ENERGY CLUSTER – AN ATTEMPT IN CHARACTERISATION AND DEFINITION

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Summary
Clusters are an organisational and economic phenomenon. This paper attempts to answer what an energy cluster actually is and whether it meets the requirements of a cluster in the classical approach of economic sciences.

The Act of 20 February 2015 on renewable energy sources (Ustawa OZE 2015) introduced the concept of an ‘energy cluster’. It was aimed at, among others, increasing energy security and environmental protection through an efficient use of renewable energy sources. In the literature on the subject, there is no single universally applicable definition of a cluster, it can only be considered in its various aspects. The concept of a cluster has so many applications, associations and meanings that in many respects it has become a ‘chaotic idea’ due to flattening and equalising different types, processes and spatial scales of economic location within one universal concept. However, the main doubt concerns the very definition of a cluster.

The paper considers the organisational attributes of clusters, based on the analysis of the following aspects:

a) Cluster in historical terms. Overview of cluster and network definitions:
   i. Overview of cluster definitions
   ii. Overview of network structure definitions

b) Energy cluster. Forms of interorganisational relations and the typology of energy clusters
   i. Forms of interorganisational relations in an energy cluster
   ii. Energy cluster against in relation to organisational network typology
   iii. Energy cluster as a form of company network – common features and differences

c) An attempt in characterisation and definition of an energy cluster

Keywords
energy cluster • network structure • cooperation • business alliance

1. Introduction

Clusters are an organisational and economic phenomenon and, as J. Kaźmierski has noted, their functioning has already been observed in many countries around the world [Kaźmierski 2012, p. 9]. They are created in virtually all sectors of the economy, such as industry, services, high-tech.
This paper attempts to answer what an energy cluster actually is and whether it meets the requirements of a cluster in the classical approach of economic sciences. The Act of 20 February 2015 on renewable energy sources [Ustawa OZE 2015] introduced the concept of an ‘energy cluster’ as a civil law agreement, which may include natural persons, legal persons, scientific units, research institutes or local government units, regarding the generation and balancing of demand, distribution or trading of energy from renewable energy sources or from other sources or fuels, within a distribution network with a rated voltage lower than 110 kV, in the area of operation of this cluster not exceeding the boundaries of one powiat within the meaning of the Act of 5 June 1998 on powiat self-government (Dz.U. 2016 poz. 814) or 5 municipalities within the meaning of the Act of 8 March 1990 on municipal self-government (Dz.U. 2016 poz. 814); the energy cluster is represented by a coordinator who is a cooperative, association, foundation or any member of the energy cluster designated in the civil law agreement, hereinafter referred to as the ‘energy cluster coordinator’.

According to M.E. Porter’s definition, a cluster is a geographical concentration of interconnected enterprises, specialized suppliers, service providers, enterprises operating in related sectors and associated institutions in particular fields, competing with each other, but also cooperating [Porter 1998, p. 200, Porter 2000, p. 15–34, Pilarska 2013, p. 19].

The analysis of the literature on the subject allows to conclude that a cluster is a kind of network with five permanent distinctive features, which must occur simultaneously [Skawińska and Zalewski 2009, p. 173, Barczak 2016, p. 195]:

- spatial concentration of entities competing with each other in a region,
- concentration of companies within one or several similar sectors,
- informal and formal cooperation of enterprises, local institutions and organizations of a horizontal and vertical nature,
- specialization of entities in a cluster,
- flow of knowledge, technology and innovation between entities of a cluster.

Additional features:
- involvement of entities representing enterprises, research organizations and administration,
- high level of interaction between the entities involved,
- network openness and durable nature,
- rather well-defined network boundaries,
- coopetition as the dominant nature of the relationship,
- achieving external benefits as a whole and benefits for individual cluster members,
- formalized cooperation of entities,
- designated entity acting as a coordinator,
- openness to cooperation, for example with academia.
In the above list of features, a term ‘coopetition’ appears meaning a type of relationship between competitors that simultaneously compete and cooperate with each other [Cygler 2007, p. 61, Skawińska and Zalewski 2009, p. 171]. So, if there is no mention of competition in the definition in the act on renewable energy sources, the question remains: what is an energy cluster? In search of an answer to this question, the desk research method was applied, based on the study of source documentation and information contained in foreign and Polish scientific publications.

2. Cluster in historical terms. Overview of cluster and network definitions

According to E. Skawińska and R.I. Zalewski [Skawińska and Zalewski 2009, p. 19–21], the oldest example of a cluster described in the literature comes from the period 4000–3500 BC in the area of today’s southern Iraq. In this area, there were special spheres for strictly defined types of crafts and specialized markets, with developed legal rules, management methods, production and exchange of goods and services. It is believed that the theoretical roots of the conception of cluster can be traced back to the 18th century in the works of the father of modern economics, Adam Smith. According to Smith, the choice of one industry as the dominant industry in a given country allowed to increase the amount of produced goods. It is believed that the first to use the term ‘industrial districts’, which is often interchangeably applied with the word ‘cluster’, was William E. Hearn, in whose name the term appears as early as 1863. On the other hand, Alfred Marshall is said to be the founder of the theory of clusters. In his work, the *Principles of Economics*, published in 1890, he stressed the importance of the benefits that can be achieved thanks to the ‘concentration of many small companies of a similar nature in one town, in other words, thanks to the industry location’ [Marshall 1925, p. 258, Pilarska 2013, p. 10].

The notion of the industrial district as a socially, economically and territorially separated unit, characterized by the active presence of both the community and specialized companies operating in naturally and historically limited areas, gained a ‘new life’ later, when economists became interested in the path of industrial development pursued in certain regions of Italy known as ‘third Italy’. This region went through a rapid development in the 1970s, especially its small and medium industrial companies, and was related primarily to the strong concentration of these companies in specific sectors and locations. The main features of these districts were determined, such as: geographical proximity, sector specialization, domination (advantage) of small and medium-sized enterprises, close cooperation, but also competition between companies, striving for innovation, socio-cultural identity (uniformity) in favour of building trust, active support authorities at both local and regional level [Becattini 1991, p. 86, Hamphrey and Schmitz 1995, p. 2–3, Bellandi 2007, p. 7, Pilarska 2013, p. 14–16].

In conclusion, geographic, specialized clusters of related economic entities have functioned in the economy for centuries, but only since the M.E. Porter’s work in 1990 (*The Competitive Advantage of Nations*) the term ‘clusters’ became popular [Skawińska and Zalewski 2009, p. 19].
'There is no single universally applicable definition of a cluster... it is only considered in its various aspects' in the literature on the subject [Jacobs and de Man 1996, p. 425]. This is very well described by R. Martin and P. Sunley, who claim that ‘(...) the notion of a cluster has so many applications, associations and meanings that in many respects it has become a «chaotic idea» due to flattening and equalizing different types, processes and spatial scales of economic location within one universal concept', however, ‘(...) the main doubt concerns the very definition of a cluster’ [Lis and Lis 2014, p. 21, Martin and Sunley 2003, p. 10]. The above statements are illustrated by the cluster definitions presented in Table 1.

Table 1. Overview of cluster definitions

| No. | Year       | Author                  | Network definition                                                                                                                                 |
|-----|------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 1992 / 1996| M. Enright              | A set of related enterprises, representing the same or a similar industry or service sector, located in the same area (geographical proximity). Concentration of economic entities in a close proximity |
| 2   | 1995       | R. Rabelotti            | A grouping of spatially concentrated and enterprises specialised to a sector (mainly small and medium-sized) with links based on market and non-market exchanges of goods, information and labour, which are connected by a common culture and social origin (translated into a specific code of behaviour), supported by a network of public and private local institutions |
| 3   | 1996       | C. DeBresson            | Innovative clusters are not a mere concentration of independent business entities, but networks of interconnected, cooperating enterprises at an industry level |
| 4   | 1996 / 1998| P. Swann, M. Prevezer  | Groups of enterprises that work together within one sector in a specific geographic area. Clusters are defined as groups of companies within one industry sector located in one geographic area. A cluster means a large group of companies from related sectors in a specific location |
| 5   | 1996 / 1997| S. Rosenfeld            | Geographically concentrated, similar, related or complementary enterprises with active channels for business transactions, communication and dialogue, having access to specialised infrastructure, labour market and services, facing the same opportunities and threats. It is a system of which membership is based on mutual dependence and contribution to the functioning of this system. Clusters of companies which have the opportunity to create synergy effects through geographical proximity and close cooperation, regardless of the scale of employment |
| 6   | 1997       | B.A. Lundvall, S. Borras | The region where innovations are delivered by regional networks of innovative entities and local clusters as a result of cooperation with research institutions will be at a higher level of development |
| 7   | 1998       | E.J. Feser              | Clusters are not so much related and cooperating entities, but rather related and supporting institutions that gain a competitive advantage through a network of connections |
| No. | Year | Author(s) | Description |
|-----|------|-----------|-------------|
| 8   | 1998 | T. Padmore, H. Gibson | Concentration of enterprises in a definite area, whose economic success is determined by their interactions and facilitated by geographical proximity |
| 9   | 1998 / 2001 | M.E. Porter | Geographical cluster of interconnected companies, specialized suppliers, service providers, companies operating in related sectors and related institutions in particular fields, competing with each other, but also cooperating. A group of enterprises and cooperating institutions related to and complementing each other. A cluster is a group of geographically closely interrelated companies and related institutions in a given field, connected by similarities and complementarity |
| 10  | 1998 | P. Swann, M. Prevezer | A large group of companies from similar sectors concentrated in one geographical area and cooperating with each other |
| 11  | 1999 | J. Simmie, J. Sennert | Highly related enterprises and/or service sector companies cooperating within the supply chain and respecting the same market principles |
| 12  | 1999 | T. Roelandt, P. den Hertog | Supplier networks and closely connected companies that create added value within a supply chain |
| 13  | 1999 | I.W. Munnich | The cluster is first of all a strategy of economic development which ensures economic growth in a coordinated and effective manner |
| 14  | 1999 | UNIDO | Sectoral and geographic concentration of companies that produce and sell a range of related and complementary products, therefore facing common challenges and opportunities |
| 15  | 2001 | C. Crouch, H. Farrell | The tendency of locating enterprises in close proximity to enterprises with a similar business profile, despite being previously absent in a given area |
| 16  | 2001 | L. van den Berg, E. Braun, W. van Winden | In most definitions, clusters are defined as localized networks of specialized entities, which are closely related to each other in the production process through the exchange of goods, services and/or knowledge |
| 17  | 2002 | P. Cooke | Companies cooperate and compete with each other within a specific market segment, use common local infrastructure and identify with the same vision of industry and region development form a geographical cluster with horizontal and vertical links. |
| 18  | 2002 | B. Asheim, A. Isaksen | The strength of the arguments in favour of regionalisation stems from the fact that regional level of operations and specific local and regional resources are still important for companies, especially when they make efforts to become competitive on the global market (...). Companies in clusters, when searching for innovations, rely on unique regional and local resources and mutual cooperation |
| 19  | 2002 | T. Brodzicki, S. Szultka | A spatially concentrated cluster of enterprises simultaneously competing and cooperating with each other in certain aspects as well as institutions and organizations, connected by a system of mutual relations of formal and informal nature, based on a specific development trajectory (e.g. technology, sales markets) |
| No. | Year | Author | Network definition |
|-----|------|--------|--------------------|
| 20  | 2002 | C. Steinle, H. Schiele | Clusters are treated as localized sector agglomerations of symbiotic organisations that can achieve better business results through interactions (club-like) |
| 21  | 2003 | European Commission | Clusters are groups of independent enterprises and related institutions which: cooperate and compete; are geographically concentrated in one or more regions, although a cluster may even be global in scope; specialize in a specific field, are connected by common technologies and skills; include modern (science-based) or traditional industries; can be institutionalised (by a coordinator) or non-institutionalised. The way of organising a production system and a territory in which enterprises operate, characteristic for entities and other organisations that are geographically concentrated and specialize in the same fields, develop mutual market and non-market relations and contribute to the innovation and competitiveness of their members |
| 22  | 2003 | M.P.V. van Dijk, Á. Sverrisson | Clusters are relatively dense networks of companies and organisations whose value chains are interconnected, but not necessarily by what we usually mean by economic transactions |
| 23  | 2004 | P. Morosini | Socio-economic unit characterised by a social community and a set of economic entities located in close proximity, in a particular geographic region |
| 24  | 2004 | OECD | Concentration in a given area of related (vertically and / or horizontally) enterprises operating in the same sector (industry or services) together with related institutions |
| 25  | 2005 | P. Masell, L. Kebir | Clusters can be defined as non-random geographical agglomerations of companies with similar or closely complementary production capacities |
| 26  | 2005 | Statistics Poland (GUS) | Networks of related enterprises, their suppliers and customers, scientific and educational institutions, special government agencies and so-called bridging institutions that provide technical and consulting services, as well as financial and insurance institutions |
| 27  | 2005 | PARP | Spatial concentration of enterprises, institutions, organisations interconnected by an extensive network of formal and informal relations, based on a common development trajectory (e.g. technological, common target markets, marketing strategy, etc.), simultaneously competing and cooperating in certain aspects of operation |
| 28  | 2006 | Ch. Pitelis, R. Sugden, J.R. Wilson | A cluster is a concentration of companies with a specific type of activity, usually located in one geographic dimension, horizontally and (preferably) vertically related and characterised by a connection between sectors (in the context of object-institutional setting) that cooperate or compete on the local or international market |
| No. | Year | Source | Definition |
|-----|------|--------|------------|
| 29  | 2006 | Ministry of Economy | Spatial and sectoral concentration of entities operating for the benefit of economic development or entrepreneurship, and at least ten entrepreneurs conducting business activity in one or more neighbouring voivodeships, competing and cooperating in the same or related industries, and connected with an extensive network of formal and informal relations, whereby the entrepreneurs constitute at least half of the entities operating within the cluster. |
| 30  | 2009 | Ö. Söllvell | Clusters are companies dealing not only with the flow of goods and services, but also focused on creating knowledge, increasing profits and innovation in the broad sense. |
| 31  | 2009 | M. Gorynia, B. Jankowska | The group of enterprises and other entities (associations, chambers of commerce and industry, scientific institutions, etc.) operating in close proximity, is characterized by an above-average intensity of various links and relationships, and these relations to a large extent go beyond typical market relationships (confrontational, competitive). There are advantages of shared location and cooperation within this group of companies (external economies of scale, synergy effect, positive externalities, diffusion effect, etc.). The cluster is ‘an island of cooperation in the assessment of competition.’ |
| 32  | 2010 | A.M. Kowalski | An innovative tool to support cooperation between individual entities in innovative processes, in particular R&D units, enterprises using the results of their works and business environment institutions supporting the commercialisation of technologies. |
| 33  | 2013 | L. Knop | A group of entities coming from various environments: business, science, local government and civil society, consciously operating in a specific ecosystem, focused on a specific territory and/or around an established specialisation. |
| 34  | 2014 | A.M. Lis, A. Lis | Sectoral and geographical concentration of enterprises linked by trade and non-trade dependencies within a community of values and goals that binds them to some extent, while cooperating and competing using the synergy effect. |
| 35  | 2014 | CLOE | Groups of interconnected industries, small and medium-sized enterprises (SMEs) and organisations that increase their competitiveness by interacting with each other. They can be customers, suppliers, researchers, partners or rivals, concentrated in certain geographic regions. |
| 36  | 2016 | PARP | Geographical cluster of independent entities representing a specific economic specialisation, cooperating and competing with each other within the value chain. Cooperation within the cluster is formalised, it is implemented both vertically and horizontally, and is aimed at achieving the assumed common goals. The cluster is a source of benefits and creates new value for all types of entities participating in it, such as enterprises, universities and other scientific units, business environment institutions, public administration and other supporting organisations. |
A cluster is a geographical concentration of specialised entities, interconnected by mutual interactions, operating in related or complementary industries, at the same time cooperating and competing with each other, including, in particular: enterprises, research organisations, business environment institutions, public entities. It is a specific form of production organisation, consisting in the concentration of flexible enterprises running complementary economic activities in a close proximity. These entities simultaneously cooperate and compete with each other, they also have relations with other institutions operating in a given field. The basis for the creation of the cluster are cooperative relations between entities, generating the processes of creating specific knowledge and increasing adaptability.

Source: Author's study based on: Kaźmierski [2012], p. 68; Martin and Sunley [2003]; Rosenfeld [1996], p. 7; Rosenfeld [1997], p. 4, 7; Porter [2000], p. 16; Porter [2001], p. 246; Porter [1998], p. 200; Cegle and Dini [2015]; ETCoI [2015]; Morosini [2004], p. 307; Matusiak [2005], p. 81; Ministerstwo Gospodarki, Dz.U. 06.226.1651, 2006; Gorynia and Jankowska [2009], pp. 274–275; Kowalski [2010]; Lis and Lis [2014], p. 81; Knop [2013], p. 33; Söllvell [2009], p. 15; CLOE [2014]; Pilelsi et al. [2006], p. 20; Munnich [1999], p. 10; Feer [1998], p. 26; Van Dijk and Sverrisson [2003], p. 185; Gorynia and Jankowska [2008], p. 100; OECD [2004], pp. 5, 20; EU [2003], pp. 9, 16; Enright [1996], p. 191; Swann and Prevezer [1996], pp. 1, 139; Padmore and Gibson [1998], p. 57; Rabelotti [1995], p. 30; Cooke [2002], Gorynia and Jankowska [2008], p. 35; Maskell and Kebir [2014], p. 1; DeBresson [1996], p. 161; Steinle and Schiele [2002], p. 850; Lundvall and Borras [1997], p. 39; Swann and Prevezer [1998], p. 1; Roelandt and den Hertog [1999], p. 9; Simmee and Sennett [1999], p. 51; Crouch and Farrell [2001], p. 163; Van den Berget et al. [2001], p. 187; Asherm and Isaksen [2002], p. 4; Maskell and Kebir [2005], p. 1; UNIDO [2001], p. 9; Brodzicki and Szultka [2002], p. 46; Gorynia and Jankowska [2007], p. 319; GUS [2005], p. 132; Ministerstwo Gospodarki [2008]; PARP [2017]; PARP [2017a]; Holub-Iwan and Wielec [2014], p. 9; Drelisch-Skulska et al. [2014], p. 24–25; Kazojć [2016], pp. 59–61; Pilarska [2013], pp. 20–24; Lis and Lis [2014].

Thus, there is no doubt that we lack a clear definition of a cluster. According to B. Glävan, ‘the definitional flexibility of the cluster concept completely prevents its operationalisation, making it an ideal tool for politicians’ [Glävan 2008, p. 52; Lis and Lis 2014, p. 39). In the light of the conducted analysis, it seems justified to extend the considerations to business networks.

As already pointed out by G. Becattini [Becattini et al. 2009], Italian industrial districts have evolved towards local integrated manufacturing networks (filière) and thus into broader structures that can be described as cluster-type structures. Despite many common elements, such as spatial concentration, the proximity of entities or the existence of mutual competition and cooperation, they differed from industrial districts basically in that they are more flexible [McDonald and Belussi 2002, p. 15]. Nowadays, they are not limited only to traditional branches of the economy, but are often targeted at sectors that are the carriers of modernity, in which innovative processes take place [Pilarska 2013, pp. 17–18]. Thus, the cluster cooperation models and industrial districts form the basis for considering business networks [Barczak 2016, p. 23; Rosińska 2005a, p. 372]. The network approach is used in such areas of research and practice as: strategic management (relations of competition, cooperation and coopetition), logistics.
management (supply and distribution chains), entrepreneurship, knowledge and innovation management or relationship marketing [Barczak 2016, p. 23; Gancarczyk 2012, p. 61).

In papers devoted to network research, there are various definitions of this notion. Common phrases include network organisations [Phillips 2010, p. 533 et seq.; Higgins and Maciariello 2004, p. 203 et seq.), interorganisational network (see e.g.) [Baker and Faulkner 2002, p. 520), and network structure [Mukherjee 2009, p. 23; Sproull and Kiesler 1992, p. 132 et seq.), ‘network company’ or just ‘networks’ [Barczak 2016, p. 53]. There are many definitions of network structures due to the different forms of relationships between network participants. The most important of them, taking into account the essence of clusters, are presented in Table 2.

Table 2. Overview of network structure definitions

| No. | Year | Author | Network definition |
|-----|------|--------|--------------------|
| 1   | 1986 | H.B. Thorelli | A network is a set of two or more organisations committed to a long-term relationship |
| 2   | 1998 | P. Drucker | A network of institutions (or their parts), companies, teams and people located in different places, organised into loosely connected and non-transparent structures, which share a common goal – working (providing services or selling products) for the same customer |
| 3   | 1998 | P. Dwojacki, B. Nogalski | The network as a relatively permanent grouping of autonomous, specialised units and enterprises participating in a system of mutual cooperation according to market principles |
| 4   | 1999 | J. Sydow | An organised, polycentric form of economic activity, often strategically directed by one or several enterprises, seeking to achieve a competitive advantage. It is expressed in relatively stable, cooperative rather than competitive relations between legally independent, but economically at least interdependent enterprises |
|     | 2001 | Strategor | The basic components of the network are the so-called Nodes and connections between them, which – translating into practice – means linking elements of various organisations and institutions into various network combinations (depending on the needs), and their number and nature are determined by the number and type of relations between the nodes. The relations between the components of the network can be multilateral and have a different character: bureaucratic – orders, applicable standards, procedures; economic material and financial transactions; operational – joint action, collective decision making, use of the same resources; cultural – sharing values, community of opportunities and threats; informative availability of information sources, exchange and sharing of information |
| 5   | 2002 | M.J. Hatch | An organization where hierarchical coordination has been replaced by horizontal relations, formal relations between organisational units have been changed to links between partners, which are different organisations, and assets are divided so that the producer of the finite whole is not any single organisation of the network, but the network as a whole |
### Table 1. cont.

| No. | Year | Author | Network definition |
|-----|------|--------|--------------------|
| 7   | 2004 | D. Delporte-Vermeiren, P. Vervest, F. van Heck | The interorganisational network in business can be a set of relations between the so-called focusing actor and external actors dependent on them, working together on the implementation of a specific service for the client |
| 8   | 2005 | K. Łobos | An interorganisational network (network organisation) is ‘a set of more than two independent organizations that are linked with the following characteristics: – decisions on resources are made not only integrally by the parties to the transaction (as is the case in the market), but also collectively by cooperating parties; – the flow of resources between the cooperating partners is repetitive, not ad hoc; – the mutual expectations of the cooperating partners cover a further horizon; – the information available to the cooperating parties is much more extensive than in the case of market coordination; – the form of coordination between the cooperating parties is negotiation, and not competition’ |
| 9   | 2005 | K. Perechuda | A set of legally independent business units implementing various undertakings and projects coordinated by the integrator’s company, which has distinctive (key, basic) competences |
| 10  | 2010 | Z. Olesiński | A system of various groups of organizations, the elements of which are: enterprises, local government units, state government institutions (they ensure the implementation of the policy of supporting banks and other financial institutions needed to finance the operations of enterprises, business support organisations and research and development institutions) |
| 11  | 2012 | J. Niemczyk, E. Stańczyk-Hugiet, B. Jasiński | Two concepts of networks: 1) structures describing a specific form of operation (cooperation) of private and or public entities, 2) forms being a new structure created by the mentioned entities, which pursue a common goal |

Source: Author’s study based on: Thorelli [1986], p. 37; Drucker [1998]; Dwojacki and Nogalski [1998], p. 69; Sydow [1999], p. 103; Strategor [2001]; Hatch [2002], p. 195; Delporte-Vermeiren et al. [2004]; Łobos [2005], p. 167; Perechuda [2005]; Olesiński [2010], p. 66; Niemczyk et al. [2012], p. 9; Barczak [2016], p. 54–58.

Taking into account the above list, the main distinctive features of a network structure are [Barczak 2016, p. 59, Niemczyk et al. 2012, p. 10]:

- Multilateral relations between network components,
- Diversified nature of network relations (bureaucratic, economic, cultural, information),
- Shared use of resources by network participants,
- Repetitive nature of resource flows between partners,
- Market-based coordination mechanisms,
- Negotiations and agreements as a form of coordination of activities between cooperating parties,
- Striving for cooperation,
Autonomy of the units (with a significant scope of coopetition),
• Long-term (strategic) nature of cooperation between network participants,
• Increasing the potential of knowledge and innovation,
• A shared value system,
• Low level of horizontal integration and hierarchy,
• Flexibility,
• Benefits of cooperation (synergy effect).

It can be noticed that in the case of network structures, there is also coopetition, as a special type of relationship between partners with a simultaneous relationship of competition and cooperation. At the same time, however, as in the case of clusters, the concept of networks is still not a fully explored and structured concept. Therefore, it is important to indicate the key attributes of interorganizational relations in the network and to classify them so that relations in the energy cluster can be defined.

3. Energy cluster. Forms of interorganisational relations and the typology of energy clusters

The following is an attempt to develop forms of interorganisational relations in an energy cluster against the background of their various characteristics presented in the literature.

The literature on the subject presents a variety of typologies of organisational networks. Table 4 shows an attempt to develop an energy cluster type against their background.

On the basis of the presented analysis, it can be concluded that an energy cluster bases its activity on cooperative relations. There cannot be any competitive relations when a subject of cooperation is taken into account. At this point, it is necessary to return to the definition of coopetition, in terms of the dependencies occurring between entities in the energy cluster, understood as a ‘dyadic and paradoxical relationship between two companies that cooperate within the same operations, and compete within other activities’ [Bengtsson and Kock 1999; Wiśniewska and Janasz 2015, p. 184). The common features and differences between the networks of companies, classic cluster and energy cluster are presented in Table 5.
Table 3. Forms of interorganisational relations in an energy cluster

| No. | Forms of interorganisational relations | Description | Forms of interorganisational relations in an energy cluster |
|-----|----------------------------------------|-------------|----------------------------------------------------------|
| 1   | Relations based on the subject of cooperation |                          |                                                         |
|     | Collaboration in the same operations     | through link, e.g. producer – producer |                                                         |
|     | Collaboration between different operations | through links, e.g. manufacturer – supplier | Cooperation in the implementation of a specific project - through links independent of the type of basic operations |
|     | Cooperation in the implementation of a specific project | through links independent of the type of operations |                                                         |
| 2   | Relations by type of interaction         |                          |                                                         |
|     | Cooperation                             | cooperation of entities | Cooperation of entities                                   |
|     | Coordination                             | organising activities carried out by many entities | Coordination – organising activities carried out by many entities (coordinator role) |
|     | Control                                 | entities supervision |                                                         |
|     | Conflict                                 | conflict of interests of entities |                                                         |
|     | Competition                              | competition of entities |                                                         |
|     | Coopetition                              | simultaneous cooperation and competition | Coopetition – cooperation within the same activities, and competition within the boundaries of other activities |
|     | Co-production                            | joint ventures carried out by entities | Co-production – joint ventures carried out by entities |


### Table 3. Forms of interorganisational relations in an energy cluster

| No. | Forms of interorganisational relations | Description |
|-----|----------------------------------------|-------------|
| 1   | Relations based on the subject of cooperation | Cooperation in the same operations through link, e.g. producer – producer or cooperation in the implementation of a specific project through links independent of the type of basic operations or collaboration between different operations through links, e.g. manufacturer – supplier or cooperation in the implementation of a specific project through links independent of the type of operations |
| 2   | Relations by type of interaction | Cooperation of entities or coordination – organising activities carried out by many entities (coordinator role) or control of entities or conflict of interests of entities or competition of entities or coopetition – cooperation within the same activities, and competition within the boundaries of other activities |
| 3   | Relations due to the distribution of power | the entities are linked by close cooperation with one of them having more power (coordinator) or the entities are linked by loose cooperation with one of them having more power (coordinator) or the entities are connected by a close relationship in which they are closely dependent |
| 4   | Relations in regard to the nature of the relationship | through the customer-supplier relations: vertical backward relations (with suppliers) or vertical frontal relations (with buyers) or direct horizontal relations (with industry actors) or indirect horizontal relations (with actors from outside the industry) or through ownership of the companies participating in the network by other board appointments by the owners of the parent company, etc. or direct horizontal market relations (with industry actors) |
| 5   | Relations due to voluntary participation | Relations with the consent of the participating parties or forced relations or relations with the consent of the participating parties or regional relations: proximity to company headquarters, common area of operations |
Table 3. cont.

| No. | Forms of interorganisational relations | Description | Forms of interorganisational relations in an energy cluster |
|-----|----------------------------------------|-------------|-------------------------------------------------------------|
| 6   | Relations based on the degree of cooperation
|    | Hostile relationship                    | organisations are ruthlessly fighting each other with all available means; the impact of conflict is destructive not only on the warring organizations, but also on their environment |
|    | Competitive relationship                | confrontation generally proceeds according to a specific legal course, can have a positive impact on the environment (increasing the level of functioning of the organisation); a conflict leading to destruction can be turned into a competitive conflict |
|    | Neutral relationship                    | in this case, the relationship between the organisations is irrelevant, the transmission of information is sporadic and does not cause any reaction in the recipient; it does not generate synergy |
|    | Friendly relationship                   | is characterised by a certain cooperation, although it is of an individual nature; generates synergy |
|    | Partnership relationship                | mutual contacts are intense, even familial, there are strong formal and informal connections; generates synergy |
|    | Cluster-type relationship               | organisations form a certain compact whole with strong and deep formal and informal links, generating strong synergy |
### Relations based on the degree of cooperation

| Form of interorganisational relation | Description |
|--------------------------------------|-------------|
| Hostile relationship                  | Organisations are ruthlessly fighting each other with all available means; the impact of conflict is destructive not only on the warring organisations, but also on their environment. |
| Competitive relationship              | Confrontation generally proceeds according to a specific legal course, can have a positive impact on the environment (increasing the level of functioning of the organisation); a conflict leading to destruction can be turned into a competitive conflict. |
| Neutral relationship                  | In this case, the relationship between the organisations is irrelevant, the transmission of information is sporadic and does not cause any reaction in the recipient; it does not generate synergy. |
| Friendly relationship                 | Is characterised by a certain cooperation, although it is of an individual nature; generates synergy. |
| Partnership relationship              | Mutual contacts are intense, even familial, there are strong formal and informal connections; generates synergy. |
| Cluster-type relationship             | Organisations form a certain compact whole with strong and deep formal and informal links, generating strong synergy. |

### Relations based on the direction of cooperation

| Form of cooperation | Description |
|---------------------|-------------|
| Vertical cooperation| So-called vertical cooperation - cooperation within the production chain, e.g. on the supplier-manufacturer or manufacturer-distributor line. |
| Horizontal cooperation| So-called horizontal cooperation – cooperation between units with a similar business profile, e.g. through mergers. It includes cooperation between companies operating in similar market segments (both product and geographical) and can lead to a creation of cluster structures. |

### Relations according to the complexity of establishing transactions, the possibility of codifying transactions and the involvement of suppliers in transactions

| Type of relation                | Description |
|--------------------------------|-------------|
| Market relations                |             |
| Modular relations               |             |
| Collaborative relationships     |             |
| Serf relationships (slave)      |             |
| Hierarchical relationships      |             |

### Relations according to the source of the relation

| Source of the relation | Description |
|------------------------|-------------|
| Internal relational resources | Resources used to create internal knowledge (general knowledge absorption capacity, general competences). |
|                         | Resources used to shape external relational resources (general competences, customer relations management skills). |
| External relational resources | Relational resources located outside the company (company image and reputation, trust). |
|                         | Resources used to shape external relational resources (general competences, customer relations management skills). |
| No. | Forms of interorganisational relations | Description | Forms of interorganisational relations in an energy cluster |
|-----|---------------------------------------|-------------|----------------------------------------------------------|
|     | Relations according to the directions of relations | From strategic centre to peripheral relations | From strategic centre to peripheral relations |
|     | From horizontal to vertical relations | **From horizontal to vertical relations** | |
|     | From complementary relations to competitive relations | From complementary relations to competitive relations | |
|     | From narrow relations to broad relations | From narrow relations to broad relations | |
|     | From complex (network) relations to simple relations (between two entities) | From complex (network) relations to simple relations (between two entities) | |
|     | From dominant relations according to the content of the relation and its type to subordinate relations | From dominant relations according to the content of the relation and its type to subordinate relations | |
|     | From relations that have little impact on the added value of a strategic centre to relations that have a significant impact on the added value of a strategic centre | From relations that have little impact on the added value of a strategic centre to relations that have a significant impact on the added value of a strategic centre | |

Source: Author's study based on Barczak [2016], pp. 68–70.
Table 4. Energy cluster in the context of organisational network typology

| No. | Type of network                              | Description                                                                 | Type of network in an energy cluster                                                                 |
|-----|---------------------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
|     | **Relationship structure**                  |                                                                             |                                                                                                      |
| 1   | Intraorganisational networks                | the interior of the organisation creates a network structure of connections between the elements of the organisation | Interorganisational networks: business–public–legal alliances                                         |
|     | Interorganisational networks                | business networks, outsourcing networks, franchise networks, alliance networks, public-law networks |                                                                                                      |
|     | **Method of coordination**                  |                                                                             |                                                                                                      |
| 2   | Asymetric networks                          | dominates the central entity that formulates the strategy and coordinates the operations of the entire system | the strategy is jointly formulated and coordination is carried out by a separate entity that represents the interest of the whole group, assumes a coordination and control function in certain areas to which the participants of the network agree |
|     | Symmetrical networks, bilateral coordination | the strategy is jointly formulated and coordination is based on common agreements                                  |                                                                                                      |
|     | Symmetrical networks, trilateral coordination| the strategy is jointly formulated and coordination is carried out by a separate entity that represents the interest of the whole group, assumes a coordination and control function in certain areas to which the participants of the network agree |                                                                                                      |
|     | **The level of dependence and formalisation of relationships** |                                                                             |                                                                                                      |
| 3   | Integrated networks                         | consist of distributed units that almost or financially belong to one group or one economic organism | consist of distributed units that almost belong or financially belong to one group or one economic organism |
|     | Contract networks                           | base their activities on concession or franchise agreements concluded between independent partners |                                                                                                      |
|     | Federated networks                          | are created by any group of legal or natural persons who are aware of their needs and are looking for ways to satisfy them on their own |                                                                                                      |
|     | Networks of direct relations                | have traditionally been used for penetration in areas of life such as religion or politics, but are now also used in economic life |                                                                                                      |
| No. | Type of network                                      | Description                                                                                                                                                                                                 | Type of network in an energy cluster                                                                                                                                                                                                 |
|-----|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | Dominated networks                                 | they are created when an enterprise has bilateral ties with many, usually smaller partners. Their advantages include the possibility of basing the functioning of the system on the high and stable quality of co-operators’ activities and the certainty of the existence of permanent orders, as well as the limited risk of functioning due to the association with a large partner | Dominated networks are created when an enterprise has bilateral ties with many, usually smaller partners. Their advantages include the possibility of basing the functioning of the system on the high and stable quality of co-operators’ activities and the certainty of the existence of permanent orders, as well as the limited risk of functioning due to the association with a large partner |
| 4   | Peer-to-peer networks                               | are created when coalition partners develop strong connections and work together in a variety of configurations. This system can be configured depending on the market needs and development opportunities. The dependencies between the participants guarantee significant opportunities to quickly react to changes in the environment, resulting from the high flexibility of the structures and activities of the group | Peer-to-peer networks are created when coalition partners develop strong connections and work together in a variety of configurations. This system can be configured depending on the market needs and development opportunities. The dependencies between the participants guarantee significant opportunities to quickly react to changes in the environment, resulting from the high flexibility of the structures and activities of the group |
|     | Social networks                                     | are based on mutual interactions between employees of the enterprises, which create a potential for cooperating of entities ready to take action if necessary. It is particularly effective when processed and shared information is difficult to evaluate under market conditions. Usually, this form is not accompanied by formal contracts or capital dependencies |                                                                                                                                                                                                                                                                                                |
|     | Bureaucratic networks                              | are typically created in situations where the involvement of individual entities is easier to measure with a gradual progression of this value. The legal basis for this agreement are cooperation agreements, and typical examples are licensing or franchising |                                                                                                                                                                                                                                                                                                |
|     | Networks based on property rights                  | their form refers to economic groups searching for synergy in a system of cooperation of their own companies. The most popular arrangement of this type is capital venture, the strategic goal of which is to operate in risky industries which, despite their considerable potential, have not yet been accepted by the market |                                                                                                                                                                                                                                                                                                |
### Structure of network

| Type of network                  | Description                                                                                                                                 |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| **Internal networks**           | arise within an organisation                                                                                                                                                                       |
| **Stable networks**             | based on long-term contracts, organised around the dominant form (coordinator)                                                                                                                      |
| **Dynamic networks**            | loose alliances of companies                                                                                                                                                                         |
| **Dominated networks**          | are created when an enterprise has bilateral ties with many, usually smaller partners. Their advantages include the possibility of basing the functioning of the system on the high and stable quality of co-operators' activities and the certainty of the existence of permanent orders, as well as the limited risk of functioning due to the association with a large partner. |

### Structure of management and stability of connections

| Type of network                      | Description                                                                                                                                 |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| **Ring network**                     | no leadership organisation or hierarchy, a rotational leader plays a steering role, it is possible to launch all agreed connections            |
| **Ring network with a coordinating organisation** | stable and systematic coordination, asymmetry of positions and roles, the leadership organization may influence the operations of other entities, but cannot function without them, or decide on their existence |
| **Ring network with lead organisation** | the leading entity is independent of its circle of suppliers and subcontractors, but it can transform this circle, power is asymmetric and hierarchical |

### Nature of relationships between partners

| Type of network                  | Description                                                                                                                                 |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| **Prosumer networks**           | producer and consumer at the same time                                                                                                                                                                |
| **Supplier networks**           | they include a subcontracting agreement between the client (central company) and suppliers of intermediate production elements; producer networks created as a result of co-production agreements that allow competing producers to combine production capacity, financial and human resources to expand their product offer and geographic reach |
| **Customer networks**           | create terminable connections of production companies with distributors, marketing channels, commercial intermediaries supplementing the product with various elements and target users on domestic or international markets |
| **Standard coalitions**         | are concluded by entities capable of imposing standards on a global scale in order to conform a certain number of companies to the patterns of their own product or its compatibility with it |
| **Technological cooperation networks** | enable the acquisition of projects, products and production technologies, joint production and technology development as well as generic exchange, scientific knowledge and results of scientific and research works |

### Type of network in Operation of their own companies

- **Stable networks**
  - based on long-term contracts, organised around the dominant form (coordinator)
| No. | Type of network | Description | Type of network in an energy cluster |
|-----|----------------|-------------|-------------------------------------|
| 8   | Star networks with a leading company | one company plays a major role in the network | Star networks with a leading company – one company plays a major role in the network |
|     | Nodal connection networks | all entities have equal rights in the network | |
|     | Temporary networks | weakly formalized, in which the intensification of contacts depends on the current needs | Regional networks – constituting a territorial corporation of economic activity, often with a high degree of formalization |
|     | Regional networks | constituting a territorial corporation of economic activity, often with a high degree of formalization | |
| 9   | Systems of relations with network features existing within the organisation | | Systems of relations with network features between enterprises conducting various activities, additionally complementing each other with systems of relations with network features between enterprises running a joint project (mixed interorganisational networks) |
|     | Systems of relations with network features between an enterprise and its environment | | |
|     | Systems of relations with network features between enterprises conducting related activities, additionally complementing each other (interorganisational networks) | | |
| 10  | Social networks | | Economic networks |
|     | Economic networks | | |
|     | Organisational networks | | Design networks |
|     | Other networks | | |
| Type of network in an energy cluster |
|------------------------------------|
| Star networks with a leading company |
| Nodal connection networks |
| Temporary networks |
| Regional networks – constituting a territorial corporation of economic activity, often with a high degree of formalization |

| Design features |
|-----------------|
| Systems of relations with network features existing within the organisation |
| Systems of relations with network features between enterprises conducting various activities, additionally complementing each other with systems of relations with network features between enterprises running a joint project (mixed interorganisational networks) |
| Systems of relations with network features between an enterprise and its environment |

| Features of relationships |
|--------------------------|
| Social networks |
| Economic networks |
| Organisational networks |
| Design networks |
| Other networks |

| Degree of intensification of market features |
|-------------------------------------------|
| Organisational networks |
| Networks of relative relationships |
| Market networks |

| Mode of origin |
|----------------|
| Networks as results of gradual tightening or one-time establishment of long-term cooperation by independent enterprises |
| Networks as results of investments leading to the inclusion of new (created or purchased) cells by at least one company implementing an expansion strategy |
| Networks as results of transformations within the structure of a large, centralised enterprise |

| Nature of network system |
|--------------------------|
| Alliances and joint ventures |
| Supplier-recipient systems |
| Branches of enterprises |
| Strategic business units |
| Bought-out, acquired or sold companies, cooperating with them |

| Networks as results of gradual tightening or one-time establishment of long-term cooperation by independent enterprises |
| Networks as results of investments leading to the inclusion of new (created or purchased) cells by at least one company implementing an expansion strategy |
| Networks as results of transformations within the structure of a large, centralised enterprise |
| No. | Type of network in an energy cluster | Cooperative networks | Strategic alliance networks (partnership agreements between competitors) | Holding networks, concerns | Cooperative networks | Clusters | Strategic alliance networks (partnership agreements between competitors) | Place in value chain |
|-----|-------------------------------------|----------------------|-------------------------------------------------------------------------|---------------------------|----------------------|---------|-------------------------------------------------------------------------|---------------------|
| 14  | Cooperative networks                 |                      |                                                                          |                           |                      |         |                                                                          |                     |
| 15  | Franchise and license networks       |                      |                                                                          |                           |                      |         |                                                                          |                     |
| 16  | Other network forms, e.g. agency networks |                     |                                                                          |                           |                      |         |                                                                          |                     |
| 17  | Horizontal networks                  |                      |                                                                          |                           |                      |         |                                                                          |                     |
| 18  | Vertical networks                    |                      |                                                                          |                           |                      |         |                                                                          |                     |
| 19  | Multidimensional networks            |                      |                                                                          |                           |                      |         |                                                                          |                     |

Table 4. cont.

Source: Author’s study based on Barczak [2016, pp. 83, 86–89; Brilman [2002], pp. 426–427; Cygler [2002], p. 156–157; Dolińska [2002], p. 23; Domański and Marciniak [2003], p. 3–4; Castells [2007], p. 195; Korenik [2003], p. 20; Penc [1999], p. 9; Koźmiński [2004], p. 40; Lichtarski [1993], p. 421; Niemczyk et al. [2012], p. 108.


| Type of network | Description |
|-----------------|-------------|
| Cooperative networks | Cooperative networks |
| Franchise and license networks | |
| Other network forms, e.g. agency networks | |
| Strategic alliance networks | Strategic alliance networks (partnership agreements between competitors) |
| Holding networks, concerns | |

| Place in value chain | Degree of organisation |
|----------------------|------------------------|
| Horizontal networks | Structured networks |
| Multidimensional networks | Unstructured networks |
| Vertical networks | |
| Clusters | |
| Strategic alliances | |
| Holding networks | |
| Public-private partnership | |

| Network density | Degree of organisation |
|-----------------|------------------------|
| Dense networks | Structured networks |
| Linear networks | |
| Clusters | |

| Network centralization | Degree of organisation |
|------------------------|------------------------|
| Monocentric networks | Structured networks |
| Polycentric networks | |
| Non-centralised networks | |

| Territorial scope | Degree of organisation |
|-------------------|------------------------|
| Local networks | Structured networks |
| Regional networks | |
| National networks | |
| International networks | |
| Global networks | |

Source: Author’s study based on Barczak [2016], pp. 83, 86–89; Brilman [2002], pp. 426–427; Cygler [2002], p. 156–157; Dolinska [2002], p. 23; Domaninski and Marciniak [2003], p. 3–4; Castells [2007], p. 195; Korenik [2003], p. 20; Penc [1999], p. 9; Kozminski [2004], p. 40; Lichtarski [1993], p. 421; Niemczyk et al. [2012], p. 108.
Table 5. Energy cluster as a form of company network – common features and differences

| Business networks | Porter cluster | Energy cluster |
|-------------------|----------------|----------------|
| **Common features** |                |                |
| loose connections |                |                |
| reciprocity of benefits |            |                |
| voluntary union |                |                |
| investing in building relationships |            |                |
| transfer of resources between units |            |                |
| creating and strengthening information channels |            |                |
| independence of individuals in economic and legal terms |            |                |
| interdependence of entities on resources controlled by other companies |            |                |
| **Differences** |                |                |
| no territorial restrictions | spatial concentration of entities | spatial concentration of entities |
| cooperation | competition and cooperation | co-production and coopetition |
| implementation of own goals by individual network entities | activation of a region | activation of the region |
| inward action | existence of an entrepreneurial company | existence of an entrepreneurial company (coordinator) |
| | outdoor operation | inwards and outwards operation |

Source: Author's study based on: Skawińska and Zalewski [2009], p. 170; Santarek et al. [2005]; Rosińska [2005b]; Brodzicki and Szulka [2002].

4. An attempt in characterisation and definition of an energy cluster

Taking into account the above considerations, it is possible to start an initial assignment of an energy cluster against the background of network structures, which is illustrated in Figure 1.

Energy cluster, in effect of its situation in the scheme of network structures, is an interorganisational network, and a business-public-legal alliance, which can be treated as a specific 'economic office.' This corresponds to M.H. Bestem's statement that 'a cluster of companies is a collective company' [Best 2001, p. 81; Skawińska and Zalewski 2009, p. 175]. The description of a network enterprise proposed by M. Castells also seems to be very accurate here:

'[It is] he organizational form built around business projects resulting from the cooperation between different components of different firms, networking among themselves for the duration of a given business project, and reconfiguring their
EnErGy clustEr – an attEmpt in charactErisation and d Efinition

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Source: Author’s study based on Barczak [2016], p. 84; Camarinha-Matos and AsArmanesh [2003], pp. 33–46; Dzidowski 2011, p. 90.

Fig. 1. Energy cluster in relation to network structures
networks for the implementation of each project. [...] Thus, the network enterprise is neither a network of enterprises nor an intra-firm, networked organization. Rather, it is a lean agency of economic activity, built around specific business projects, which are enacted by networks of various composition and origin: the network is the enterprise. While the firm continues to be the unit of accumulation of capital, property rights (usually), and strategic management, business practice is performed by ad hoc networks. These networks have the flexibility and adaptability required by a global economy subjected to relentless technological innovation and stimulated by rapidly changing demand’ [Castells 2001, pp. 80–81; Barney 2008, pp. 100–101].

This allows us to conclude that entities in an energy cluster, become a part of an industry, despite not belonging to it initially, by creating a network of strategic alliances. At the same time, they remain with their core business and therefore there is no competition in the implementation of the alliance. Therefore, for an energy cluster not competition, but rather energy security and ecology is the goal.

Summarising the above considerations and at the same time taking into account the importance of prosumers as producers and consumers and coopetition as cooperation within the same activities, and competition within other activities, the following definition of an energy cluster can be proposed:

Regional interorganisational network, which is a business-public-legal alliance, constituting a concentration of mutually related prosumers, cooperating in the implementation of a specific project, through ties independent of the type of basic operation; the entities work closely together, and one of them has predominant power (the coordinator).

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