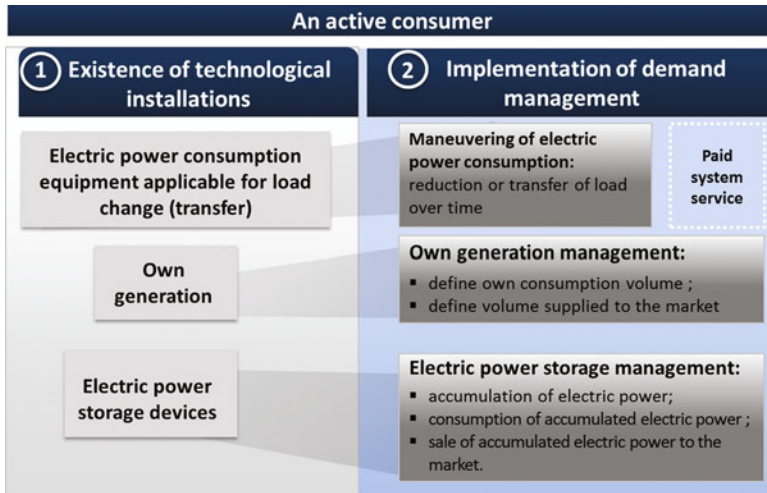


Fig. 1 An active consumer in the energy sector

but begins to play an important role in the energy system by ordering a set of services that he needs. From a subject subordinated by strict regulations and requirements, he becomes a customer. The analysis of international studies and developments on this problem allows us to formulate two main characteristics of an active consumer (Fig. 1): first, technological capabilities and devices that can either generate electric power or use an electric power storage system and second, opportunity and implementation of consumer demand management. The key changes include new consumption patterns. Centralized energy system was focused on large consumers: large steel mills and factories that were not interested in implementing energy efficiency programs and energy saving; now the world trend is the increasing share of consumption of domestic sector, new customers, such as data processing centers (e.g., Google consumes more energy than some industrial consumers).

Thus an “active” consumer is a subject of the electric power market which has a technological capability to change its consumption mode and willingness to participate in demand management programs forming the main characteristics of generated electricity: volume, quality, consumer characteristics, and energy services.

Formulating the above characteristics of “active” consumers determines their main functions in the energy system:

- Coordinated and automatic management of power consumption devices operation mode in accordance with their needs determined by the production plans or household’s needs
- Control operation mode of generating equipment and electricity storage systems
- Development of a strategy for participation in the provision of ancillary services [1]

Table 1 Analysis of possibility of realization of “active” consumer functions in the Russian electric power industry (example for household customers)

Scope	Parameter	Now	In perspective
Household consumers	Electric power consumption management	Not implemented or carried out in small volumes in manual mode	Automatic control of the operation mode of electrical appliances (electric isolated devices, for which there is the possibility of changing work schedule: washing machine, dishwasher, air conditioning, heaters, refrigerators, electric device) on the basis of minimizing the cost of energy and satisfaction with the work schedule
	Own generation	None	Presence of own generation (increase in the availability of renewable energy); possibility of transfer its own generation of electricity to the grid
	Electric power storage	None	Availability of electric power storage device
	Strategy	Electrical device mode planning is not carried out or done manually	<ul style="list-style-type: none"> • Planning of operation mode of each appliance with automatic on/off option for those devices which has a possibility of transferring load in time • Define strategy of own generation loading; consumption and the volume of electric power output to the network • Define strategy of using electric energy storage device: charging, selling of accumulated electricity to the grid, own consumption of accumulated electricity

Our study allows estimating opportunities of implementing “active” consumer functions and behavior strategy of consumers from various fields and economic activities selected based on various power consumption devices’ characteristics (Tables 1 and 2).

The analysis shows that in the current environment, the ability to implement the functions of the “active” user is limited due to low availability of electricity storage technologies and small generation and electricity market model specialties: the absence of consumer services market sector and the inability to sell electricity from its own generating capacity to the grid (for small generation). In addition, technological features of some areas of activity result in the inability to implement functions of an “active” user now and in the near future.

Key requirements for an energy system that determine the significance of a consumer “activation” process are the following [2, 3]:

Table 2 Analysis of the possibility of realization of “active” consumer functions in Russian electric power industry (example for industrial customers)

Scope	Parameter	Now	In perspective
Industrial consumers	Electric power consumption management	Reduction in load at peak hours is not considered by the market as an alternative to downloading a backup/peak generation and is not paid by the market	Participation in programs of demand management: <ul style="list-style-type: none"> • Automatic load reduction in case of emergency • Automatic control of equipment operation modes (load time transfer) on the basis of cost minimization • Provision of system services of reduction in energy consumption to produce the equivalent of the payment in the amount of peak load/ backup generation.
	Own generation	No possibility of selling electricity on the market	Possibility of selling electric power from own generation to the network
	Electric power storage	None	Presence of electric power storage devices with large volumes
	Strategy	In some cases (e.g., OJSC “Surgutneftegas”) planning of consumption mode and load of own generation is carried out on the basis of market prices	<ul style="list-style-type: none"> • Planning of equipment operation mode with automatic shutdown option in case of participation in relevant programs with interruption, transferring the load to provide ancillary services to the corresponding payment • Define strategy of own generation loading; consumption and the volume of electric power output to the network • Define strategy of using electric energy storage device: charging, selling of accumulated electricity to the grid, own consumption of accumulated electricity

Motivation of Active Consumer Behavior

This includes creating conditions for independent determination of volume and functional properties (safety and quality) of consumed electric power by consumers in accordance with their needs and grid capabilities based on information on prices, volume, reliability, and quality of electric power.

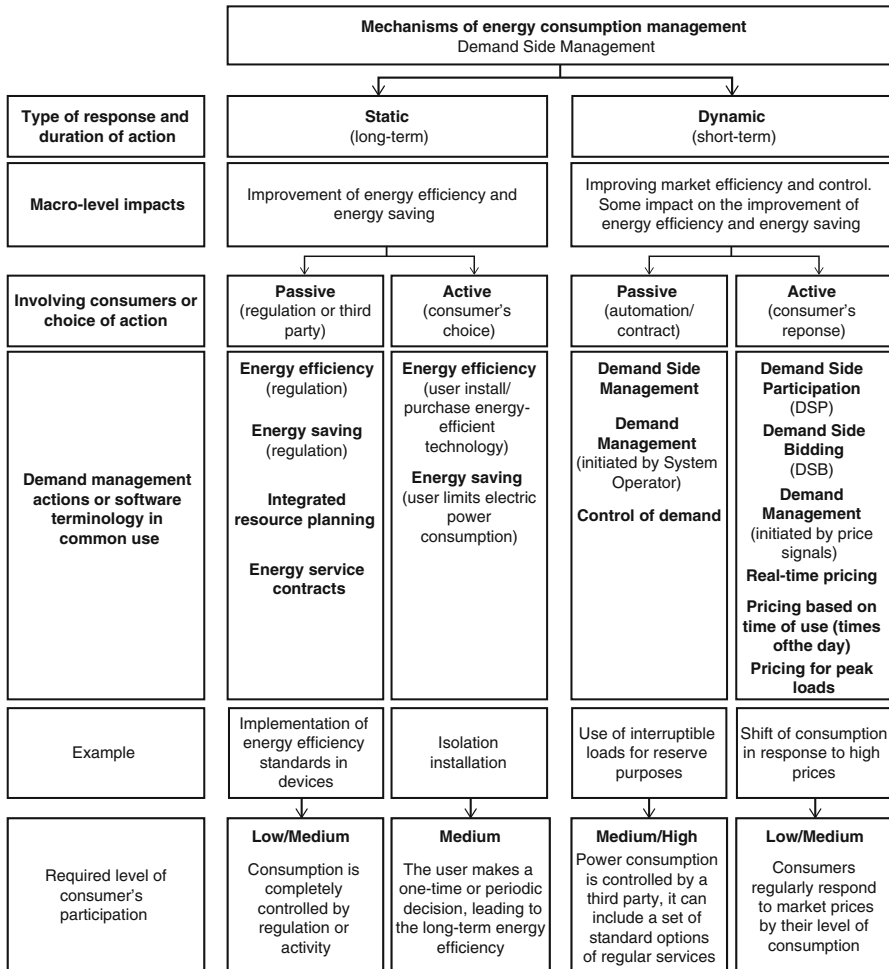


Fig. 2 Mechanisms of demand-side management

Integration of Consumers' Own Generation of Electricity

This includes improvement in the procedure of technological connection and certification of small and distributed generation and power energy storage systems in order to ensure their integration into the power system.

Provide Access of Active Consumers to Electric Power Markets

The ability to implement functions of the “active” consumers in electric power system is provided through mechanisms of power management (demand-side management), which involve a variety of forms of interaction between consumers and other members of the power system. Figure 2 shows the classification of these parameters, developed on the basis of generalization of different terminology and definitions [4, 5].

The first reason for classification of demand-side management mechanisms is the duration of exposure to consumer behavior:

- Long-term perspective: mechanisms to improve energy efficiency
- Short-term: demand management mechanisms (demand response and load management) [6, 7]

Furthermore, one of the important parameters of classification is a type of response:

- Static response (increase in energy efficiency, including through the use of standards) – actions to be taken at any time, depending on the specific signals received from market, or technological system operator requests. Basically, these actions are long-term, for example, the replacement of old equipment with energy efficiency will reduce energy consumption throughout their lifetime.
- Dynamic response – actions to be taken in response to signals received from the market or to predetermined system conditions. Such actions are carried out in accordance with short-term requirements and have a short-term impact (only at run time) although the accumulated effect of the actions of a few consumers can contribute to changing consumer behavior in terms of consumption and market development.

The third parameter of classification is the level of participation of consumer: active or passive. An example of a static response with passive participation of consumers is regulation through establishment of energy efficiency standards of manufactured equipment by the state. This demand management mechanism is the most common nowadays. Active participation of consumers is provided by making a decision, for example, of installation of energy-efficient equipment.

In the case of dynamic response, passive consumer response is influenced by the other participants and is not due to the action of a consumer (e.g., technological operator or energy supply companies, etc.). Most often, these actions are planned and fixed in the contract and are required to maintain the reliability, balancing the energy system or in the case of emergencies. The active participation of consumers implies implementation of proactive actions by the consumer, for example, the transfer of electric power consumption to another time as a reaction to high prices in power system during peak periods. In this case consumers make a choice based on information received from the market and decide to change their behavior in response to said signal. Examples of mechanisms ensuring the implementation of such actions in the electric power market are dynamic pricing and trading on power management. Barriers for implementation of such actions are the concept of management of electric power, focused on producers, and lack of information necessary for decision-making for participants from the demand side [5].

On the basis of these characteristics of an “active” user as well as the analysis of current rules, principles, and technological parameters of an energy system, the authors formulated a system of requirements for the development of energy required for the emergence and integration of an “active” user, which are presented in Table 3.

Table 3 System of barriers to overcome for the emergence and integration of “active” consumers to the power grid

Barriers	Measures (examples)
<i>Technological</i>	
Underdevelopment of electricity accounting and measurement systems as well as information and communication technologies of transferring and processing data	<ul style="list-style-type: none"> • Development and equipping of power consumer devices with automation systems of remote control modes • Development and implementation of intelligent systems for accounting and measurement allow to monitor the price of electricity in real time • Implementation of information and communication opportunities for two-way interaction between a consumer and energy system using smart metering
Technological complexity of integration of distributed generation to the grid	<ul style="list-style-type: none"> • Improvement of technologies, methods, and standardization requirements for the integration of the small distributed generation (including renewable energy) to the grid while maintaining the stability and reliability of its work
<i>Economic</i>	
Creating incentives for consumers’ “activation”	<ul style="list-style-type: none"> • Development of motivational management mechanisms • Formation of demand management program system • Dynamic pricing methods • Direct load control methods • Creating a market of system services for a consumer
<i>Organizational</i>	
Need for coordination of consumer retail market	<ul style="list-style-type: none"> • Agency contracts in terms of selling the potential volume of reduced loading on retail market • Interaction with consumers and aggregation of consumers’ offers in terms of costs and volume of potential loading reduction

In this study the authors systematized and highlighted a wide range of components of an effect due to emergence of active consumers. The study shows that this effect is distributed among all market participants. Its appearance in any aspect will be an interesting and positive impact on the development of all sectors of the electric power market (Fig. 3).

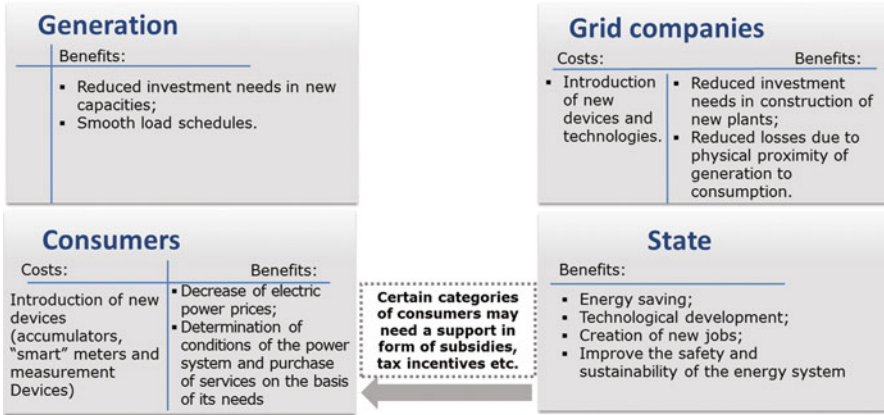


Fig. 3 Effect of "active" consumers' appearance and its components

3 Conclusion

The current situation in the electric power market is characterized by a decreasing efficiency of the industry (lack of competition, extensive practice of "manual" control, etc.) and increasing discontent of consumers on the one hand, and the development of technology on the other creates preconditions for changing the role of consumers in the electric power system from "passive" to "active." This transition calls for revision of management approaches in industry: reorientation from supply-side management, the concept of focusing on cost management of producer companies, to a demand-side management, a concept based on the direct involvement of the consumer in the value creation process.

Switch to a new paradigm of innovation development of electric power industry including integration of "active" consumers involves the following stages:

- Adoption of a strategic decision to move to the industry development based on the intelligent electric power concept fixing that provision in all documents that define the long-term development of the electric power industry
- Development of key provisions of the concept of Smart Grid taking into account the requirements of all participants, technologies for the intelligent infrastructure formation, and legal framework of Smart Grid system, as well as a pilot application of "breakthrough" technologies
- Launch of a new customer-centric electric power market model including the mechanisms of the "activation" of consumers (demand response)

References

1. Volkova, I.O., Salnikova, E.A., Shuvalova, D.G.: Active consumer in an intelligent power industry [in Russian]. *Energy Acad.* **2**(40), 50–57 (2011)
2. Kobec, B.B., Volkova, I.O.: Innovative Development of the Electric Power Industry Based on the Concept of SMART GRID [in Russian]. IATs Energiya, Moscow (2010)
3. Kobec, B.B., Volkova, I.O.: Smart Grid: Conceptual statements [in Russian]. *Energy Mark.* **3**(75), 66–72 (2010)
4. Davito, B., Tai, H., Uhlaner, R.: The Smart Grid and the Promise of Demand-Side Management. McKinsey & Company (2010) http://www.calmac.com/documents/MoSG_DSM_VF.pdf
5. Grubb, M., Jamasb, T., Pollitt, M.G.: Delivering a Low Carbon Electricity System. *Technologies, Economics and Policy*, p. 536. Cambridge University Press, Cambridge (2008)
6. Zgurovets, O.V., Kostenko, G.P.: Effective methods for managing the consumption of electric energy [in Russian]. Online. http://dSPACE.nbu.gov.ua/bitstream/handle/123456789/3094/2007_16_St_11.pdf?sequence=1 (2007)
7. Oboskalov, V.P., Panikovskaya, T.J.: Energy consumption management in a competitive electricity market [in Russian]. Online. <http://www.sei.irk.ru/symp2010/papers/RUS/S4-14r.pdf>