

Organizational determinants of creating and developing energy clusters in Poland

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Abstract: *The subject of the article is organizational conditions of creating and developing energy clusters in Poland. The aim of energy clusters is the development of distributed energy. They are used to improve local energy security in a way that ensures economic efficiency, as well as in an environmentally friendly way by providing optimal organizational, legal and financial conditions. Energy clusters also allow the use of local resources and domestic energy potential. The effectiveness of energy clusters depends on the rational and effective use of potential, i.e. locally available energy resources, renewable energy sources, innovation, entrepreneurship in the area of manufacturing, industry, distribution, as well as management of energy consumption. The aim of the article is to analyze the formal conditions of clusters, in particular the essence of their existence, the tasks that the cluster performs and the role of key cluster participants. As a result of this paper the author shows the process of creation and functioning of a energy cluster.*

KEYWORDS: DISSOLVED ENERGY, ENERGY CLUSTERS, ENVIRONMENT, RENEWABLE ENERGY SOURCES.

1. Introduction

The energy market in Poland is gradually evolving towards the promotion and intensive development of civic energy translating into various regional and local initiatives and activities [1]. One of the visible trends of the global economy, which enables effective management of raw materials and local energy potential, is the development of distributed energy. Forecasts show that these sources can be an important formula for supplementing energy supply in less urbanized areas. The place for the development of these sources are energy clusters. They give the opportunity to build new areas of activity for local entrepreneurs, as well as to accelerate economic growth in the areas covered by the cluster. Thanks to the cooperation of various entities in the energy cluster there is a platform for creating new areas of profits for its participants. The Strategy for Responsible Development developed by the Polish government as one of the main development challenges of Poland indicates: ensuring stable and optimally adapted to the needs of consumers energy supply [2].

Therefore, the reliability of energy supply resulting from the organization of clusters is important for the pace of economic and social development of energy and investment neglected areas. Nevertheless, technical coordination between the generation, supply and use of electricity by businesses, the public sector and households is also important [3].

The aim of the article is to show how the energy clusters function in Poland. The author focuses on the definition of the energy cluster, the purpose of its existence, as well as the tasks that are carried out by the energy clusters and the role of key participants in the energy cluster. In the last part of the article the author focuses on the process of formation and operation of energy clusters in Poland.

2. Preconditions and means for resolving the problem

In Poland, the Centralized National Power System is particularly vulnerable to increasingly frequent extreme weather events and to the large extent of the consequences of failures when they occur [4]. In turn, droughts and hot weather, resulting in low water levels in rivers and its elevated temperature, reduce efficiency and consequently limit the power and amount of energy produced in traditional power plants. It is important to remember that water abstraction from rivers or lake complexes for cooling of open-cycle coal units currently accounts for 70% of the total water abstraction in Poland [5]. Thus, the high variability of precipitation and the increase in non-stationary flows can cause disruptions in the operation of power plants, felt nationwide [6].

The state of Poland's electricity networks is debatable, and the effects of insufficient investment are more noticeable in less urbanized areas. Today, the Polish countryside is heavily polluted by exhaust fumes from household boilers and stoves, untreated sewage, and improperly managed waste [7]. It is estimated that in areas with high dispersion of energy consumers, the frequency of

power outages due to failures can be several times higher than in cities [8]. The same applies to the quality parameters of electricity supply, such as voltage or phase symmetry [9]. Thus, improving the availability of energy and its quality is the basis for activities that reduce barriers to local development.

3. Solution of the examined problem

Energy clusters can turn these nuisances into sources of energy and even profit. The aforementioned Strategy for Responsible Development indicates the values resulting from choosing such - the right path. It requires stimulation of innovation, creativity, development of engineering and scientific potential in Poland and development of Polish technical solutions. This will form the basis for new products offered on the domestic market and globally.

The solution to the problem may be energy clusters, which are in line with and even ahead of the objectives set by the European Union for the coming years. They were included in a package of directives and regulations titled "Clean energy for all Europeans, or how to unleash Europe's growth potential", also known as the "Winter Package", which begins a new chapter in building the European economy after 2020.

Energy clusters are a new concept, it was introduced into the Polish legal order by the Act of 22 June 2016 amending the Act on renewable energy sources and some other acts [10]. Formally, an energy cluster is defined as a civil law agreement, i.e. an agreement concluded by the participants. The agreement may be concluded by natural persons, legal entities, scientific units, research institutes, as well as local government units. Its subject is the generation and balancing of demand, distribution, energy trading (including from renewable sources), or individual elements selected by the cluster members. The activity of the cluster is located within the distribution network with rated voltage lower than 110 kV. The area of cluster activity should not exceed the borders of the economic area, which in Poland is usually the county. The energy cluster is represented by a coordinator. This is any member of the energy cluster or a specially established cooperative, association, foundation, etc. [11].

In accordance with the above definition, as an energy cluster can be considered an agreement between locally operating entities dealing with the production, consumption, storage and sale of: electricity, heat, cold and electricity in transport (fuels). The cluster formula is flexible enough to allow participants to build an individual business model of cluster operations and choose the optimal legal form of its activities. Cluster members do not have to give up their current activities, but through cooperation - wherever it brings benefits to them and other cluster participants - they generate added value for the local community. Joining or leaving the cluster may or may not have a significant impact on the activities of other members. Table 1 presents the role of key members of energy clusters.

Table 1. The role of key participants in the energy cluster

Cluster Participant	The role of a cluster participant
Power Generators	They may be the initiators of the cluster, interested in its development due to the sale of energy and the possibility of implementing new investments in technical infrastructure, including in particular energy production.
Energy cluster coordinator	It can be one of the members of the cluster or an entity appointed specifically to perform this function within the cluster. It conducts current affairs of the cluster, administrative services, provides legal and tax services, represents the cluster externally.
Final recipients	Related to the cluster because of the perspective and opportunity to optimize supply costs and improve energy quality.
Local Self-Government Units	They are important stakeholders in the cluster. They may be the initiators of its creation because of the prospect and possibility of optimizing supply costs and improving energy quality, as well as the possibility of being an indirect beneficiary of increased opportunities to obtain funding through the cluster.
Companies	Business units (small, medium and large enterprises) related to with the use of energy - production, trade and services. These enterprises, depending on their size, have different qualitative and quantitative needs that must be provided in whole or in part by the energy cluster.
Public transport companies	Their membership in the cluster is aimed at securing access to low-emission fuels (biofuels) or energy from renewable sources or from waste sources from industry (development of low-emission transport - electromobility).

Source: Own study based on [12].

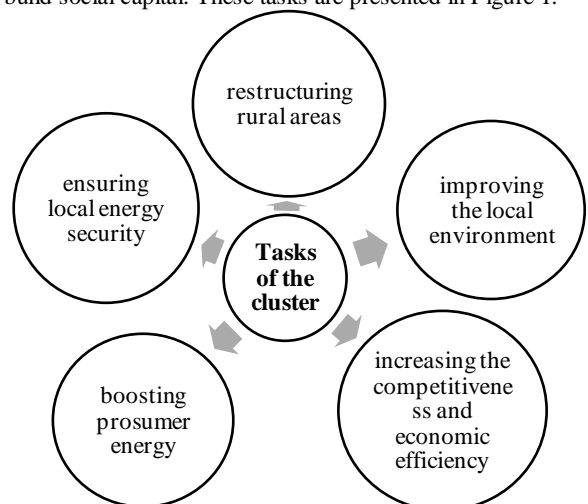
Considering the purpose of the existence of clusters, it should be pointed out that the goal set by the Ministry of Energy for cluster market participants is to identify and implement such business models that will be able to maintain and compete in the market in an effective manner, also without financial support in the long term. Thus, the development of energy clusters enforces the development of rules for the interaction of equal entities in the cluster [13]. An important role in this case is also played by the cooperation of energy producers with network operators. In turn, the objectives of creating and developing energy clusters in Poland should be considered [14]:

- Creating self-balancing areas of the electricity grid,
- Development of renewable energy,
- Ensuring reliability of supply and low prices of energy and distribution services in the area,
- Improving local energy security by creating energy self-sufficient regions - increasing energy efficiency,
- Ensuring better conditions for local entrepreneurs, attracting new investors,
- Supporting low-emission economy, reducing negative impact on environment,

- Modernization of rural areas and supporting development of municipalities,
- Diversification of income in rural areas,
- Creation of new jobs,
- Reduction of electricity costs borne by local governments,
- Increase in innovation - cooperation with scientific institutions and R&D,
- Increase in awareness of the local community regarding the production and consumption of electricity and heat.

Another important issue considering the purpose of clusters is its addressees. The energy cluster is represented by a coordinator, which is a cooperative, association, foundation, or any member of the energy cluster [15]. The energy cluster is addressed to a very wide range of stakeholders and customers whose activities or needs are related to electricity and/or heat [16]. It is a platform for cooperation between local government units, the scientific community, entrepreneurs and their organizations, and all institutions and entities that declare themselves involved in the implementation of the objectives set by the cluster.

Having indicated the purpose of existence of clusters and its addressees, it is worthwhile to outline the tasks that are undertaken by the energy cluster. The tasks of energy clusters are to ensure local energy security, improve the local environment, and increase competitiveness and economic efficiency of the local economy. Cooperation within clusters can also contribute to the restructuring of rural areas, prosumer energy stimulation and further development. Through the development of these initiatives, it will be possible to achieve an increase in innovation and build social capital. These tasks are presented in Figure 1.

**Fig. 1** Tasks of the cluster

Source: Own study.

4. Results and discussion

Energy clusters primarily pursue individual goals of their members while being able to plan and implement local goals. Broader, regional or national goals can be achieved through economies of scale. However, attachment of cluster members to tasks of national character has a limited range, which results from the strictly bottom-up character of cluster initiatives. Based on the analysis, it is possible to detail the various stages of energy cluster formation, which are presented in Figure 2.

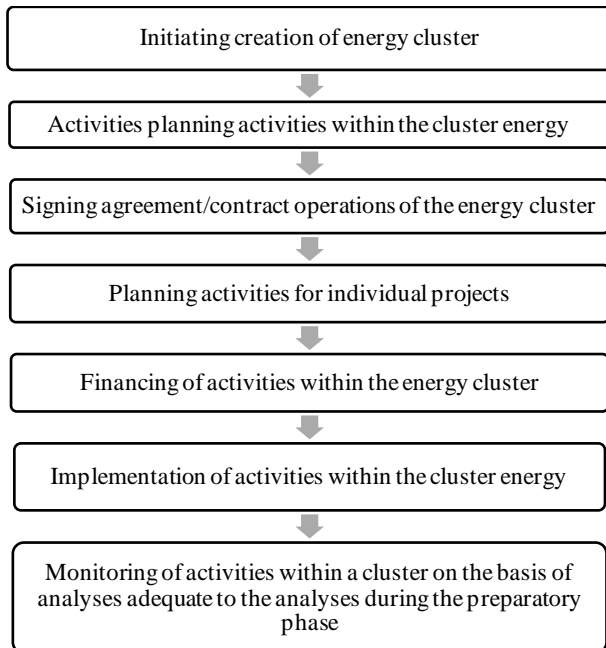


Fig. 2 Diagram showing the process of creation and functioning of a energy cluster

Source: Own study based on [5].

Cluster participants can achieve many potential benefits through cluster cooperation. Firstly, it is obtaining a lower cost of energy and obtaining funding for planned investments. Secondly, participation in energy auctions dedicated to clusters. Cluster participants can also count on solving local problems related to, among others, low emissions, development of new energy sources (dispersed energy), raising residents' awareness of environmental attitudes, maintaining the status of spa municipalities or creating the image of a green municipality, creating new jobs or development of underdeveloped areas.

5. Conclusion

The development of distributed generation is seen as an opportunity to increase energy security through greater diversification of fuel and energy production. Distributed sources also provide greater possibilities for production control, and their location close to consumers and cooperation with networks with rated voltage below 110 kV can significantly reduce the construction of costly high-voltage networks in the long term.

The idea of energy clusters, strongly promoted in recent months, has started to be put into practice. There are already several dozen such structures in Poland, with new ones joining every week. The models of functioning are different and so are the organizations forming them. Energy clusters have a chance to become an important element of Polish economy both on regional and national level, especially supporting development of less urbanized areas. Rural or urban-rural municipalities could become attractive areas for investment on condition that certain investments can be included in the energy cluster initiative.

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6. References

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