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MODELS AND STRUCTURES FOR CONSUMER-CENTRIC ELECTRICITY MARKET

Introduction. Today, energy systems around the world are being transformed due to the impact of a wide range of factors associated with the global trend of decarbonization accompanied by the process of decentralization and digitalization in the electricity industry. The typical features of this energy transition are increasing the share of electricity from renewable energy sources in the energy balance and expanding distributed generation with diffusion of SMART technologies. There are countries, where technological, economic, financial and organizational initiatives and incentives, established by national energy policies, have already led to the formatting this new type of energy systems, which can be characterized as multi-agent, intelligent, decentralized and environmentally friendly energy systems.

To overcome the barriers regarding the formation of a consumer-oriented electricity market, in March 2019, the European Parliament approved two key documents: Directive on common rules for the internal market for electricity and Regulation on the internal market for electricity, that are a part of the Clean Energy for All Europeans package. Since the rules enter into force in the very near future, it makes possible to state that the EU electricity market design will be changed towards increasing consumer participation. As Ukraine intends to be integrated into the European energy market, there is a need to investigate the potentials of market design existing in Ukraine regarding the adopting the European concept of the consumer-oriented electricity market as well as the conditions necessary for implementing this type of market.

The purpose of the research is to identify the perspectives for the consumer-centric electricity market in Ukraine under the liberalization of the market access for pro-active consumers to establish a more competitive electricity market environment.

To reach the purpose, the analysis of existing concepts of consumer-centric electricity markets including their business models and structures has been provided.

Results and discussion. Observed structural changes, caused by privatization and unbundling the energy business, modify the pattern of the energy sector. In the short and middle-term perspectives, these changes, in turn, must lead to the empowerment of consumers in the electricity market and increasing the number of prosumers. However, in most cases, the traditional design and structure of electricity markets are not prepared to adopt the participation of prosumers. The existing incentives to activate the participation of consumers in the market are still far from effective support tools. Regarding prosumers participation in the retail electricity market, a few concepts of market mechanisms are commonly discussed. Among them are peer-to-peer energy trading, prosumer grid integration, indirect customer-to-customer trading and prosumer community groups [1-4]. These concepts have been consolidated in three approaches to business models and structures of the local electricity market considered below.

Peer-to-peer business models (P2P) of local electricity market have a completely decentralized implementation and are the least structured set of the models. These markets involve numerous contractual relations between different agents, in which prosumers interconnect directly each other without a supervisory agent, buying or selling electricity and other services (e.g. electricity storage, water heating). Such multi-bilateral trade is organized according to the pre-defined trading scheme with a set of rules and guidelines to facilitate the transactions between numerous individual agents.

Prosumer-to-grid business models (P2G) of the local electricity market are the most structured set of models. Depending on whether or not a microgrid is connected to the main grid, P2G models have two versions. In the interconnected version, the prosumers provide services to a microgrid connected to the main grid. In the island version, the prosumers provide services to a stand-alone independent microgrid. Numerous individual prosumers have different incentives in each version. In the interconnected version of P2G, the prosumers have incentives to generate more electricity to be sold to the main grid. In the island version of P2G, the prosumers should optimize their service at the microgrid level. This set of models involves prosumer marketplaces (e.g. low or high marketplaces according to the voltage level), brokerage system and pre-defined participation rules to help networks operators improve the energy distribution efficiency.

Business models of Prosumer Community Groups are situated between P2P and P2G. They are more structured than P2P and less than P2G. These models serve interests the limited numbers of prosumer groups. In terms of scale and structure, the prosumer groups can be defined as community-based prosumer groups and community-organized prosumer groups. Such business models of the local electricity market may present opportunities for communities, local organizations and authorities to pool their resources to efficiently manage energy needs and generate a revenue stream for community benefit. In this business model, there is a possibility to aggregate the distributed energy resources as a single virtual power plant connected to the main grid. This type of aggregators can supply electricity to different markets and even participate in the wholesale market.

The comparative analysis of existing concepts of the consumer-centric electricity market has shown that the local electricity market can be provided in the frame of the wholesale and retail electricity market design. However, to improve the actors' competitiveness on the local electricity market, there is lack of research focused on consideration of consumer-centric electricity market as a complex system through a topological approach to its technological and commercial systems [5-6]. Further development of consumer-centric models will be spreading out the electricity market deregulation from wholesale to retail electricity market design.

Conclusions. In the context of electricity market design, an evolving the decarbonization strategy of the national economy and transition towards decentralized production of electricity with growing part of renewable energy technologies require a revision of existing trade rules as well as regulatory framework regarding new market players. In perspective, the Ukrainian electricity sector should adopt some types of local electricity market. However, today there are constraints to implement any type of business models (P2P, P2G, and Prosumer Community) in the frame of new wholesale electricity market design, caused by the national regulatory framework and not sufficient level of digitalization in the electricity sector. To implement the competitive local electricity markets within the framework of Ukrainian electricity market design, a more comprehensive analysis of market design with using a topological approach is recommended to carry out.

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