9 Energy clusters in Poland

Towards diffused green energy communities

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Introduction

Mobilizing society to actively partake in sustainable energy transitions is often a daunting task in the Baltic Sea Region and the track record of Polish bottom-up citizens' projects in renewable energy has been rather mixed so far. Recent years have been marked by the stagnation of the wind energy sector due to unfavorable regulations, whereas the first renewable energy cooperative in the country, "Cooperative Our Energy" (*Spółdzielnia Nasza Energia*), is still in its early development stages despite initial plans to open in 2020. Simultaneously, the development of photovoltaics and a growing number of prosumers show vivid societal interest in renewable energy sources (RES) that needs an appropriate financial and legal framework to grow. In this light, energy clusters are becoming crucial platforms for the involvement of local actors in sustainable energy solutions. First introduced into the Polish law in 2016, they are based on agreements of local entities involved in the production, consumption, storage and sale of local energy sources such as renewables (Ministerstwo Aktywów Państwowych, 2018). They aim at meeting the energy needs of the local communities while mobilizing the latter to actively engage in green energy production. Given the newness of the initiative, the actual impact of energy clusters on the involvement of local actors in energy transformations has not been extensively studied. Some broad studies looked into energy clusters' characteristics and challenges across different geographical locations (e.g., Jaegersberg and Ure, 2017; Lowitzsch et al., 2020; Bergal, 2020), while a number of scholars have conducted some preliminary analysis of energy clusters in Poland, for example, discussing the necessity of flexible cluster models (Moszkowicz and Bembenek, 2017), most suitable locations for RES-based clusters (Szewrański et al., 2019), their energy balance and potential for self-sufficiency (Wiktor-Sułkowska, 2018) or clusters' impact on city's air pollution (Czaplicka-Kotas et al., 2020). This chapter seeks to add to this emerging scholarship by conducting an in-depth study of Słupsk's Bioenergy Cluster in Pomorskie, the northern district of Poland. Although still in the early stages, the initiative has been recognized twice by the Polish Ministry of Energy as a national model and ranked among the ten top pilot energy cluster projects in Poland in 2018 (Sołtysik, 2018). For this reason, Słupsk's Bioenergy Cluster constitutes a

good case study to identify and analyze energy clusters' model characteristics as well as best practices for active stakeholders' engagement at the local level, while identifying the remaining challenges.

This chapter does that based on semi-structured interviews with the local producers, energy consumers and larger entities that are actively engaged in the Słupsk's Bioenergy Cluster's operation. The analysis is steered by two main research questions: what key features determine the energy clusters' success in the Polish context, as illustrated by the model characteristics of the Słupsk Bioenergy Cluster? And, what are the key challenges to the energy cluster initiatives in Poland? The argument unfolds as follows: first, the general background of the energy cluster initiatives in Poland is outlined; second, the discussion zooms in on the Bioenergy Cluster in Słupsk, scrutinizing its formation process, model traits as well as the existing legal, economic and societal barriers to its development.

Background

The potential for developing consumer co-ownership in Poland remains rather limited, despite growing interest in RES among the population. The recent 2016 RES Act amendment favored the medium-size projects, at the expense of both large-scale RE projects and individual prosumership among households, farmers and micro-enterprises (e.g., the abolishment of favorable FIT for small installations) (Ustawa, 2015, 2016). Moreover, the development of energy cooperatives – so popular in Western Europe, is still in its initial phases in Poland. Although energy cooperatives were defined already in the Cooperative Law from 1982 (Goebel, 2019) and the 2016 RES Act additionally specified the scope of their potential electricity production from RES (Art. 2 §33a RES Act), only one cooperative has been established so far. The “Cooperative Our Energy” (*Spółdzielnia Nasza Energia*) is the first renewable energy cooperative in the country, established in 2014 in southeastern Poland as a joint project of Bio Power Sp. z o.o., Elektromontaż Lublin Sp. z o.o. and four municipalities: Sitno, Skierbieszów, Komarów-Osada and Łabunie. It involves the construction of over a dozen biogas plants, that will supply electricity and heat to local public buildings and households at prices lower than the national system (gramwzielone.pl, 2014). However, despite initial plans to open in 2020, it is still in the early development stages. This delay partially owes to the fact, that energy cooperatives suffer from the lack of dedicated support, as the recent RES legislation focuses rather on the development of energy clusters.

Energy clusters (*klastry energetyczne*) were first introduced into Polish law in 2016 by an amendment to the 2015 RES Act (Ustawa, 2015, 2016). According to the 2016 RES Act, the energy cluster is defined as a civil law agreement, which may include physical persons, legal persons, units and research institutes or local government units. The purpose of the energy cluster is the production and balancing of demand, distribution or trade in energy within the distribution network with a rated voltage lower than 110 kV (*ibid.*). The cluster's area of operation may not exceed the limits of one *powiat*¹ or five communes (*ibid.*). Clusters are an initiative with a local territorial scope, and therefore their primary aim is to

meet local needs with the use of renewable sources and modern technologies. For a number of reasons, they are becoming a favored model for the development of self-sufficient local energy initiatives and crucial platforms for the involvement of societal actors in sustainable energy solutions in Poland.

Their role, as envisioned in the Polish Ministry of Energy regulations at the time, is to stimulate local communities' cooperation in renewable energy production for local needs, develop prosumer energy, improve local energy security and increase the competitiveness and efficiency of the local economy (Moszkowicz and Bembenek, 2017). Having a share from renewable energy, cogeneration or waste energy in the energy consumption of cluster members is one of the formal criteria of the clusters' establishment (Błażejowska and Gostomczyk, 2018). Not surprisingly then, among the most common declared goals of the recently formed energy clusters in Poland are the production of renewable energy and improvement of local energy efficiency measures, as well as the development of cooperation between science and the economy, development of new energy technologies and R&D facilities, improved local energy security and reduction of the negative impact of energy production on the environment (Burzyńska, 2016). Energy clusters also seek to provide specific business and financial benefits, e.g., through reducing operating costs and costs of building or modernizing power infrastructure, better identification of local energy needs or new investments (Czarnecka, 2018). In the long-term perspective, they are meant to utilize local entrepreneurship potential and available raw materials and facilitate the implementation of new technologies and business models at the local level (*ibid.*). If successful, energy cluster initiatives should be able to improve the living standards of local communities, not only in the technical and economic dimensions, but also in the social dimension – by activating societal actors and facilitating multilevel cooperation of various entities operating within a cluster.

The Ministry of Energy has actively encouraged the formation of local energy cluster initiatives and the development of their action strategies, which form the basis for applying for specific public support. So far, developments suggest that the concept met with a favorable response from market participants. Namely, the Ministry of Energy announced the first competition for a certified energy cluster in 2017 and 115 clusters from 15 voivodeships entered the competition, representing approximately 17% of all municipalities in Poland (Sołtysik, 2018). In Spring 2018, an expert panel chose 33 clusters from 12 voivodeships that received the Pilot Energy Cluster Certificate and ten clusters with the highest scores were additionally honored with the distinction (*ibid.*). The competition for a certified energy cluster contributed to the popularization of the concept. Additionally, the chosen pilot clusters can serve as a basis for identifying the best local practices that could be replicated nationwide. Currently, energy clusters meet around 27% of local electricity demand, by producing energy from renewable (16%) and cogeneration (11%) sources. It is expected that within a decade the average energy cluster would meet 99% of local electricity demand – with 53% coming from RES (*ibid.*).

However, several barriers remain. The formal and financial obstacles to the development of energy clusters and the use of renewable energy sources include, for

example, the economic risk resulting from financial expenditure, the cost of connecting to the transmission network, project profitability or the return on investment (Moszkowicz and Bembenek, 2017). Finding sources of funding in the initial stages of cluster operation at the regional, national or EU level is particularly challenging, as in most energy clusters in Poland a stable self-financing system has not yet been developed and the main source of financing comes from membership fees, which are set on different principles (*ibid.*). Moreover, the literature on the subject highlights several factors that are likely to be decisive in the energy clusters' relative success and that constitute a challenge to the newly emergent initiatives. Some of these factors are successful vertical and horizontal integration into the energy industry, development of technological and organizational innovations, good cooperation with scientific/research units that will help in the elimination of barriers, a viable marketing strategy to promote clusters' activities (Pylak et al., 2017) or successful mobilization of the local societal actors. All these factors are key for achieving a potential synergistic effect, where diffusion of know-how and staff rotation within the cluster could increase productivity, lead to more innovation or attract resources and enterprises (Burzyńska, 2016).

Having those factors in mind, the emerging empirical studies on the subject have attempted to identify common characteristics and challenges to the clusters' establishment, governance and the policymaking process. Some have analyzed the recurring barriers to cluster development in the renewable energy sector while looking into examples from five continents and focusing on the stakeholders' relations on the ground (Jaegersberg and Ure, 2017); others compared RE clusters with renewable energy communities as defined by the European Clean Energy Package 2019 drawing on a dataset of 67 best-practice cases of consumer (co-)ownership from 18 countries (Lowitzsch et al., 2020); still others attempted to create a system of interactive data on energy clusters in the leading energy powers in the world that would allow, among others, to assess the impact of clusters on economic development (Bergal, 2020). However, although the cluster-based policy is the focal point of local and regional policy implemented by governments in many countries around the world, no single cluster model is universally applicable to different policy settings, but rather each country adapts it to its unique political and socio-economic context (Gronkowska, 2017). This warrants in-depth empirical investigations into single case studies across different national settings.

As far as the Polish case is concerned, local analysts noted that the pioneering nature of energy clusters requires the development of an effective and flexible model that would be suited for the Polish legal, economic, social and technological conditions (Moszkowicz and Bembenek, 2017). Several authors have analyzed the emerging energy cluster initiatives in Poland from a broader perspective, e.g., by exploring Polish Small and medium-sized enterprises (SMEs) main motivators to join the clusters (Pamula, 2020); discussing the potential of energy clusters in Poland vis-à-vis the experience of German energy cooperatives while highlighting the need for flexible structures (Gostomczyk, 2018); or mapping the most suitable areas in Poland for the development of biomass, solar and wind energy to aid the decision-makers in sustainable energy cluster allocation and management

(Szewrański et al., 2019). Based on calculations of clusters' energy balance some have also speculated whether RES-based energy clusters can become independent from external energy sources while pointing to the need of supplementing with more stable conventional energy (Wiktor-Sułkowska, 2018). Additionally, a couple of studies zoomed in on the concrete energy cluster initiatives. Using the "willingness to pay" (WTP) method to calculate the impact of air pollution on the tourist city of Zakopane and comparing it with the Polish average, the case study of the Zakopane energy cluster analyzed the influence of the initiative on the city's development and drew further conclusions for the local transformation to RESs (Czaplicka-Kotas et al., 2020). Another study zoomed on the Mazovian Energy Cluster to compare the classical theory of clusters with the principles of energy clusters' formation and gave recommendations on the cluster's desired structure, operation and cooperation with the Polish Energy Group (PGE) (Adamiak and Viswanathan, 2018). Although the study mentioned some of the existing challenges to cooperation (e.g., lack of motivation amongst the cluster's members, lack of flexible structure or a specific strategy) it did not discuss them further (*ibid.*).

This chapter seeks to contribute to this growing research on energy clusters by identifying mechanisms that facilitate the effectiveness of the energy cluster initiatives in Poland at the example of an in-depth study of Słupsk's Bioenergy Cluster's formation process and operation. This pilot cluster, located in Pomerania, the northern district of Poland with a population of 90,000, was ranked among the ten best out of 33 pilot energy cluster projects in Poland in 2018 (Sołtysik, 2018). It was also among three clusters that prepared presentations during the conference on energy cluster financing organized by the Polish Ministry of Energy (Lipiecka, 2017). The presentation emphasized the strong orientation of the Słupsk Bioenergy Cluster on local conditions and needs, and the potential for scaling and multiplication of the experiences of the Słupsk cluster in the context of other cluster initiatives (*ibid.*). Moreover, the potential of the Słupsk Energy Cluster to create a model for the operation of water supply and sewage enterprise within the energy cluster was highly rated by the Chamber of Commerce "Polish Waterworks" – the only organization of the economic local government (*samorząd gospodarczy*) of the water and sewage industry in Poland, associating 480 enterprises on the water and sewage market. The Chamber recognized innovation in the operation of Słupsk Waterworks and saw it as a partner in the process of developing a model for the participation of a water and sewage company in an energy cluster that could serve as a road map for other enterprises of this kind in the country (*ibid.*).

For these reasons, Słupsk Bioenergy Cluster constitutes a good case study to identify and analyze best practices for active stakeholders' engagement in the energy cluster initiatives, while identifying the remaining challenges.

Methodology

The analysis is based on the document analysis (municipal strategies, cluster's documentation) as well as one hour-long semi-structured interviews with 12

participants from the main entities of Słupsk's Bioenergy Cluster. The interviewees include the leader of the cluster Słupsk Waterworks (*Wodociągi Słupsk*), heating company Engie Słupsk, the Pomeranian Regional Development Agency (*Pomorska Agencja Rozwoju Regionalnego*), city council (*Urząd Miejski w Słupsku*), local wind turbine owners (Baltic Wind) as well as other types of local initiatives engaged in the promotion of renewable energy and sustainable energy solutions such as informational "green points" in the city of Słupsk or Słupsk's Technology Incubator. The analysis employs thick description – a qualitative research method that gives detailed descriptions and interpretations of situations and their background context, as observed by a researcher (Ponterotto, 2006). The thick description provides background information necessary for understanding the relevance, meanings and intentions that underpin social interactions in a given setting (Hollaway, 1997). In this case, the chapter draws heavily on the interview material to provide detailed accounts of the Słupsk's Bioenergy Cluster formation process, operation and background, which also shed light on the wider national context of the pilot energy cluster initiatives in Poland and their challenges. Given that the cluster is still in the formative stages, the chapter assesses cluster's potential role in sustainable energy transition, by taking into account, in particular, the process of its establishment and organization, usefulness to the local stakeholders, significant innovation, so far diffusion of know-how, the long-term development plans and the remaining challenges.

When it comes to assessing the potential for societal involvement in the energy cluster operation, the literature on the subject suggests that several factors should be considered: first, the existing socially rooted connections, long-standing traditions of a given activity in a region and significant resources of social capital that would aid in the cluster's development (Burzyńska, 2016); second, the kind of organizational and financial support received on the governmental and local level, as well as collaborative research and support from the educational/research institutions that could enhance inter-sectoral collaboration (McCauley and Stephens, 2012); third, the framing of the cluster strategy, which if inclusive enough, has the potential to facilitate social learning and social change in addition to technical innovation and change (*ibid.*). And lastly, the regional "buzz" created around local sustainability initiatives that contributes to collective learning, as "actors are surrounded by a milieu of rumors, impressions, recommendations, and strategic information" (*ibid.*, p. 213). The above factors serve to streamline the analytical focus and assess the potential of the Słupsk Bioenergy cluster to serve as a trigger of the local sustainable energy transition with societal involvement.

Słupsk's Bioenergy Cluster

Background

When discussing the formation process of the Słupsk's Bioenergy Cluster, it is worth considering the general favorable local context of the initiative. In the

years 2014 to 2018, the city was governed by a leftist politician Robert Biedroń who was an outsider with political experience gained during his term as a parliamentarian (2011–2014). Biedroń surrounded himself with a couple of energy experts from Warsaw who advised him on his pro-ecological local policy and some smaller initiatives introduced by his team attracted much publicity and created a certain local “buzz” around the topics of green energy and sustainability that increased social environmental awareness.² During Biedroń’s term, the city council was allocated special funds for green projects³ and, among others, realized the thermo-modernization of public buildings, made investments in photovoltaics and engaged in several smaller initiatives, such as the free of charge replacement of old lighting systems into LED and thermostats by inhabitants, which resulted in savings and reduced energy poverty (Błażejowska, 2019). At the institutional level, Słupsk became the first Polish city to establish a post for a plenipotentiary for sustainable development and the green modernization of the city. A number of “green points” were also opened to serve as informational and ecologic education centers for the inhabitants. There were also plans to establish the Green Energy Institute in Słupsk in cooperation with the Ministry of the Environment that would conduct research, implement ecological education and serve as a development laboratory for the innovative activity, yet the initiative did not launch – partly due to the changed political environment at the national level and a lack of political will at the time (Jaźwiński, 2019). In 2018, following Biedroń’s term in office, Słupsk has also become one of the three European pilot regions⁴ employing a Consumer Stock Ownership Plan within the Horizon 2020 project SCORE⁵ launched by the European Commission to facilitate consumer joint ownership of RE (Goebel, 2019). The program was targeted at groups affected by or at risk of energy poverty, as it enabled for the proactive and profitable acquisition of production assets in power stations powered by RES by consumers who did not have savings or the ability to access investment credits (Błażejowska, 2019).

The above developments created a certain “buzz” around green energy solutions and constituted a favorable context for the energy cluster initiative. However, although the activities of the Słupsk Bioenergy cluster have been included in Robert Biedroń’s “green city” framework, which somewhat created an outside impression that the idea of the cluster was initiated by his team, the process of establishing the cluster had longer roots and was driven by local actors who built on the existing significant social capital.

Cluster formation process

The bioenergy cluster was initiated by the company Słupsk Waterworks (*Wodociągi Słupsk*), the publicly owned agency that operates the Słupsk wastewater treatment plant and has a license for energy production with rights to RES and combines heat and power (CHP) certificates. The company became a managing coordinator of the cluster, which was formally established in October 2017 with 19 founding members that included the city of Słupsk, the heating company Engie SC Słupsk Ltd., the Pomeranian Regional Development Agency,

as well as local entrepreneurs operating in and near the Słupsk Special Economic Zone. Cluster participants include producers of electricity and heat from RES and conventional sources as well as large energy consumers, such as the local aqua park Three Waves (*Trzy Fale*) and the fishing industry.

Crucially, the project draws on the Słupsk Waterworks' experience in the implementation of energy efficiency solutions, with its main undertaking being the establishment of the "Bio-refinery Słupsk" – a project based on the energy potential of sewage treatment plants. The director of the company was among the first ones in the country to launch cogeneration units based on waste from sewage treatment plants (Rasmussen et al., 2020). Having over 20 years of experience in pollution reduction, sludge composting and reuse, and biogas energy production, the company under his leadership grasped the momentum to utilize the thermal energy and electricity produced and to propose a project that could address local power supply while developing solar and wind sources that could be difficult to integrate into the old transmission systems (*ibid.*). At the core of the cluster initiative is the idea to connect local energy users with energy suppliers, who would all send their wastewater (as well as some biomass waste) to the Słupsk Waterworks to locally produce more electricity and heat from renewables while lowering costs and recycling nutrients recaptured from the sewage sludge. As such, the cluster is to be based on the use of cogeneration and local distribution of thermal energy and electricity.

Given the newness of the energy cluster initiatives in Poland, it is worth highlighting the importance of local leadership in launching the project. Interviewees all agreed that the personal initiative of the Słupsk waterworks' director was key both in introducing innovations within the company and in setting up the bio-cluster. Whereas some ideas for sustainable energy projects emerged in the city in the past (e.g., the proposal of the Baltic Center for Clean Energy to be established in Słupsk), and Robert Biedron's term provided some local "buzz" around the topic of green energy solutions, the vision of the Waterworks' director was key here. As one of the interviewees from a local wind company stated: "If it weren't for the chairmen of the Waterworks and Engie, nothing would have happened, these are people who can and want to talk, the rest can only see their own backyard for now."⁶ While personal determination and communication skills were crucial, so was the public trust in the Waterworks company. As a representative of the company noted:

generally there was a high level of trust in us, we are safe, we are also a form of monopoly as a water supplier, but our goal is not profit [...] With us, we saw that a part of this community felt safe, they did not get involved in it, but willingly signed this agreement, because they believed that we were able to produce some products that would be beneficial for them from a business point of view.⁷

Moreover, trust in the company was also high at the national level. The Ministry of Energy that evaluated different cluster proposals at the time saw its

local potential and appreciated the successfully implemented smaller steps of relevance to the project. For instance, one of the cluster members, the Słupsk Aquapark, has been making financial losses since its establishment and has created much burden for the city's budget. Due to the initiative of the Waterworks director, several energy efficiency solutions introduced in the aquapark improved its operation and had a positive effect on the municipal budget.⁸ Furthermore, the planned heat pipeline between the Aquapark and Waterworks company within the cluster framework would further optimize energy usage within the area.

This combination of strong local leadership and a high public trust might be one of the key success factors behind launching bottom-up energy projects in Poland. It is also not confined to the energy cluster initiatives, as local actors and businesses are often risk-averse and unwilling to assume a more active role. In the case of Słupsk's bioenergy cluster, the initial leadership met with the enthusiasm of several key stakeholders at the local level. The latter included especially the Pomeranian Regional Development Agency, which could identify additional local entities interested in the project, and the local heating company Engie, which sought to switch from the coal sources to more sustainable alternatives. The key stakeholders were motivated to jointly optimize their energy consumption.

When it comes to the technical parameters, the investments in the cluster so far have aimed to increase the local electricity and heat generation potential in renewable energy sources, as well as in conventional and cogeneration units. As of 2017, the cluster's production potential was over 15 MW of electricity installed in renewable energy, with 1.2 MW coming from the biogas sources, 14 MW from the wind sources and 195 kW from photovoltaics (Lipiecka, 2017). Simultaneously, the cluster's thermal power production potential was at 1.5 MW in biogas sources and 190 MW in conventional sources (*ibid.*). The cluster aims at further investments in cogeneration, wind and photovoltaic sources that include local wind and solar farms, processing plants that would supply waste from the production process and production plants that would receive cheaper heat and energy (Błażejowska and Gostomczyk, 2018). Ultimately, the cluster's strategic goal is to use the potential of sludge and waste to launch a local initiative in line with the low-carbon, resource-efficient circular economy. To do so, the project aims to establish intelligent energy management and balancing system using energy storage, build a local smart grid and improve energy efficiency measures. While the cluster is still in the early development stages and the mentioned technological solutions are underway, it has several characteristics that make it a potential model for others to follow. The next section looks into these factors in more detail.

Model elements of the cluster

Słupsk's Bioenergy cluster was one of the pilot clusters in Poland and early on became recognized as a potential model for other small cities seeking to make the

transition to a circular economy based on the optimization of local costs, development of renewables and waste recycling. In large part, the cluster's innovative potential draws on the technological solutions that have been implemented at the cluster's leader Słupsk waterworks treatment plant. The latter has an ambitious development vision, as it seeks to achieve zero sewage (through pollutant removal, water recovery), zero emissions (through GHG reduction), zero waste (through resource recovery, organic recycling) and zero waste energy (through energy efficiency, renewable energy cluster) (Rasmussen et al., 2020). As such, the company has previously introduced technical solutions that contribute to the local circular economy model. The most obvious one is the sludge-generated biogas that can be returned into the cluster system as heat and electricity. Moreover, the sludge composting produces a rich in phosphorous certified crop fertilizer that is in high demand by the agricultural businesses nearby. The technological innovations introduced by the company also include dry fermentation, green waste management, special liming processing for the sediment with signs of toxicity or connecting surrounding rural areas within one sewage system.⁹ All the above determine that Słupsk's wastewater plant is among the top three cheapest out of 47 companies of this size to run in the country (Rasmussen et al., 2020).

However, all the technological innovations could not be successfully implemented and utilized without strong local leadership that facilitated foreign knowledge transfer and eased the launching of the initiative by drawing on its prior project management experience. First, the leading members of the cluster have taken some inspiration from the technical solutions observed at the German energy cooperatives, as well as during study visits to Denmark, Norway and Sweden.¹⁰ As one interviewee stated, getting some knowledge and solutions from countries with practical achievements were important, as: "after coming back from such trips, we build knowledge and competencies. [...] Our goal was to create a structure that could function in this energy market, which is difficult and unpredictable."¹¹ Currently, the cluster also collaborates with foreign partners within some wider frameworks (e.g., Bonus Return with Sweden). Second, the experience of the founding cluster members translates into better business and risk management strategies. The establishment of the latter is necessary yet challenging, as being new initiatives, clusters are meant to pave the way for new business models. Doing so requires significant experience in the legal, economic and political aspects of the local project management and entails higher than usual risks due to the novelty of the undertaking. It is in this sense that local entities can facilitate the process. Here, the Słupsk Waterworks was able to draw on its project investment and risk management experience gained, for example, during the implementation of smaller initiatives and innovations at the treatment plant. Moreover, as local actors noted, both the Słupsk Waterworks and the local company Engie have sufficient budgets and adequate organizational structures to take certain investment risks, such as the project of the heat pipeline currently underway or the planned power lines.¹²

Whereas local competencies are key for implementing technological innovations and managing the initiative, another key advantage of the cluster comes

down to its scalability due to the unusually close geographical proximity of the cluster members. Słupsk Bioenergy cluster concentrates on very small area producers and recipients of electricity and heat while having both conventional and renewable generation sources in its portfolio. As one interviewee from a local wind company noted:

In a small space, we have close sources of energy and the recipients, close industrial zone, which is a perfect match when it comes to energy demand, thermal energy, and a water park – such a close connection is rare. There is probably no cluster that would concentrate so many sources on such a scale in Poland.¹³

As others point out, the fact that the members of the Słupsk special economic zone, aquapark – a recipient of heat and electricity, companies such as Engie that own cogeneration, waterworks, windmills and smaller companies are all within a radius of 2–3 km makes the ultimate creation of a self-sufficient energy system highly realistic.¹⁴ Consequently, the cluster aims to develop an independent distribution system. Whereas the heating network is already under construction, there are also plans for a local electricity grid to be built. Despite its scalability, the cluster strategy was not too broadly defined, as managing too many stakeholders from the start would be problematic. Rather the initial 20 signatories included entities both geographically close to each other and highly interested in the project.¹⁵ As such, in line with other cluster programs around the country, the Słupsk Bioenergy cluster aimed at the level of diversity in terms of participants, energy sources and technologies that would still allow for the most effective local management.

The geographical proximity also translates into other benefits that define the cluster's model characteristics. Most importantly, it gives strong economic incentives to cluster members and magnifies the potential for the cluster expansion to interested parties. Local stakeholders are bonded by business and strategic goals as they ultimately seek to reduce their costs. A series of smaller initiatives that make up the whole project (biogas plant, technology incubator with a photovoltaic power plant, windmills) also create an added value for each partner that becomes involved in the cluster. For instance, given the need for changes as a part of the energy transformation, the cluster gives its members a chance to enter the electricity market (e.g., some cluster member companies received additional funding for that purpose) or to provide them with a viable alternative to big electricity companies (e.g., for the small wind farm owners). In this environment, establishing a platform for exchanging information and searching for joint initiatives is also easier and gradually leads to the local synergistic effect.¹⁶

Crucially, the project has also an important societal dimension. Given a mixture of legal, economic and societal barriers to establishing a participatory energy system in Poland, the successful cluster initiatives are in a unique position to facilitate bottom-up projects in citizens' energy with a variety of local stakeholders.

The Słupsk Bioenergy Cluster managed to coordinate a diverse group of energy producers and consumers via strong leadership and articulated goals from early on and in a longer perspective envisages that individual prosumers would join the project. As such, the initiative creates possibilities to engage private capital and to limit the capital outflow from the region while contributing to the local self-sufficiency. This is particularly important in the case of Słupsk. While there is a great potential for the development of renewable energy in the Pomorskie district where the city lies (e.g., appropriate land and weather conditions), the region remains somewhat excluded from the more industrialized and economically dynamic centers of the country. For this reason, there is also a significant brain drain from the city to the larger metropolitan areas. Creating a local project that requires a high level of specialization and social competencies could retain some of the young talents in the city. In this way, the cluster initiative would utilize the local potential to address both the economic and societal challenges. In the short term, however, the societal benefits are likely to derive mostly from the reduced costs of electricity and heat, as well as the increased awareness of the local community regarding energy production and consumption.

The latter is also facilitated by the educational and informational activities in the city, which contribute to the local “buzz” around the project and sustainable energy topics more broadly. On the general level, the already mentioned “green points” that are currently located in the public libraries focus on educational activities for the wider public that take the form of lectures, debates and classes for local schools.¹⁷ However, although the public turnout is quite high there and especially young people show interest in the “green energy” topics, the activity of the green points and its impact is not so visible to the members of the cluster, as they focus on the slightly different audience.¹⁸ As such, the cluster initiative itself is promoted in a number of direct and indirect ways. An example of the former includes local happenings that promoted different energy topics in the city with the participation of cluster members every one or two months.¹⁹ Worth mentioning are also smaller promotional activities such as cluster members’ company electric cars covered with informational material²⁰ or practical initiatives visible to the public, such as photovoltaic installations on buildings arranged by the cluster.

Crucially, the cluster also benefits from more technologically focused innovation and educational platforms that address the topics of renewable energy and sustainable energy transition in Słupsk. Most importantly, the local technological incubator runs a “laboratory of renewable energy sources” and, since 2017, conducts educational training for the companies (including start-ups), entrepreneurs and schools. The practice-focused program for technical schools from the region consists of thematic blocks on photovoltaics, heat pumps, wind microturbines, solar collectors and energy-efficient construction (e.g., professional energy-saving houses). It also involves a series of laboratory-type seminars on the design and assembly of photovoltaic systems run by professionals working around the world in the field of renewable energy installation.²¹ The building of the technological incubator itself is equipped with the largest photovoltaic installation in the

region, as well as different examples of prosumer installations. The above programs, coupled with initiatives for the wider public, such as open days, contribute to raising local awareness. They also gradually build local competencies, albeit so far to a limited extent, as local companies are only a fraction of business participants, with the majority coming from the rest of the country.²²

Despite all these activities, the leading cluster members point out that based on their experience, the best way to promote the initiative and mobilize local society is to show concrete projects that will provide practical solutions to the local community, e.g., for improving energy and financial efficiency, that local actors could replicate.²³ If the cluster offer is to be widened to a large number of stakeholders, then similarly what is needed are concrete project proposals, negotiated with the representatives of the local stakeholders who enjoy high public trust and have high competencies (e.g., housing associations or local public administration). Otherwise, the local population could doubt whether ambitious undertakings such as energy clusters are to be successful in the long term. As one interviewee stated while discussing the way forward:

In Słupsk, everyone has heard about the cluster, and everyone believes that it has enormous potential. That said, at the same time, everyone believes that it will fail [without a clear roadmap] ... so we need specifics [of how to get there, i.e., concrete project proposals connected to the cluster].²⁴

Challenges to the cluster initiatives

Despite its model characteristics, Słupsk Bioenergy Cluster, similarly to other energy cluster projects in Poland, faces some key challenges. The challenges include significant legal, technical and operational barriers, as well as passive and risk-averse societal or business attitudes.

The most immediate obstacles to the development of energy clusters exist at the operational level and owe to the lack of established business models for clusters and cooperatives as well as the lack of cooperation models for distribution systems operators (DSOs).²⁵ Whereas strategic leadership and experience of the main cluster members can help to overcome these challenges to some extent, as discussed earlier, insufficient professional tools for the cluster coordination on the market remain problematic. As such, the pilot initiatives need to navigate between different interests and expectations of private companies, local government and later also individual private actors in finding the best management, financial and technical solutions.

The establishment of the well-functioning energy balancing and storage system for the cluster members, as well as the development of the long-term financing mechanism, in particular, will be decisive for the future success of the Słupsk Bioenergy cluster. The works on the former are in the initial stages, as the cluster looks for a company with relevant “know-how” to balance the electricity from different energy sources.²⁶ Adjusting the entire system is not easy, as cluster members have different energy balancing techniques and different cost

considerations that need to be justified at the state (e.g., control of municipal budgets) or company level.²⁷ Hence, dedicating enough resources for analysis and making a functional program for a cluster's balancing system will be crucial here. It would also increase the cluster's ability to obtain additional external funds in the future, although the cluster budget is likely to remain comprised mostly of its own funds.²⁸ As a representative of the Pomeranian Regional Development Agency in Słupsk noted:

The problem of clusters in Poland is that they functioned as long as there were EU funds, no one thought about the need to develop certain mechanisms of cooperation between cluster participants. [...] What we do – we know that we do not have EU money in the sense that we came into existence at a time when there was no such possibility of support, and it is a bottom-up initiative that seeks to create a mechanism that will make it earn for itself at some point.²⁹

Sufficient funds are crucial not only for conducting the cluster's eco-friendly policies and running new projects but also for opening the initiative to citizens' energy and other local companies. At the moment, the cluster members mostly incur mutual costs while applying for additional funding from the regional and EU funds.³⁰ External funding is also key as far as the innovative potential of the individual cluster's members is concerned. As an interviewee from Engie that received a subsidy for gas cogeneration from the National Fund for Environmental Protection (*Narodowy Fundusz Ochrony Środowiska*) noted: "Heating in Poland is generally underfunded, if the country is to move away from coal there must be a signal for these companies that they will get help [for innovation]."³¹ Despite certain optimism that this type of funding will be available in the future, the cluster focuses on the strategies for generating its own income. This task is made harder by the track record of the unfavorable legislative environment in Poland.

Legal barriers constitute one of the most pressing challenges to energy cluster initiatives in the country. They largely derive from a combination of technocratic energy governance at the state level that protects big energy businesses under its control and a lack of a clearly defined long-term energy strategy that would be followed by the subsequent governments. First, the strength of the coal lobby and the current dynamic of the energy market that remains dominated by several big companies creates divisions between different market players and hinders the development of the renewable energy sector. Although cluster initiatives are a certain exception here, local actors point that there is still insufficient support from the governmental side in terms of dedicated programs (e.g., tax incentives for developing RES projects locally) coupled with a lack of consistency in following the current regulations (e.g., a need to build new distribution networks by the cluster, while there are existing ones locally). The perceived problem also exists at the level of the local government, as cities' local development plans are often not specific enough, as far as cluster initiatives are

concerned.³² If the type of the above support is not available in the future, there is a risk that cluster initiatives will be only realized in a limited form.

Second, there is a general instability of state regulations. The frequently changing regulations have previously forced many companies working with RES to withdraw from the projects, leaving the investors embittered. Currently, there are similar concerns that “the rules of the game” can change during the ongoing ventures. As a representative from the Pomeranian Regional Development Agency pointed out: “it is a matter of trust ... the state by creating a confusing energy market and making decisions that are sometimes incomprehensible to its participants caused the level of trust to drop significantly.”³³ Moreover, the regulations themselves are often unclear, and the risks involved in their interpretation (e.g., whether the network under construction a direct network) magnify the general risks for the investors. In the case of Słupsk Bioenergy Cluster, e.g., this lack of clarity effectively left some entities more loosely affiliated with the cluster (e.g., local wind companies that are partners, not participants of the cluster in a formal sense).³⁴ Therefore, there is high pressure from the market participants for the cluster initiatives to be firmly based on legislation to avoid changing legal frameworks mid-way through project developments. Especially, the business trends currently are changing. As the staff from the training department of the local technological incubator in Słupsk noted, whereas previous legislative changes had stopped for a couple of years new RES business initiatives in the region, since 2019, this trend has been slowly reversing due to new rules, subsidies as well as changing market needs (e.g., renewable energy installations on single-family houses).³⁵

Lastly, there are significant barriers when it comes to general societal and business attitudes. Whereas lack of enthusiasm for the new bottom-up undertakings in sustainable energy solutions can be partially explained by the unclear regulatory framework and, to some extent, overcome by strong local leadership, it is also deeply entrenched in a wider socio-economic context in Poland. As the leader of the cluster noted: “at the moment, we are not able to cross two barriers, the legal barrier and the mental barrier that we can undertake such projects in Poland in general.”³⁶ The risk aversion among local businesses hinders innovation and translates into mostly short-term economic focus that comes down to the question of “how much less will I pay for electricity when I am part of the cluster?”³⁷ As the cluster member notes:

The first question we encounter is who will make money from it, the conversation starts with money and not with potential, [and] even if we cross the first barrier, then there is a question of commitment. I do not even talk about financial involvement, but business is focused on its activity and [often] has no research and development potential.³⁸

The lack of business competencies in this area often goes hand in hand with a lack of an appropriate structure to change the company’s energy policy at the local level so that it would have a stronger political and economic dimension.

As a result, local entrepreneurs often avoid taking risks and look for immediate profits, while waiting for a ready offer from the cluster. This low stakeholder engagement and expectant attitudes reflect the wider socio-economic context in Poland, and as an employee from the city council office working on the implementation of energy efficiency projects noted “it’s not about money, it’s about our mentality.”³⁹ Yet, an attitude change is much needed, especially among cluster initiatives that comprise of a different set of actors with different expectations, who nevertheless need to work jointly on common projects that will ensure the initiative’s self-sufficiency in the long term.

For the time being, local companies, as well as key cluster participants, are awaiting further development steps of the project. Whereas a photovoltaic farm might enter the design phase soon, the current plans revolve around building an energy distribution system – starting from a heat pipe and an energy cable between Waterworks company and the Aqua Park, as well as an independent electricity grid for renewable energy produced and shared within the cluster. Once the system is established, it will allow for better integration of cluster participants and higher self-reliance in managing the initiative.

Conclusion

To conclude, this chapter sought to shed light on the model traits as well as the existing challenges of the new energy cluster initiatives in Poland, by zooming in on the pilot Słupsk Bioenergy Cluster in the Baltic coast region. By discussing the cluster’s background, formation process and key characteristics the analysis identified several model elements of the initiative and some pressing challenges ahead.

A combination of factors has determined the cluster’s so far success. The leadership of the Słupsk waterworks company played a key role in forging an agreement, as it enjoyed high public trust locally and brought to the table a solid track of project management experience, technological innovation and know-how. The geographical proximity of clusters’ diverse members additionally contributed to the project’s scalability and heightened its potential for circular economy solutions, while creating joint business goals for the participants. In a wider perspective, the favorable political context and the ongoing educational and promotional activities in the city in the field of sustainable energy solutions also create a certain “buzz” around the topic and increase inter-sectoral collaboration. Although the initiative is still in the early stages, the above conditions will increase the synergistic effect of the project in the long run. It is worth highlighting though that if some model elements of the cluster owe to the pre-existing conditions (e.g., geographical proximity), the local leadership is particularly important in the Polish socio-economic context. The example of the Słupsk Bioenergy Cluster shows that a strong cluster leader can create enough enthusiasm to mobilize local social capital and to mitigate some risks related to the business, legal and societal barriers by drawing on its high public trust, resources and experience. This example is highly applicable to other regions of Poland, as the bottom-up cluster initiatives

face similar challenges across the country, where the general risk-averse business attitudes and societal disengagement could be partially mitigated by strong local leadership. However, although local actors can initiate and facilitate the development of the local projects and use innovation to overcome some of the obstacles, scaling-up projects such as energy clusters inevitably remain dependent on the legislative framework in place. In Poland, the strong traditional fossil fuel industry inhibits regulatory solutions that would provide the distributed, RES-based initiatives with better access to the energy market. In the case of the Słupsk Energy Cluster, this resulted in a need to build an alternative energy distribution network for the cluster members. Moreover, other significant barriers to the advancement of the decentralized energy initiatives also remain, including insufficient governmental support and incentive schemes for energy production from RES at the local level, a lack of established market tools for new business models, lack of a stable legislative environment or the slow implementation of the EU regulations. Therefore, as far as energy cluster initiatives are concerned, it would be especially recommended that the legislative framework ensures better access to the energy market for the new local RES producers in the future and that better tax incentive schemes (e.g., for the production of energy from RES) are developed to foster the development of the bottom-up initiatives. On a wider scale, it is also crucial that there is a clear long-term energy policy course at the national level and that subsequent new regulations align with it to provide a stable business environment for the market players.

Despite insufficient governmental support, energy clusters remain in a unique position to advance the bottom-up transition to sustainable energy systems. The early experiences of the pilot Słupsk Bioenergy Cluster also highlight that strategic leadership, which can maximize local innovative potential and mobilize local actors, is crucial to overcoming some of the key barriers to the cluster initiatives in Poland.

Notes

- 1 Local administrative unit.
- 2 Author's interviews at the City Council and at the "green point," the main public library in Słupsk, 13 July 2020, Słupsk.
- 3 Author's interview at the City Council, 29 July 2020, Słupsk.
- 4 Together with Susa Valley from Italy focused on heating systems using biomass and Litomerice in the Czech Republic using photovoltaics.
- 5 "SCORE" = Supporting Consumer Ownership in Renewable Energy (CSA 2018–2020) Grant Agreement 784960.
- 6 Author's interview at the Baltic Wind.
- 7 Author's interview nr 2 at Słupsk Waterworks (*Wodociągi Słupsk*), 18 July 2020, Słupsk.
- 8 Author's interview at the Pomeranian Regional Development Agency – PARR (*Pomorska Agencja Rozwoju Regionalnego*), 27 July 2020, Słupsk.
- 9 Author's interview nr 1 at Słupsk Waterworks, 16 July 2020, Słupsk.
- 10 Author's interview nr 2 at Słupsk Waterworks and interview at the Pomeranian Regional Development Agency.

- 11 Author's interview at the Pomeranian Regional Development Agency.
- 12 Author's interview at the Baltic Wind and interview nr 2 at Słupsk Waterworks.
- 13 Author's interview at the Baltic Wind.
- 14 Author's interview at the Pomeranian Regional Development Agency.
- 15 Author's interview nr 2 at Słupsk Waterworks.
- 16 Ibid.
- 17 Author's interview at the "green point."
- 18 Author's interview nr 2 at Słupsk Waterworks.
- 19 Author's interview at the "green point."
- 20 Author's interview at Engie (heating company), 20 July 2020, Słupsk.
- 21 Author's interview nr 1 at the Słupsk Technology Incubator, 30 July 2020, Słupsk.
- 22 Author's interview nr 2 at the Słupsk Technology Incubator, 30 July 2020, Słupsk.
- 23 Author's interview nr 2 at Słupsk Waterworks and interview at the Pomeranian Regional Development Agency.
- 24 Author's interview at the local company, 16 July 2020, Słupsk.
- 25 Author's interview nr 2 at Słupsk Waterworks.
- 26 Author's interview at Engie, *ibid.*
- 27 Author's interview at the Baltic Wind.
- 28 Author's interview nr 2 at Słupsk Waterworks.
- 29 Author's interview at the Pomeranian Regional Development Agency.
- 30 Author's interview nr 2 at Słupsk Waterworks; *ibid.*
- 31 Author's interview at Engie.
- 32 Author's interview at the Pomeranian Regional Development Agency.
- 33 Ibid.
- 34 Author's interview at the Baltic Wind.
- 35 Author's interview nr 2 at the Słupsk Technology Incubator.
- 36 Author's interview nr 2 at Słupsk Waterworks.
- 37 Author's interview at the Pomeranian Regional Development Agency.
- 38 Author's interview nr 2 at Słupsk Waterworks.
- 39 Author's interview at the City Council.

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