



Evolution of the definition of energy security and local component (clusters) in the theoretical perspective

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Abstract: Energy security is primarily associated with access to energy resources at an affordable price. Due to the increasing number of changes taking place in the environment, security should be perceived by states, entrepreneurs and local communities as a process that requires continuous cooperation of all its stakeholders in both the short and long term at the local, national and international level. It is therefore worth paying attention to energy clusters whose goal is to develop distributed energy, which serves to improve local energy security. In the face of the changing environment, local energy independence becomes more important. The initiative consists in generating, transmitting, storing and using energy locally. For this reason, the aim of the article is to answer the research questions: does today's view of energy security take into account the behavioral component? Do energy clusters, in terms of definition, take into account local actors, their interests, needs and opportunities? The article aims to verify the research hypothesis that energy clusters suggest the need to modify the definition of energy security taking into account the local component with its potential and social needs. The article can be a starting point for further analysis in the field of ensuring energy security at the local level.

Key words: energy security, energy clusters, behavioral component, local component, Poland

Introduction

Energy security is a concept that has been given many definitional approaches in the scientific literature, the most common of which is the one that indicates that it is access to energy resources at an affordable price (Yergin 2006). This concept is perceived in terms of the state of the economy or as a process consisting of dynamically changing conditions. Taking into account the increasing number of contemporary challenges arising from the environment that affect energy security, it is reasonable to perceive this concept as a dynamically changing process (Ruszel 2016). This means that the state will not ensure energy security once and for all, but must constantly pursue an active policy based on strategic planning in the area of energy to ensure energy security for its country (Garrison 1981). While the state is responsible for ensuring energy security, it should take into account local conditions in its strategy and the needs of increasingly aware societies that want to be co-responsible and strive to reduce the costs of electricity and heat. For this reason, the aim of the article is to answer the research questions: does today's view of energy security take into account the behavioral component? Do energy clusters, in terms of definition, take into account local actors, their interests, needs and opportunities? The article aims to verify the research hypothesis that energy clusters influence the need to modify the definition of energy security taking into account the local component with its potential and social needs.

1. Energy security. Theoretical background

Energy security should be ensured by the state, which is responsible for implementing energy policy aimed at guaranteeing the continuity of supplies of electricity, heat and fuels (Ruszel, 2016). Considering that in the area of energy, from a subjective perspective, the key role is played by the state that striving to pursue its political interests competes internationally, energy security is often perceived in terms of the theory of realism (Morgenthau, 1956). Perceiving them from the perspective of processes that are characteristic of the European Union (EU), one can see the theory of liberalism. The foundation of European integration is the freedom of movement of goods, services, people and capital. The liberalized common EU energy market through bilateral interconnections strengthens the possibilities of diversification of sources and directions of energy raw material supplies, becoming, in the opinion of some researchers, a pillar of security (Sencar, Pozeb, Krope 2014). A realistic approach in the political context and a liberal approach in relation to the economy may complement each other. Nevertheless, this requires respecting the regulations resulting from liberalization processes. Unfortunately, there are exceptions in the form of derogations from the principle of Third Party Access (TPA) to energy infrastructure, i.e. EU gas pipelines. This creates certain precedents in the energy market that increase the competitive advantage of one entity over another. Current external situation poses a large number of challenges and variables to the state's energy security. The war in Ukraine, which began in 2022, and growing threats in cyberspace increase the risk of interruptions in the supply of energy raw materials to end users. Political decisions taken at the EU level result in a shift away from Russian energy resources, and at the same time in increasing renewable energy sources, which will contribute to the diversification of countries' energy balances and ultimately reduce import dependence. This opens up opportunities for the rise of distributed generation, already developed in some countries, such as Denmark, based on renewable energy with the growing role of citizens who are involved in the process of co-creating energy security on a local scale. Taking into account the above aspects, the existing definition in the Polish energy law: "energy security is the state of economy enabling the coverage of the prospective demand of consumers for fuels and energy, in a technically and economically justified manner, while maintaining environmental protection requirements" needs updating (Energy Law 1997).

Already in 2003, the regional security complex was defined as a set of units where security cannot be analyzed as a separate element due to the aspect of securitization and desecuritization. Some of these processes can be transferred to the area of regional clusters. It is important to understand that each level should be analyzed as a characteristic and separate element, but also as functioning in relationship with other participants (Buzan and Wæver, 2003). Behavioral theory lists the observation and consideration of behavior in decision-making as key elements. The concept of Behavioral-Based Safety (BBS) in management terms means safety based on behavior or safety based on the observation of behavior. Taking into account social expectations and needs in creating local energy security is crucial. Proper assessment of both needs and opportunities allows us to indicate, on the one hand, key risk areas, and, on the other hand, opportunities for the investment success and benefits on a regional scale. This means that today the key challenge for the ruling elites responsible for the state's energy policy is understanding the social needs in the area of energy. On the one hand, the state is and will be the

guarantor of energy security. The costs of energy security must be shared with citizens. However, on the other hand, social contribution to building energy security should be tailored to the needs of the state and society in such a way as to reconcile interests that are not always consistent, as well as balance price and market aspects that cannot obscure the foundations of state security.

2. Energy clusters as a result of a certain evolution of the cluster concept

If we look at the history of the creation of clusters, the two names most frequently mentioned in the literature are Alfred Marshall and Michael E. Porter (industrial cluster theory). In Marshall's approach, clusters originate from the so-called concept of industrial districts. Business entities have a similar profile, which translates into benefits within the region. We were talking about network cooperation, an example of which was the metallurgical industry in Birmingham (Marshall 1890). Porter, on the other hand, introduced the concept of industrial clusters based on a geographical element, due to the concentration and interconnection of not only enterprises, but also suppliers, other units providing services, and interestingly, those that compete and those that cooperate with each other - i.e. connections in the production process and the value creation chain and the voluntary nature of the relationship. Attention was focused on geographical, institutional and even cultural proximity, which significantly increased the efficiency of enterprises included in the cluster (Porter 1998: 77). Porter also pointed out the essence of competitive advantage - the so-called state competitiveness diamond or Porter's diamond (Porter 1990: 78). Here, he drew attention to the factors determining competitive advantage: access to qualified labor, scientific resources, infrastructure, demand factors (specific demand for services and products), correlation or lack thereof among suppliers and conditions for creating, organization and management of enterprises. The indicated elements include a method of flexible and quick response to market needs, both in regional cooperation and competition (Mataczyńska 2020: 13). To sum up, what characterizes a cluster is a certain community, a certain concentration of entrepreneurs that cooperate with one another in certain areas, while competing with one another does not prevent cooperation in certain areas. This allows for flexibility in responding to the needs of the market in which entities operate (Mataczyńska 2020: 15).

An interesting starting point for analysis is Ph. Aydalot, who believed that innovations are related to the local environment. His research was followed by Groupe de Recherche Européen sur les Milieux Innovateurs, among others. GREMI has distinguished the concept of a local innovation environment based on informal relationships. The following aspects were identified as important elements: the geographical area (not only in administrative terms), all operating entities, material and intangible elements, and the element of learning, i.e. behavior modification. All these activities translate into risk reduction and, consequently, success. There appears a statement of relational capital, i.e. common norms, values, formal and informal rules of conduct. Therefore, a territorial, organizational and technological paradigm can be indicated (Olejniczak 2003: 60). This is not the only division, there are found many of them in the literature. Due to the criterion of territorial scope, local, national and international clusters are indicated. In terms of the criterion of the number of related sectors the following are mentioned: narrow and wide; in terms of the production chain: shallow clusters (several links) and deep (all

links); in terms of competitiveness: known in the world or in the country, having an average or weak position; also, based on creating work places: with increasing or decreasing employment and having technological significance, where high, medium and low-technological ones are indicated. The OECD distinguishes clusters based on knowledge or benefits of scale, dependent on a supplier or offering their own products. We can also mention the division of clusters into those geographically concentrated, emerging from related sectors and cooperating with the area of science, vertically integrated production chains in a given geographical area and clusters related to a sector or industry (Jacobs et al. 1996).

J. Stachowicz treats the cluster as a network enterprise in which a high level of social capital provides the opportunity to implement an effective development strategy. Therefore, a business goal appears, and the implementation of the project provides the opportunity for above-average competition. This happens because social capital is taken into account (Stachowicz 2006). It is therefore worth adding the so-called cluster attributes, i.e. geographical proximity, interactions and connections between horizontal and/or vertical entities and the presence of cooperation and competition (Żabińska 2010). Therefore, it was stated that a cluster is a cooperation of companies or their networks related to several functions that create a value chain. (Dagnino et al. 2002). We cannot forget about the complementary competences of cooperating entities (den Hertog et al. 2001).

In the case of the organizational structure of clusters, the following three types are worth pointing out. The first one is based on competition and trust, the second one is a hub and spoke based on the potential and strength of large corporations, but hierarchically related to small and medium-sized companies, and the third one is the so-called satellite, where we have a concentration of small and medium-sized companies, but dependent on other external companies (Knorringa et al. 1998). Additionally, we need to look at the Danish, Dutch and Italian models. In the Danish model, we have a coordinating dominant entity which facilitates contacts, identifies solutions, and advises. The Dutch model highlights the role of a scientific unit, the emphasis is made on innovation and technology. However, the Italian model does not have a formalized structure, but cooperative and family connections are important.

The concept of technology cluster and industrial cluster should be considered separately. In a technology cluster, as the name suggests, the essence is technology transfer (Porter 1998), while in an industrial cluster the attention is focused on creating connections with subcontractors, suppliers or competitors (Markusen, Yong-Spok, DiGiovanna 1999). Therefore, we can identify factors influencing the formation of a cluster, often called conditions, i.e. ideas (innovation or imitation), non-economic factors (relations, information channels, local roots) (Ryśnik 2008) and the role of the state in creating clusters (local authorities), and also the so-called location factor. We should not forget about the role of stakeholders and, consequently, the creation of corporate responsibility clusters (Zadek, Sabapathy, Dossing, Swift 2023). This should lead not only to economic success, which includes, among others, the idea, connections, knowledge and competences, but also the competitive advantage of clusters.

The Cluster White Book - International Organization for Knowledge Economy and Enterprise Development (Anderson, Schwaag Serger, Sorvik, Wise 2004) distinguishes 5 models of cluster policy. First, the brokerage one, concerns cooperation between enterprises and non-governmental organizations or public sector institutions in which the idea is to register competences in order to create a certain system. The second one is demand-oriented, the essence of

which is focusing on cluster participants in order to achieve greater market efficiency. Next one is learning-oriented - where the essence is to improve competences – is the implementation of new technologies, accumulation of knowledge and information. Finally, a model of promotion on an international scale to attract FDI taking into account such criteria as policy framework, e.g. the level of social capital.

There is also a definition of a cluster from the perspective of implementing a new model of the electricity market based on the functioning of the so-called microgrids. The definition of a microgrid includes clusters of facilities that have capabilities in the areas of generation, demand, technology and storage. Its essence is synchronous or island cooperation with the system related to balancing energy demand. The definition of a cluster, however, remains in the form of formal and legal cooperation between the structure participants (Mataczyńska 2017). Therefore, three distribution models can be distinguished: a cluster operating on the operator's network, a cluster based on a microgrid connected to the operator's network and a cluster operating within its own closed network (off-grid).

Looking at Poland and the legal regulations regarding the creation and operation of energy clusters, it is worth mentioning that the Ministry of Development and Technology issued a document in 2020 titled *Kierunki polityki klastrowej po 2020 r* (Directions of cluster policy after 2020). It is a summary of the studies by the Working Group on cluster policy at the Ministry of Development and Technology, established in February 2019. The document contains conclusions that should be taken into account in the creation of cluster policy after 2020 (Ministry of Development and Technology 2020). The following aspects were included:

- distance between the level of development of National Key Clusters (KKK) and the level of development of other clusters in Poland,
- low level of advancement of intra-cluster cooperation in the field of R&D,
- insufficient cooperation of cluster entities with R&D entities,
- clusters should be able to: perform professional management, be leaders in innovation and digital transformation,
- cluster policy at the regional and central level should be correlated with the European policy, because only such an approach could ensure the success of investments (Ministry of Development, Department of Innovation 2020).

It is worth emphasizing that the system for selecting National Key Clusters (KKK) consists of an assessment of five areas of cluster functioning: human, infrastructural and financial resources, economic potential of the cluster, creation and transfer of knowledge, activities for public policies, customer orientation. The mentioned areas are a kind of tool for assessing cluster development, as well as indicate the direction of development of the country's cluster policy and the priorities of our ministry (Ministry of Development and Technology 2021). At the beginning of February 2021, a strategic document for Poland's energy security was approved *Polityka Energetyczna Polski do 2040 r.* – PEP2040 (Polish Energy Policy until 2040 – PEP2040). It was supposed to be a pillar of the Polish energy transformation. However, the Polish Chamber of Commerce for Renewable and Distributed Energy - PIGEOR emphasized that the document does not contain key provisions for the development of energy clusters. It does not contain information what legal, systemic and supporting actions will be taken so that local energy initiatives can actually begin to develop dynamically and become a pillar of energy security at the local level. Omitting such an important issue significantly weakens the dynamism

of the development of this type of initiatives (Polish Chamber of Commerce for Renewable and Distributed Energy 2019).

In legal terms, the guidelines for the operation of energy clusters in Poland are set out in the RES Act. Until 2023, under this act, energy clusters had been guaranteed access to the distribution network. According to art. 38a section 3 of the Act, the operator of the electricity distribution system with which the cluster intends to cooperate is obliged to conclude an agreement for the provision of distribution services with its coordinator. Distribution services are listed in Art. 5 of the Act of April 10, 1997 - Energy Law (Journal of Laws of 1997, No. 54, item 348). However, art. 38a section 4 of the RES Act, states that the area of operation of an energy cluster is determined on the basis of the connection points of energy producers and consumers who are its members. On April 5, 2023, the Council of Ministers adopted a draft act amending the RES Act and certain other acts. It implements Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources into the Polish legal order. From January 2024, new provisions on the RES Act have entered into force, which affect the principles of operation of clusters. The principles of creating clusters, the role of the coordinator and the obligation to be registered by the President of the Energy Regulatory Office were indicated. The Act introduces an obligatory participant, i.e. local government units or companies that will be controlled by them. Additionally, the following elements were defined: rights and obligations of the parties, subject scope, energy cluster coordinator, area of activity with indication of energy consumption points and points of its access to the network by energy cluster members, duration of the agreement and rules for its termination, authorization of the energy cluster coordinator to access energy market information and measurement data regarding each member of the energy cluster (Journal of Laws 2023.1436). From 2025, the coordinator will be forced to submit reports on activities for a period of one year. The existing cluster members will be able to operate under the existing rules, but if they want to benefit from financial support in the new system, they will be forced to accept the new regulations. The register of energy clusters is to be kept in electronic form and placed in the Public Information Bulletin. The amendment to the RES Act announces changes to the rules of cooperation between the cluster coordinator and the distribution network operator; on July 2, 2024, the support mechanism for energy clusters suggested in addition to the Act articles 184k–184m shall be in force (Pajak 2024).

The European Union has been attaching great importance to the development of clusters for many years. The initiative began with launching of a working group called European Cluster Policy Group to evaluate cluster initiatives and assess support for the best clusters (EC 2008). Interestingly, EU documents also include such terms as renewable energy community (REC – Renewable Energy Community), introduced by the directive on support for energy from renewable sources (European Union 2018); citizen energy community (CEC - Citizens Energy Community), introduced by the Market Directive (European Union 2019); group consumers of electricity, introduced by the REDII directive. These solutions are described in detail in the publication *Klustry energii. Regulacje, teoria i praktyka* (Energy Clusters. Regulations, theory and practice) (Mataczyńska, Kucharska 2020). It should therefore be clarified that clusters and energy community are different concepts. The EU attaches importance to the development of energy communities, which are finally defined in the REDII and IEMD directives in the form of REC and CEC. It turned out that Polish energy clusters do not meet the requirements of these

directives. Therefore, in May 2023, in the justification to the published draft act amending the Act on Renewable Energy Sources and certain other acts (form UC99), it was indicated that the energy cluster is not an implementation of the EU directive provisions. Therefore, energy clusters in terms of Polish legislation do not have a direct equivalent in the European Union countries. However, it was found that they fit into a specific direction of energy transformation. Additionally, they create a platform for cooperation at the local level between entities such as local government, entrepreneurs, research units and citizens. As a result, the Act of August 17, 2023 amending the Act on Renewable Energy Sources and certain other acts, published in the Journal of Laws on August 31, 2023, significantly supplemented the regulations on the operation of energy clusters (Journal of Laws 2023, item 1762).

Another example of an initiative addressed to cluster participants in the field of innovation policy are programs that financially support these investments, such as Europe INNOvA, Horizon 2020. Moreover, in the *Europe 2020* document, the European Union directly refers to cluster policy when talking about the development of the business environment. (European Commission 2010). In 2018, new directions for cluster policy were indicated (European Commission 2018).

The EU also documents the activities of clusters and their impact on regional development, employment, innovation and competitiveness. One such example is the European Cluster Observatory. It also uses the *mapping* method in its analyses. There is an assumption that the dynamics of interactions between entities and transfer depend on the size of the cluster, the level of its specialization and the so-called concentration of activities – specific sector or area. This is necessary to achieve critical mass in terms of specialization - specialized critical mass. It enables achieving positive spillover effects and creating connections, as well as evaluates clusters according to the number of stars, from 1-3 if the employment is not less than 1,000 people (European Cluster Observatory 2024).

To sum up the above considerations on the definition of clusters, it is worth recalling the position of the European Research Network (EMES) on the social economy. It emphasizes the importance of two elements: the social (i.e. grassroots) and economic ones (Defourny, Develtere 2006: 22–28). Clusters are a good example of such a solution. They are characterized by cooperation and giving up competition in favor of a competitive gap. Synergy allows them to achieve higher goals and guarantees support in crisis situations. Concentration of activities creates a competitive advantage, thus enabling energy independence. Cooperation on various levels, among others, reduces the risk of managing an entity increasing security on a local scale. This affects, for example, the costs associated with the chosen management strategy. Additionally, a network of connections on various levels of initiatives is established, such as infrastructure, cooperation with stakeholders (based on knowledge), local investments increasing the region's resilience to crisis situations. Therefore, security at the local level has cross-sectoral value. That is why, synergy at the local level with the assumptions of the energy security strategy at the national and international level remains crucial. This element cannot be omitted, because without the support of, for example, the legal or political environment, even the best concept will be only an idea and not an action with a positive effect.

According to the definition found in the document *Strategia rozwoju energetyki rozproszonej w Polsce do 2040 roku* (Strategy for the development of distributed energy in Poland until 2040), distributed energy means energy generation sources and energy storage

intended for local use, connected directly or indirectly (using household installations, industrial networks, etc.) to the distribution system (Ministry of Development and Technology 2022). Interestingly, the document notes at the very beginning that the national regulations lack a definition of distributed generation. It is emphasized that local and community energy has been indicated in the second pillar and is one of the elements of the long-term direction of Poland's energy transformation PEP 2040. The distributed energy development strategy of 2022 draws attention to the indispensable role of clusters in shaping distributed generation, which we cannot disagree with. After all, it is important to manage energy locally not only within households, but also to build cooperation relationships between the cluster and large consumers, which influences the correlation between demand and supply, the construction of micro-grids, direct lines, automation, etc. (Center for Research and Development 2022).

Summary and conclusions

Summing up, distributed energy organizes the environment at the regional level so that energy production should rely on local resources closest to residential areas. Low-emission sources are supported, new jobs are created, energy costs and prices decrease, and energy storage facilities are promoted. By utilizing local potential, distributed energy enhances regional energy security. This strategy is common to both energy clusters and decentralized energy. However, it wouldn't be possible without behavioral aspects, the role of local governments in creating conditions for energy communities, consistent state policies at national and local levels (legislation, streamlined procedures), social education (including social dialogue and responsibility), and R&D efforts (technological innovations and new business models). Previous approaches to defining energy security overlooked essential behavioral elements. Viewing the energy sector through the lens of interests, competition, power, and state roles aligns with a realist perspective, while understanding market mechanisms and regulatory instruments from EU laws reflects a liberal approach. However, as the energy security landscape evolves, social awareness grows each year, and citizens expect more than passive observation of political processes. The indirect social role in wielding power through participation in political elections partially satisfies societal needs. The significant interest in photovoltaic energy confirms citizens' desire to contribute to national energy security. Consequently, addressing the first research question, today's perspective on energy security should encompass social aspects. Regarding the second research question, it's essential to note that energy clusters have primarily focused on the electricity sector in their development. Contemporary challenges indicate ongoing energy transformation processes, including decarbonizing heating and electrification. Similar trends occur in the transportation sector, where discussions involve new fuels, including electricity and hydrogen. Consequently, the current definition of energy clusters doesn't account for all actors, their interests and needs. Positively, this verifies the research hypothesis that energy clusters influence the need to modify energy security in order to include local components and their requirements. Effective collaboration based on geographic proximity criteria can lead to above-average competitive advantages, not only in energy production and local energy storage but also in servicing local energy infrastructure and investments. The participation of local government entities and citizens will not only reduce investment risk but also foster

civic actions that enhance understanding of security aspects—an essential consideration in times marked by increasing physical and cyber security challenges.

Taking into account the above scientific discussion and the conclusions obtained as a result of the research analysis, the authors suggest the following form of the energy definition: Energy security is a process consisting of dynamically changing states of the economy that are able to cover current and future energy demand in a continuous, reliable, effective, diversified and environmentally sustainable manner, so as to increase the security of the state and the competitiveness of the economy, taking into account its geoeconomic interests, geopolitical and local conditions, as well as social needs. Further scientific and expert research is necessary to develop not only a definition, but a model of energy security that considers behavioral aspects, the needs of the local community and the role of energy clusters.

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