

SONNET – SOCIAL INNOVATION IN ENERGY TRANSITIONS

Co-creating a rich understanding of the diversity, processes, contributions, success and future potentials of social innovation in the energy sector

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Research report on ‘Participatory experimentation and incubation’ in Poland



About SONNET: SONNET is a research project that aims to develop an understanding of diversity, processes, contributions and future potential of social innovation in the energy sector. It is co-funded by the European Commission and runs for three years, from 2019-2022. The SONNET consortium consists of 12 partners across Europe, including academics and city administrations. For more information, please visit our website: <https://sonnet-energy.eu>

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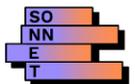
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1 FORWARD

SONNET (Social Innovation in Energy Transitions) brings diverse groups together to make sense of how social innovation can bring about a more sustainable energy sector in Europe. The project aims to co-create a rich understanding of the diversity, processes, contributions, successes and future potentials of social innovation in the energy sector (SIE). As part of this work, we make use of an embedded case study approach to build a better understanding of the development of diverse SIE-fields (e.g. participatory incubation and experimentation, framings against specific energy pathways, local electricity exchange) over time. Our research questions that frame the case study work are:

- How do SIEs and SIE-fields emerge, develop and institutionalise over time?
- How do SIE-field-actors and other field-actors interact with the 'outside' institutional environment and thereby co-shape the SIE-field over time?
- What are the enabling and impeding factors for SIE-field-actors and other field-actors to conduct institutional work and change the 'outside' institutional environment?

According to the SONNET's terminology (D3.1, 17), **social innovation in the energy sector (SIE)** is a combination of ideas, objects and/or actions that change social relations and involve new ways of doing, thinking and/or organising energy. A localised version/manifestation in time and space of a SIE is defined as a **SIE-initiative**. **SIE-actors** are individuals, organisations or other collectives who actively work on SIE and are part of a certain SIE-field. **Other field-actors** are individuals, organisations or other collectives who are part of a certain SIE-field - these can enable and/or impede SIE.

A **SIE-field** is an arena/space that includes a specific SIE as well as SIE-field-actors working on it and other field-actors enabling and/or impeding it. In this arena/ space these actors take one another

and their actions into account and have a shared (but not necessarily consensual) understanding of a SIE and of their relationship to other actors. They recognise (but not necessarily follow) shared norms, beliefs and rules. SIE-fields are often not homogenous but are composed of actors with diverse and contradictory aims and interests. An example: The UK cooperative energy field includes SIE-initiatives and SIE-field-actors (e.g. Brighton Energy Co-op, Cooperative UK, Community Energy England, UK Government, City of Brighton), who have a shared understanding of an SIE, which exists as 'organising under cooperative principles to generate renewable energy'.

The structure of this report is as follows. Section 2 provides a summary of the SIE-field relevant for this report and lists some key insights. Section 3 outlines the boundaries of the SIE-field and shows how it has been studied in the country context. Section 4 shows a visual development of the SIE-field. Section 5 tells the historical development of the SIE-field over time, including analytical/interpretive reflections from the SONNET researchers and quotes from the actors involved in the field developments. Section 6 outlines key research findings, providing answers to the three research questions. Section 7 outlines recommendations for policymakers based on the findings. Finally, Section 9 outlines the methodological approach and includes a more detailed timeline of the SIE-field and its actors.

2 The field 'Participatory experimentation and incubation' in Poland

This report investigates the field of 'Participatory experimentation and incubation' in Poland. In accordance with the SONNET case studies on this topic in Germany and the Netherlands, this refers to the multi-actor collaborative formats that aim to experiment with and/or test novel solutions in specific local settings. These solutions are of a socio-technical nature and can be driven by technological (e.g. innovative devices for microgrids' management) and social (e.g. novel business models for prosuming energy) developments. Some of the multi-actor collaborative formats have been referred to as pilot energy clusters, living laboratories, real-life laboratories and regulatory sandboxes. They involve the collaboration of actors from different societal spheres (e.g. state, market, science, community, third sector) at different levels of aggregation (e.g. individuals, collectives and organisations). This collaboration is geared towards experimenting with and/or

testing solutions in relation to specific energy pathways (e.g. collective energy prosumerism) and usually contains an implicit or explicit component of learning. They can have a broader focus (e.g. sustainability and climate change) or narrower focus (e.g. energy efficiency and energy savings).

In the Polish context, I focus on several experimental formats based on collaboration in real-life settings that have emerged in the Polish energy sector up to date: “urban experiments” on the topic of energy efficiency or RES development supported by innovative technologies (incl. so far the only living lab on energy in Poland), socio-technical experiments towards energy self-sufficiency led in an eco-village, as well as pilot energy clusters aimed at collective prosumption and local energy balancing.

Investigating this topic is of particular importance as, to my best knowledge, no such research has been done up to this date in the Polish context. Moreover, this research is a valuable contribution to the neoinstitutional theory, focusing on the understudied phenomenon of practices carried out by actors within experimental collaborative formats with an aim to influence the dominant – regulative, normative and/or cultural-cognitive – institutions in the energy sector.

Key insights

For the SONNET project, the field ‘Participatory experimentation and incubation’ in Poland is particularly interesting because it reveals a number of important issues for social innovation in energy transitions. In particular, it illustrates that:

- In the Polish energy policy, the need to decentralise the energy sector has been recognised relatively recently. It has been caused mainly by the growing pressure from the EU and the withdrawal of key institutions from financing and underwriting of coal projects. The energy transition is to be enabled by developing and testing new social and technical solutions at the local level, primarily within energy clusters. The turn to the local is dictated by a number of important factors: a) the need to seek new solutions tailored to specific regional conditions, responding to the actual needs and using available resources, b) reducing the costs of energy distribution and making it more efficient by responding to current real

By “urban experiments” I mean experiments conducted in the urban context. None of the interviewees referred to these initiatives as such (probably because they are still very niche in Poland and thus there is no need of using any specific terms other than “experiments” or “pilots”). The only exception is “Energia Living Lab” – to my best knowledge, the only living lab on energy in Poland.

demand, c) balancing the levels of production and consumption of energy within energy clusters in order to relieve the national energy distribution system and to increase national energy security.

- Before the creation of government programs aimed at supporting the process of searching and testing new solutions (organisational, technological, legal, economic) in real-life settings to support the distributed energy system development (primarily in the form of pilot energy clusters), local actors from different social spheres (NGOs, municipalities, private companies, citizens), conducted experiments on the ground in the areas of energy efficiency or self-sufficiency and/or development of RES, using innovative technologies and/or funding models. These activities were possible mainly due to: a) participation in various EU projects in line with its energy and climate policy, which was ahead of Poland's readiness to carry out the energy transition, b) growing public awareness of the harms related to the fossil fuel-based energy and the benefits of RES prosumerism.
- There is considerable potential of social capital at a local level to be used to develop a dispersed Polish energy system based on energy clusters, i.e. the Polish version of energy communities. However, so far, it has been largely untapped due to: a) unclear, unstable, and unspecific law, b) prevalent strong technocratic approach, c) lacking a coherent vision of the energy transition's social dimension and effective mechanisms for involving local communities in the cooperation hitherto taking place under the Triple-Helix model, d) underdeveloped technologies related to storage and smart management of energy.

3 Introduction to the field 'Participatory experimentation and incubation' in Poland

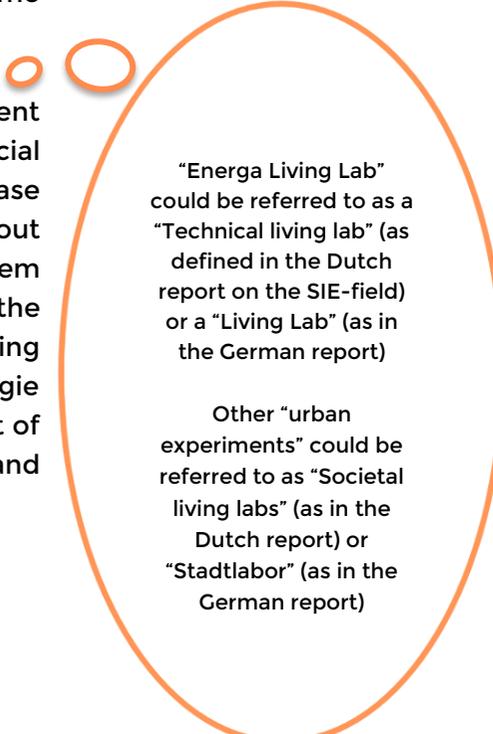
As the "Poland's National Energy and Climate Plan for the years 2021-2030" indicates, one of the priority strategic goals in Poland is to enable the transition towards the decentralised energy sector

based on increased energy production from renewable energy sources¹. While coal is still the most important source of energy, novel technological, legislative, financial and organisational solutions for new energy pathways are being tested and implemented.

In line with this, the SIE-field 'Participatory experimentation and incubation' encompasses all kinds of collaborative formats that have so far developed in Poland, aimed at multi-actor experimentation with these novel solutions in real-life settings. SIE-initiatives and other field actors interact with each other to work on, enable or impede the following SIE: collaboratively searching for and testing on local ground (action) novel solutions related to energy production, consumption, storage, and/or distribution (objects) in order to learn about the most effective means of managing energy in a decentralised realm (ideas).

The major starting point for the development of the SIE-field in Poland was the increasing pressure from EU institutions to decentralise large-scale energy by developing distributed generation sources and supporting civic engagement in energy projects (Jasiński et al., 2021). Therefore, it became necessary to search for and test new local solutions that would support this process.

The first stage of the SIE-field's development refers to bottom-up experiments initiated by different actors (NGOs, firms, municipalities, citizens), which were made possible primarily by financial support from various EU programmes and projects. Therefore, in the first part of this report (Phase 1), I describe several "urban experiments" on energy efficiency and/or RES development carried out with the use of innovative technologies (such as a dedicated application, internet platform, system for managing electricity, smart microgrid and heating microsystem) that were led by the Infrastructure Department of Warsaw City Hall, the Energa company (in the framework of a living lab, so far the only one in Poland), and the Association of Municipalities Polish Network „Energie Cités". Additionally, I describe activities undertaken in an eco-village "Osada Twórców" as a part of socio-technical experiments with energy self-sufficiency (e.g. building devices to produce heat and electricity from biomass) and development of novel financing models (e.g. crowdfunding).



"Energa Living Lab" could be referred to as a "Technical living lab" (as defined in the Dutch report on the SIE-field) or a "Living Lab" (as in the German report)

Other "urban experiments" could be referred to as "Societal living labs" (as in the Dutch report) or "Stadtlabor" (as in the German report)

¹ <https://www.gov.pl/web/klimat/national-energy-and-climate-plan-for-the-years-2021-2030>

The second stage of the SIE-field's development (Phases 2 and 3) is driven by changes in Polish legislation which, in line with EU law, has recognised the need to create structures for decentralising the energy sector. Building energy self-sufficiency at local levels is expected to take place on the basis of energy communities (Soeiro & Dias, 2020) that in Poland have materialised as pilot energy clusters (Jasiński et al., 2021).



"Poland lacks a forward-looking and economic approach to energy (...) A golden mean must be found between the national energy system and local initiatives"
Interviewee 5

The first Polish strategic document that mentioned the need to take action towards a low-carbon economy was the 'Strategy for Responsible Development' adopted in 2017. The energy was identified as one of the key issues, the so-called horizontal areas. Although large-scale energy based on coal and gas was still prioritised in this document, it was also noted that the transition towards a low-carbon economy would require a complete restructuring of the energy system and development of new business models. This was the first strategic national document that pointed to the need for the development of energy clusters, which, in the perspective of 2030, would support ensuring the stability of energy supply and gradually, in accordance with EU objectives, increasing the share of RES in the energy balance. The "Strategy for Responsible Development" has formed the basis for the "Poland's Energy Policy until 2040" (PEP2040) - the primary national document that sets the framework for the energy transition. It was adopted in January 2021 (13 years after the last update). This document already emphasises much more clearly the need to develop a distributed energy system based on energy communities, primarily energy clusters. By 2030, it is expected that 300 energy self-sufficient areas based on the energy cluster model will be established in Poland, becoming fields for further experimentation and creation of innovative solutions (PEP2040).

Policies and policy making

One of the SONNET's research questions is which role policy mixes play in SIE processes. The following definition has been adopted: Policy mixes of relevance for SIE encompass policy strategies and instrument mixes at different governance levels and policy fields which enable or impede the development of SIE, and have developed incrementally over many years through policy processes. Particular attention is paid to the co-evolution between policy mixes and SIE

within the energy system, as well as to the multi-level nature of policy mixes and the role of SIE in policymaking (D1.2, 49-50).

The Polish RES Act entered into force on 20.02.2015. It clarifies the principles, conditions and benefits of energy production from RES and defines some important concepts, e.g. of a prosumer. The definition of an energy cluster was introduced into the Polish legislation by the Act of 22 June 2016 amending the Act on RES. It was created in order to bring Polish law closer to the existing law of the other Member States in the field of energy and to help achieve the climate goals set by the EU.

Regarding energy clusters' emergence and development in the Polish context, the following EU directives have been of the greatest importance:

- 1) Directive 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Renewable Energy Directive II), which sets targets for the consumption of renewable energy sources from 2021 to 2030;
- 2) Directive 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity.

These directives introduce concepts such as Renewable Energy Communities and Citizens Energy Communities. Their members cooperate in energy production, consumption, distribution, storage and/or sale of energy from renewable sources. Their main objective is to provide environmental, economic and/or social benefits to the local communities. In Poland, such energy-sustainable areas take the form of energy clusters.

[For more information about the role of SIE in policymaking, see box "Institutional work conducted by the field actors"]

Energy cluster has been defined as: "a civil law agreement, which may include natural persons, legal persons, scientific units, research institutes or local government units, and which pertains to the generation and balancing of demand, distribution or turnover of energy from renewable sources, or

other sources or fuels, within a distribution network with a rated voltage of less than 110 kV²". In Poland, energy clusters are meant to act as smart micro-networks balancing demand and supply of energy from various forms of generation in cooperation with local partners (Caramizaru & Uihlein, 2020), ultimately becoming energy self-sufficient areas. However, up to this date, none of the existing energy clusters fulfils this task. Several interviewees even claimed that none of the currently functioning initiatives is entitled to this name yet, since, due to legislative limitations, local balancing of energy is impossible to achieve. At the moment, there are several dozen pilot energy clusters that are aimed at searching for and testing the most effective means (organisational, economic, legal, technological) for the energy clusters' development. In order to support this process, two nationally-funded programs have been launched: the "Competition for the Pilot Energy Clusters Certificates" and the project "Development of distributed energy in energy clusters - KlastER". These are the first large programs in Poland that stress the importance of transdisciplinary research for energy sustainability in real-life settings.

'Outside' institutional environment shaping the development of the field

The SIE-field and its actors are nested within an outside institutional environment linked to an energy system that is constituted by formal and informal institutions. These institutions shape the activities of SIE-actors and other field-actors within the SIE-field. One of the SONNET's objectives is to investigate the 'outside' institutional environment that surrounds and penetrates the SIE-field (D3.1, 17-18).

The growing climate and energy pressure from the EU and the withdrawal of the most important institutions from financing investments in fossil fuels have made it necessary to seek novel solutions in the Polish energy sector. Distributed energy has been identified as an important direction of the sector's development, which assumes the need to test social and technological innovations at a local level. Such an approach is justified by the recognition of fundamental

² <https://www.gov.pl/web/aktywa-panstwowe/co-robimy-energetyka-odnawialna-i-rozproszona-klastry-energii>

differences between regions in Poland in terms of economic, social, geographical, geological and other conditions.

The need for developing decentralised solutions in the energy sector has been recognised even by some of the largest Polish energy companies. The Vice-President of the Management Board of PGE Systems (a provider of ICT services for the members of the PGE Capital Group, which is the largest energy company in Poland) stated³ that the recent decision of the European Investment Bank to resign from financing investments in gas confirms the need for energy clusters' emergence. Due to the insufficient development of energy storage technology, large-scale RES installations must be compensated by gas, as they supply energy only when weather conditions permit. Local solutions provide the answer. Energy clusters know their customers, which makes it easier for them to manage energy distribution more effectively by responding to real demand. Such initiatives bring value in the form of satisfying specific market's needs: not only providing energy, but also doing it at the right time. Large-scale energy production can only adapt to the new situation by relying on huge subsidies. But by acting collaboratively on a small scale, optimal solutions can be found using existing resources. Furthermore, as one of the interviewees pointed out, energy clusters can ensure the stability of energy supply by developing, above all, biogas plants. According to the interviewee, irregular energy supplies from PV and windmills should not be secured by coal, gas or nuclear units. The under-utilisation of the capacity installed in such blocks causes a fiction of savings, as the necessary parameters (e.g. temperature) need to be continuously maintained. This means that an average block operates 50% of its rated time. As the interviewee observed, local biogas plants can provide the solution – they are more economically and environmentally beneficial, while simultaneously supporting Polish agriculture (Interviewee 5).

However, for the time being, the Polish energy system is largely based on fossil fuels with a clear dominance of coal. The share of coal in electricity production in 2019 was 73.6% (4.8 percentage points less than in 2018). Polish mines extract yearly around 50 million tons of hard coal (as of 2019),

³ II Distributed Energy Forum <https://www.er.agh.edu.pl/wydarzenia/ii-forum-energetyki-rozproszonej/>

and 61 million tons of lignite coal (as of 2017). Additionally, around 13 million tons of hard coal are imported, mainly from Russia⁴.

To a large extent, changes in the Polish energy system occur under the influence of a changing external context, including the financial sector. Already in 2013, the European Bank for Reconstruction and Development, as well as the European Investment Bank (EIB) introduced some important modifications in their energy policies. Adopting a strict Emissions Performance Standard made the EIB the first international financial institution to effectively end financing for coal and lignite power generation⁵. Subsequently, in 2019, several European banks and insurers introduced new restrictions on financing coal investments or resigned from insuring lignite and hard coal mines in Poland. Ultimately, two largest Polish banks – PKO BP S.A. and Pekao S.A. – have decided to withdraw from the investment in a new power plant unit Ostrołęka C that was supposed to be the last coal power plant construction in Europe. As a result, in establishing the energy law, legislators cannot ignore the increasingly unfavourable financial conditions that make coal projects unfeasible.



“All decent acts of protection of environment, health and water came not from Polish legislators, but from the implementation of EU directives.”
Interviewee 8

Apart from the financial institutions, the EU's climate and energy policies have had a key influence on shaping the national energy strategy. Since Poland's accession in 2004, the country has had to follow the EU policies which put an increasing pressure to move away from fossil fuels in the national energy mixes. Today, most of the environmental legislation in force results from the fact that Poland is a member country of EU and, having obtained funds, must implement appropriate regulations. However, subsequent Polish governments enacted these policies only reluctantly and have often stalled ambitious EU environmental strategies. The EU climate policy has been repetitively presented by the governments as contrary to Poland's best economic and political interests.

Among the most important EU regulations, a package of measures was adopted in 2009 which set three main objectives by 2020 (the so-called '3 x 20% package'), committing Poland to:

- increase energy efficiency by saving primary energy consumption by 13.6 Mtoe between 2010 and 2020, compared with the 2007 forecast;

⁴ <https://wysokienapiecie.pl/31452-gornicze-zwiazki-uslyszaly-ile-wegla-bedzie-potrzebne/>

⁵ <https://www.eib.org/en/press/all/2019-313-eu-bank-launches-ambitious-new-climate-strategy-and-energy-lending-policy>

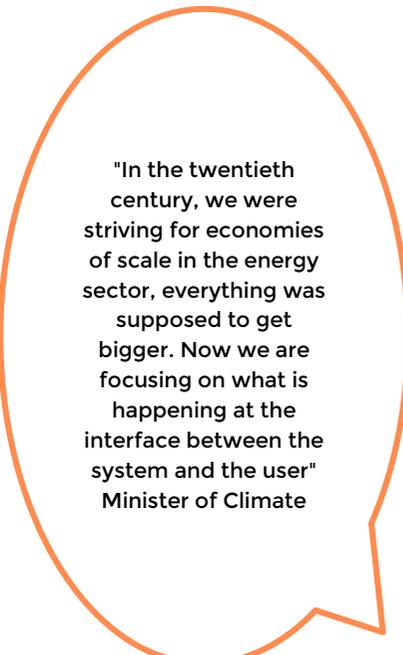
- increase to 15% the share of energy from RES in gross final energy consumption by 2020;
- contribute to the EU-wide reduction of greenhouse gas emissions by 20% (compared to 1990) by 2020.

Also, the Paris Agreement adopted in 2016 has been of key importance for the Polish energy policy. The main long-term goal of this agreement is to keep the increase in global average temperature to well below 2 °C above pre-industrial levels. During the 24th United Nations Climate Change Conference that was held in Poland in December 2018 r., the so-called Katowice Climate Package implementing the Paris Agreement was signed. It has been emphasised that the transformation resulting from the Paris Agreement must be carried out in a fair and solidarity-based manner (PEP2040).

Another very important package of directives and regulations is the so-called 'Winter Package', in other words, 'Clean energy for all Europeans, or how to unleash Europe's growth potential'. It was completed in 2019 at the EU forum, setting targets of reducing CO2 emissions by 40% and a 27% share of energy from renewable sources in final energy consumption in 2030. Importantly, consumers are to play a key role in the energy transition process. The new legislation is intended to give citizens more control over their energy choices and more benefits from participating in energy markets (Ministry of Energy, 2017).

Finally, the European Green Deal strategy presented in 2019 aims to achieve climate neutrality in the EU by 2050. Poland supported this objective but negotiated special conditions due to the difficult starting point of the Polish transformation and the high social and economic costs it entails. According to the information provided in the draft 'Energy Policy of Poland until 2040', EUR 45 billion of EU and national funds will be allocated for the national energy and climate change transformation by 2030 (PEP2040).

To sum up, the difficult situation in the Polish coal industry and the current energy policies of European financial and political institutions clearly indicate the direction of further changes in the Polish energy sector. It is necessary to move from a centralised system to a dispersed one, based on energy generation from local RES installations. The development of dispersed energy is to



"In the twentieth century, we were striving for economies of scale in the energy sector, everything was supposed to get bigger. Now we are focusing on what is happening at the interface between the system and the user"
Minister of Climate

contribute to increased energy security through greater diversification of energy sources. Distributed sources also provide better possibilities of production control, and their location close to the consumers and cooperation with networks with nominal voltage below 110 kV may significantly reduce the construction of cost-intensive high-voltage networks in the long term. The development of distributed energy systems using intelligent technologies and low-carbon solutions, however, requires strategic government decisions (Ministry of Energy, 2017).

Overview and structure of the report

This research is aimed at tracing the emergence and development of SIE-initiatives aimed at developing and testing new energy-related solutions in the local settings based on multi-actor arrangements. The development of these initiatives and framings is presented and interpreted in the context of changing social, political, and economic institutions to better understand the investigated topic and the way it has changed in time. The story covers the years from 2011 when the first experiment in the field of energy was conducted by the Infrastructure Department of Warsaw City Hall, until 2020 when the first recommendations for energy clusters were shaped as an outcome of pilots conducted within the Ministry-led KlastER project. For the ordering of information in the report and greater clarity of the argument, this time period has been divided into three main phases:

PHASE 1: 'EU-(co)-funded projects enable first local multi-actor experiments in the field of energy'

This phase covers the years 2011-2016, before launching the governmental strategies (e.g. The "Strategy for Responsible Development" adopted in 2017) and programmes (e.g. "My Electricity" programme launched in 2018, offering subsidies for photovoltaic installations in households) supporting the energy transition towards the decentralised energy system in Poland. Without government support, local actors, such as NGOs, municipalities, firms and citizens relied mostly on funds provided by various European programmes, aimed at the development of novel solutions related to energy efficiency and/or RES technologies. The Infrastructure Department of **Warsaw City Hall** participated in two EU projects: 'ICE-WISH' and 'Step by Step' aimed at conducting experiments to find new ways for improving energy efficiency among the inhabitants of Warsaw. **The Energa company** led a 3-years-long 'Energa Living Lab' that was co-financed by the European Commission.

The experiment was conducted with the active participation of Gdynia inhabitants and was also aimed at improving energy efficiency. **The Association of Municipalities Polish Network „Energie Cités”** led several EU-financed projects involving various local stakeholders who developed some pilots on RES and energy efficiency. Finally, **the eco-village ‘Osada Twórców’** has experimented with energy self-sufficiency (exceptionally without using EU funds but rather through novel business models, using e.g. crowdfunding).

PHASE 2: ‘Competition for the Pilot Energy Clusters Certificates and emergence of the first energy clusters’

This phase covers the years 2016-2018. In 06.2016 the amendment to the RES Act was implemented, which **introduced the definition of an energy cluster** and initiated the process of building a dispersed energy system in Poland but did not specify its target shape. At the same time, **Working Groups for Energy Clusters** were established to determine the topics of pilot implementations. In 03.2017 the **Zgorzelec Energy Cluster** was established as one of the first energy clusters in Poland. In 08.2017, the **first competition for a Pilot Energy Cluster Certificate** was launched, aiming at identifying initiatives with the greatest potential that would contribute to the process of refining the rationale for energy clusters’ development. On 6.2018 the recruitment for **the second edition of the Competition** started. In total, 66 pilot energy clusters have been selected.

PHASE 3: ‘KlastER Project – conducting pilot projects and taking stock of the experiment’

This phase covers the years 2019-2020. In 2019, the **project "Development of distributed energy in energy clusters (KlastER)"** was launched, implemented by a consortium consisting of Ministry of Energy (leader), AGH University of Science and Technology and National Centre for Nuclear Research. The aim of the project is to develop a strategy for the development of energy clusters in Poland, based on analyses and pilots conducted in selected clusters. In the period from 2.2019 to 8.2020, a **Research Phase of the project** took place, aimed at analysing energy clusters’ needs (organisational, technical, social, legal) and developing tools supporting their management. In 09.2020, the **Preparation for Application Phase** started, aimed at a pilot implementation of the developed technological solutions in selected clusters, pilot launch of an information and educational platform, and delivering of a coherent strategy for the development of energy clusters in Poland.

Key changes over time

The story of the field's development shows how the new paradigm of the 'socialised', dispersed energy sector has been evolving. In the process, multiple actors operating on the local level (NGOs, municipalities, citizens, local entrepreneurs) got involved in the process of finding new solutions in the energy sector, which has been unthinkable in the paradigm of a large-scale energy system and top-down governance.

Before the government took action to develop and test new solutions in the energy sector, local entities such as local governments, NGOs, firms and citizens were the first to start experimenting with new solutions on the ground. Above all, these activities were made possible through participation in EU projects, but also through purely bottom-up creativity and the search for new, sustainable solutions that are more environmentally friendly and increase energy independence (activities described in the Phase 1).

However, with the EU's increasing pressure to shift towards the distributed energy system, the government has decided to launch a major pilot programme for energy clusters to find measures supporting their energy self-sufficiency. These local multi-actor initiatives have been perceived as cornerstones of the transition towards distributed energy in Poland. The competition for a Pilot Energy Cluster Certificate was created by the Ministry of Energy to support their functioning, predominantly in financial ways (Phase 2). However, it soon turned out that practically all clusters have shown great difficulty in pursuing their primary objective, namely, to achieve energy self-sufficiency. Therefore, in order to verify which legal, technical, economic and organisational means would support fulfilling this ambitious task, the KlastER Project was initiated by the Ministry in cooperation with two important scientific institutes. The project is aimed at developing a strategy for the effective development of energy clusters through experimentation with new solutions and exchange of knowledge between actors involved on both local and national scale (Phase 3).

Among various actors and initiatives active in the field, two SIE-initiatives were chosen to be studied in more depth. The first initiative is the eco-village “Osada Twórców” (“The Creators’ Settlement”) established in 2016. It was conceived as a self-sufficient village under construction, developing alternative energy technologies and introducing them into everyday village life. According to its creators, it has been a socio-technological experiment, based on permaculture, natural construction, and energy microsystems development. In the future, the settlement is to become energy self-sufficient, based on self-made devices to produce heat and electricity from biomass. It is an interesting case of experimenting with novel energy-related solutions as it is aimed at building its own sources of energy based on open-source designs. It is also the only such an initiative in the Polish context.

The second initiative is the Zgorzelec Renewable Energy Sources Development and Energy Efficiency Cluster (ZKlaster) that was initiated in 2017. The cluster is widely regarded as one of the most successful energy clusters in Poland. Its coordinator is also the president of the National Chamber of Energy Clusters (an economic self-regulatory organization established in April 2020, representing the economic interests of its affiliated entities, entrepreneurs and their unions, operating within energy clusters). Numerous research activities, development and testing of new technologies are conducted in the ZCluster. Within its structure, there is a start-up conducting experiments in the field of energy storage technology, and the Innovation Hub that created Poland's first off-road electric vehicle. Currently, the cluster is building the largest photovoltaic farm in Poland. Interestingly, the cluster functions on the territory of Zgorzelec County, where an open-pit mine and coal-fired power plant in Turow have been operating for many years. Therefore, innovations developed within the ZCluster are also of an explicitly social nature, as much work has been needed to convince local communities about the benefits of RES development in an area dominated by conventional energy. This makes this initiative a particularly interesting case to study in more depth.

SIE changing social relations

In the SONNET’s terminology, social innovations in the energy sector (SIE) are combinations of ideas, objects and/or actions that change social relations and involve new ways of doing,

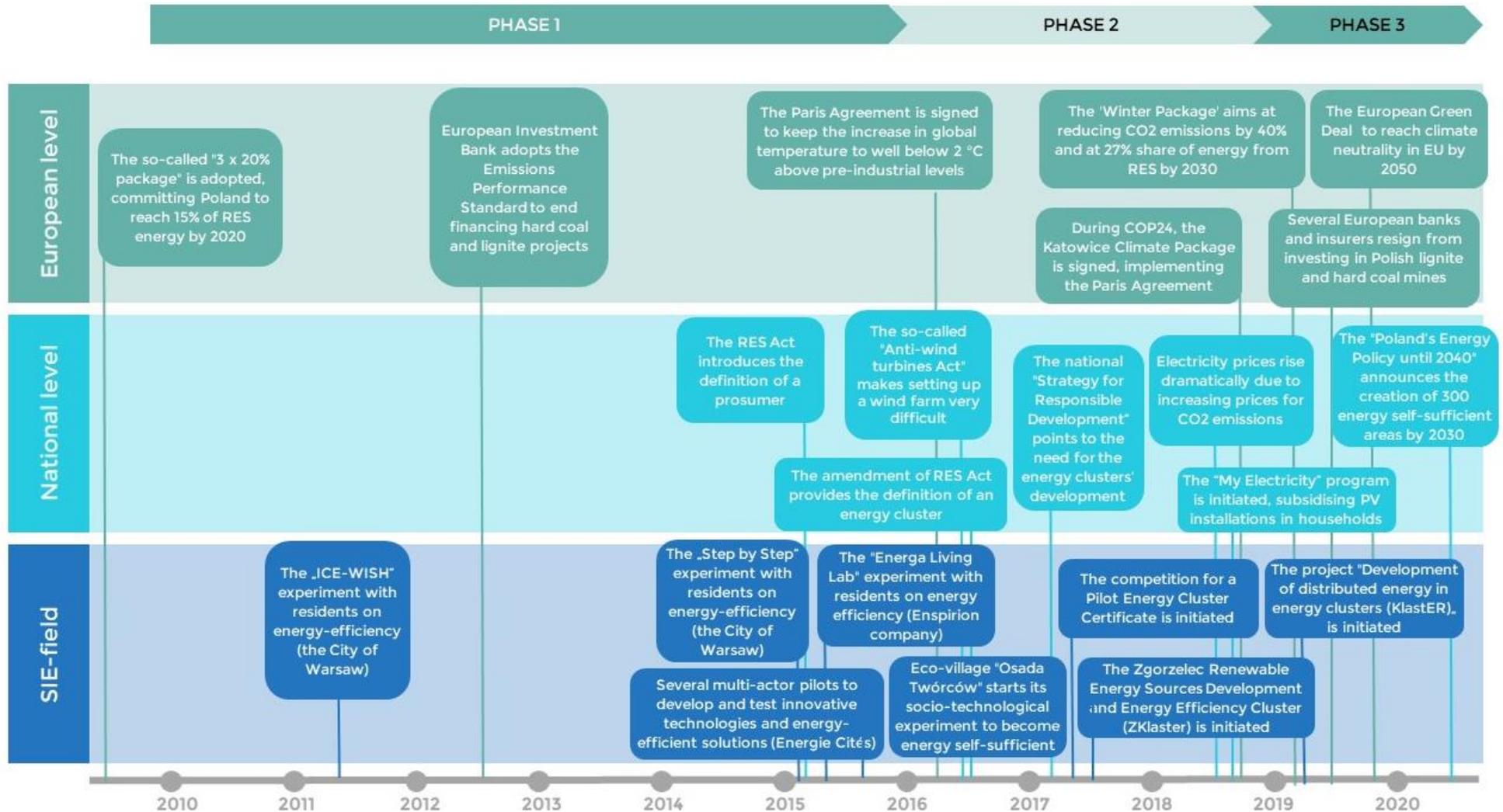
thinking and/or organising energy (D1.2, 4). Since energy systems do not only consist of techno-economic features but also various socio-cultural processes, the SIE development contributes to shifting social interactions between actors who have to undergo changes concerning their roles, practices and beliefs (Schmid et al. 2016).

As the empirical findings clearly show, the relations between the SIE-field-actors have been predominantly based on cooperation. The effectiveness of the SIE-initiatives aimed at developing and testing new solutions in energy is tightly connected to the ability of various actors to establish an agreement and conduct coordinated joint action. This cooperation has engaged actors on different levels of aggregation (e.g. individuals, communities, districts, municipality, region, country), but also from different societal spheres (e.g. citizens, local authorities, entrepreneurs, scientists, politicians) (Avelino and Wittmayer, 2016).

As the empirical findings show, experiments conducted within energy clusters, some of which as a part of the KlastER project, have been based on the Triple-Helix model, i.e. engaging actors from public, scientific and private sectors. It has been recognised in the literature (e.g. Dresler, 2019) that the Quadruple-Helix model, which is created by introducing civil society representatives to a collaboration, allows for making innovations more sustainable in economic, political and social ways. However, citizens so far have had no voice in the debate on creating new solutions in this area, and local communities have not engaged in activities conducted by energy clusters in local settings. On the other hand, citizens have been largely involved in experiments described in the Phase 1 of this report, led by NGOs or municipalities. However, these initiatives have taken place only on a small scale, and without a viable potential for scaling up. Therefore, it can be concluded that there is a need to find ways of including civil society in local experiments conducted in a Triple-Helix manner, which should be enabled by the experience already gathered by citizens, municipalities and NGOs when testing novel energy solutions on a smaller scale.

4 Timeline of the field 'Participatory experimentation and incubation' in Poland'

For a detailed SIE-field timeline and its actors, see Annex 2.



5 Emergence and development of the SIE-field 'Participatory experimentation and incubation in Poland' over time

PHASE 1: EU-(co)funded projects enable first local multi-actor experiments in the field of energy

In the City of Warsaw, a Climate Protection Team was set up in 2008, one of the objectives of which has been to inspire and trigger action to mitigate climate change by reducing greenhouse gas emissions. As a consequence, in 2009 the "Sustainable Energy Action Plan" (SEAP) was adopted in 2011 by the City of Warsaw Council. The main objective of the SEAP was to reduce energy consumption and CO₂ emissions by 20% in 2020 compared to the base year 2007. However, the city's ambition for sustainable development could not be achieved without experimenting with innovative organisational and technical solutions or without cooperation with local companies, NGOs and citizens⁶. The development of new energy solutions in the city on the basis of cooperation between different partners has been made possible mainly through participation in EU energy projects.

The first such experiment was conducted by the Infrastructure Department of Warsaw City Hall within the project "ICE-WISH: Demonstrating through Intelligent Control (smart metering, wireless technology, cloud computing, and user-oriented display information), Energy and Water wastage reductions in European Social Housing". It was carried out from April 2011 to September 2014.⁷ The project was financed from the Competitiveness and Innovation Framework Programme and was aimed at increasing energy-efficient behaviours among Warsaw social housing residents. The pilot and control groups were identified, both consisting of 30 flats. The residents in the pilot group were provided with information on their energy consumption and estimated costs through a special application. Additionally, they were given advice on how to improve their energy efficiency. The electronic devices used to transmit the information to the inhabitants were owned by the project

⁶ <http://urbnews.pl/projekty-miasta-stolecznego-warszawy-zwiazane-z-rozwiazaniami-smart-cities-efektywnoscia-energetyczna-i-ochrona-klimatu/>

⁷ <https://cordis.europa.eu/project/id/270898/pl>

partners and after the end of the project, they were returned, which made it impossible to continue the activities or scale up the solution.

The second experiment, conducted by the same department, also dealt with the topic of energy efficiency and it was a part of the project 'Step by step commitments for energy-saving' financed by the Horizon2020 programme. It was carried out from January 2015 to February 2018. The project aimed at reducing energy consumption in households and encouraged households to invest in energy-efficient products. The project was joined by 3113 households and an additional 1100 in the control group. An internet platform - built by the French project partner based on behavioural strategies - served as the basis of the project activities. Contact with the inhabitants took place every few weeks by phone and consisted of proposing personalised measures to reduce their energy consumption and, consequently, their electricity bills. At the same time, data on heat and electricity consumption was provided by the suppliers in order to verify whether a behavioural change was actually taking place. As one of the interviewees observed, learning from the experience of the previous project (ICE-WISH) realised the importance of obtaining reliable data to verify the results of the experiment.



"The advantage of the experiment was that work on a living organism took place - it was for the inhabitants and with their commitment (...) the 4-helix approach was still very innovative then"
Interviewee 4

According to the interviewee, this project was one of the most difficult for her, because it was hard to convince the residents to take part in the experiment (a total of 15,000 flats had to be visited with a proposal to join the experiment) and to serve such a large number of participants. It was also necessary to coordinate actions between the various partners involved: energy suppliers, a company serving residents, project partners providing an internet platform, residents and officials. Despite a huge effort, the project did not bring the expected results (the total energy consumption was reduced by 397 MWh), and the only perceived success was the prolonged contact with the inhabitants, who appreciated the city's involvement and declared higher environmental awareness. At that time, it was a great achievement as environmental awareness was still very low back then.

"Climate awareness has changed dramatically since 2015. I have been dealing with the climate-related issues for 13 years and then, when I said something about climate change, they laughed at me, but now (...) this is a completely different society" Interviewee 4

Also in 2015, probably the only living lab in the field of energy in Poland started to operate. It was a commercial venture organised by the Enspirion company. The experiment was half-financed by the European Commission and responded to the main EU policies, such as the 3x20% energy and climate package, reducing greenhouse gas emissions and improving energy efficiency.⁸

Enspirion is the first company in Poland to start providing electricity demand management services. The company enables a voluntary reduction of electricity usage, offering its clients remuneration for shifting consumption. The so-called negawatts, i.e. unused megawatts, are an effective way to support the power system in energy deficit situations. The "Energa Living Lab" experiment, which ran from April 2015 to January 2018, tested similar solutions among 300 households.

The test households had a multi-zone tariff with different energy rates depending on the time of day, day of the week or season. 150 of them also had a Smart Home Network, which is a modern system for managing electricity. The system included various ready-made scenarios: for example, the "go out of the house" scenario allowed the user to remotely turn off the light in the house, using a smartphone or tablet. Motion detectors were also installed, as well as window opening detectors that could inform about longer ventilation of the room and the need to switch off the heating. Test data were collected from more than 2.5 thousand devices. As a result of the experiment, an average household reduced its electricity consumption by 4.3%. Moreover, after the test phase, the participants had considerably higher levels of energy and environmental awareness⁹.

⁸ http://nfosigw.gov.pl/download/gfx/nfosigw/pl/nfoaktualnosci/113/185/2/2014_10_29_life_energa_living_lab.pdf

⁹ <https://media.energa.pl/pr/387563/energa-living-lab-optimalizuje-zuzycie-pradu-i-obniza-rachunki>



Picture 1. Tablets used in the Energa Living Lab experiment aimed at increasing the energy efficiency in households¹⁰.

Simultaneously to the experimental activities undertaken by the City of Warsaw and the Enspirion company, activities aimed at testing new solutions in the energy sector were also conducted in the non-governmental sector. They have been led by the Association of Municipalities Polish Network "Energie Cités" (PNEC) which is an NGO that since 1994 has been cooperating with local governments for shaping the local low-carbon economy, energy efficiency and RES. The PNEC serves as the official Supporting Organisation of the Covenant of Mayors for Climate and Energy. It is a bottom-up initiative of European cities and municipalities that have decided to support the implementation of EU climate and energy policy. The cities and municipalities joining the Covenant today aim to reduce CO₂ emissions by at least 40% by 2030 by improving energy efficiency and making greater use of renewable energy sources. The implementation of these objectives is made possible, among other things, by inviting cities to cooperate in the implementation of projects financed by the

¹⁰ <https://wgospodarce.pl/informacje/48047-innowacja-z-energi-pozwala-zaoszczedzic>

INTERREG programme from the European Regional Development Fund, aimed at creating and testing new energy solutions in local settings. The information provided on the PNEC website shows that within the framework of these projects, participants of local energy markets (local authorities, regional agencies, suppliers, etc.) have worked together to develop and implement pilot investments to test novel solutions on energy efficiency (e.g. in municipal buildings) and innovative technologies (e.g. smart microgrids or heating microsystems).

Introduction to the selected SIE-initiative 1

In 2016, an unusual place was created in Marcinowo - an eco-village (although its residents dislike this term) occupying an area of 7 hectares and bearing the name „Osada Twórców” (The Creators' Settlement). According to its founder, it is "a place that is supposed to prove that man is able to give more to the environment than he took from it."¹¹ Osada Twórców was established on the initiative of the Cohabitat Foundation, which is an informal group formed less than a decade earlier. It was conceived as a self-sufficient village under construction, developing alternative energy technologies and introducing them into everyday village life. According to its creators, it is a socio-technological experiment, based on co-existence in the community, permaculture, natural construction, and energy microsystems. According to the original plans, the settlement was gradually to become energy self-sufficient, creating devices to produce heat and electricity from biomass. They assumed that the energy obtained from photovoltaic panels is unstable and problematic in terms of energy storage.¹² In order to raise money for prototyping these innovative devices, they developed a novel business model. It was based on organising an annual summer workshop „Summer of Creators”, to which they invited people willing to learn more about carpentry, natural construction, permaculture and energy. Funds raised in that way were to allow for the development of the energy microsystem, making the Settlement independent of external energy supplies.

¹¹ <https://zaklad.org/kamil-w-osadzie-tworcow/>

¹² Osada Twórców, przykład zrównoważonego założenia na wsi <https://www.youtube.com/watch?v=IfD9-W407Ww>

"My dream is to show people in the countryside that they can grow fuel themselves in their own fields, that it simply pays off"
Interviewee 3

"Only ideas dedicated for the industry can be developed at Technical Universities. In my opinion, this is not progress in social terms. Our Foundation was supposed to be some kind of grassroots technical university based on crowdfunding"
Interviewee 3

Importantly, this initiative has been based solely on crowdfunding and commercial activity in obtaining the necessary funding (which distinguishes it from the other experimental projects described in this chapter, as all of them have benefited from EU funds in their activities).

However, from the interview with the founder of the Foundation, it appears that the original plans of the Settlement have not been realised. The main problem was the inappropriate way of financing the prototyping. It soon turned out that the "Summer of Creators", an activity conceived merely as financial and promotional support, started to consume most of the available resources of the Settlement. Currently, its founder plans to develop a new, sustainable business model. It is based on raising money from business activities in the form of building ecological yurts and developing online educational activities on creating micro-devices for energy autonomy. Funds gathered this way will be used to build prototypes of a biomass gasifier using energy willow. The resulting wood gas will drive a generator supplying several devices simultaneously, while all CO₂ will be sequestered by discharging it directly into the soil. The project is developed in cooperation with a scientist from the Poznań University of Technology, and the ultimate goal is to create an energy microsystem based in 100% on local biomass acquisition. The system is to include five houses in the Settlement, which will serve as energy banks for each other.

According to the interviewee, the biggest challenge for innovators wishing to develop local energy self-sufficiency is the lacking access to open source technology designs. There is a lack of institutions to support such initiatives as fab labs or makerspaces. The interviewee observed that this is all the more necessary because the topic is of great public interest and there is a huge demand for innovative solutions in the field of energy microsystems and technologies enabling energy independence.

PHASE 2: Competition for the Pilot Energy Clusters Certificates and emergence of the first energy clusters

A cluster can be understood as "a group of entities coming from different backgrounds - business, science, local government, civil society - and consciously operating in a specific ecosystem, focused on a specific territory and/or around an established specialisation. The synergy effect is achieved by formal and informal relations, shaped by the potential and social capital of the cluster, which are created and developed on the basis of joint ventures, exchange of knowledge and improvement of competences" (Knop 2013, s. 33).

In 2012, there were a total of 212 cluster initiatives in Poland (PARP 2012, p. 8). Such a large number was dictated by incentives from the Ministry of Economy under programmes supporting entrepreneurship and stimulating economic development (Jabłońska, 2015). The growing recognition of a knowledge economy as the main driver in sustaining long-term economic growth contributed to the development of the cluster formula. The model of innovation has also changed, evolving from a simple chain of activities - often carried out independently within large organisations - into a complex, multi-relational model based on feedback loops, involving both core and satellite organisations (such as business environment institutions, local government units, financial institutions), as well as end-users (Daczyńska et al., 2011).

At the end of 2014, there were 14 registered clusters operating within the fields of renewable energy or environmental protection¹³. Their main objectives were to increase the effectiveness of obtaining European funds for RES, conducting educational and informational activities and creating platforms for cooperation between cluster participants. In most cases, however, they carried out activities of a non-innovative nature, without fully exploiting their potential.

As the document review indicates, with the growing need to adapt the Polish energy and climate policy to the EU requirements, in 2016 the Ministry of Energy decided to run a program that would build on the potential of cluster initiatives. Its aim was to find the best ways to support clusters

¹³ www.pi.gov.pl/PARP/data/klastry/index.html

"Energy clusters constitute the logic of distributed energy. They plough the ground where nobody thought it was possible to sow something"
Interviewee 1

operating in the field of energy, so that they become the main driver of change towards the development of distributed energy in Poland, ensuring the delivery of RES Act targets.

"We are aiming for dispersed energy, democratic energy, to become a reality in the next few years. I think that within three to five years energy clusters will definitely fill the energy system in Poland, and will also become the foundation of our energy security" Ireneusz Zyska, Deputy Minister for Climate and Environment, Government Plenipotentiary for Renewable Energy Sources¹⁴

Therefore, in July 2016, amendments to the RES Act were adopted, introducing the concept of an energy cluster into Polish law. It has been defined as: "a civil law agreement, which may include natural persons, legal persons, scientific units, research institutes or local government units, and which pertains to the generation and balancing of demand, distribution or turnover of energy from renewable sources, or other sources or fuels, within a distribution network with a rated voltage of less than 110 kV¹⁵".

The legislator intended to create a legal institution that would contribute to the grouping of energy producers and consumers from a given area in such a way as to maximise the energy flows between them, without taking into account the high voltage grid. One can distinguish three basic models of energy clusters: 1) A cluster based on cooperation with an existing distribution system operator, 2) A cluster based on its own distribution infrastructure, 3) A solution combining these two options. Especially the second model has a great potential for innovation, allowing for testing a new technical solution in the area of smart grids or demand management (Ministry of Energy, 2017).

The main (target) benefits associated with the functioning of energy clusters are the following¹⁶:

- increased and rationalised use of local resources;
- cheaper energy supply and higher energy efficiency;
- RES development without external subsidies;

¹⁴ <https://wroclaw.tvp.pl/49767897/chcemy-by-klastry-byly-waznym-elementem-bezpieczenstwa-energetycznego>

¹⁵ <https://www.gov.pl/web/aktywa-panstwowe/co-robimy-energetyka-odnawialna-i-rozproszona-klastry-energii>

¹⁶ <https://eneris.pl/klastry-energii/korzysci-klastra-energii/>

- increasing the attractiveness of investment sites by reducing energy supply costs and guaranteeing the security of energy supply;
- improving air quality;
- creating new jobs.

"Energy clusters are the answer to the needs of energy policy objectives and to take action to eliminate the many years of lagging behind in the use of RES. (...) they are laboratories for energy market change." (Bembenek and Moszkowicz, 2017; 295)

However, as the Parliamentary Mining and Energy Group pointed out, the amended RES Act initiates the process of building a dispersed energy system but does not specify its target shape.¹⁷ Therefore, enabling clusters to achieve the aforementioned benefits requires an effective and flexible model of their development in Polish legal, economic, social and technological conditions. The tailored framework is needed that would allow these pioneering initiatives to function effectively while gradually developing self-financing mechanisms. Therefore, the Ministry of Energy has created an institution of pilot energy clusters to verify in practice what kind of support these entities need and to be able to propose appropriate solutions. Certified pilot clusters can count on public support but must be able to function on their own after the end of funding (Pylak et al., 2017). In 2016, the Ministry of Energy established Working Groups for Energy Clusters, which were to define the topics for pilot implementation. Overall, the competition for a Pilot Energy Cluster Certificate was aimed at¹⁸:

- stimulating the development of energy clusters,
- identification of investment needs in clusters,
- promotion of good practices within energy clusters,
- external verification of a cluster's strategy,
- creating a platform for the exchange of experience.

¹⁷ [http://orka.sejm.gov.pl/opinie8.nsf/nazwa/390_20160907_3/\\$file/390_20160907_3.pdf](http://orka.sejm.gov.pl/opinie8.nsf/nazwa/390_20160907_3/$file/390_20160907_3.pdf)

¹⁸ http://www.nfosigw.gov.pl/download/gfx/nfosigw/pl/nfoaktualnosci/15/1299/22/3.me_deo_nfosigw.pdf

The Ministry of Energy has conducted two rounds of calls, in which it has awarded sixty-six certificates for pilot energy clusters. The first competition ended in May 2018 and the second competition in October 2018. In total, 199 cluster initiatives were submitted to the competition (Nowakowski, 2018).

Certified Energy Clusters have been allowed to use funds available under the Regional Operational Programme and the Operational Programme Infrastructure and Environment. Some forms of co-financing of projects implemented under energy cluster agreements are loans and grants (Błazejewska and Gostomczyk, 2018). In 2017, the National Fund for Environmental Protection and Water Management allocated EUR 160 million for co-financing of energy clusters from the EU funds. In the Regional Operational Programme for 2014-2020, for all the voivodships, the EU funds of the total amount of EUR 897 million were provided¹⁹.

According to the survey²⁰ carried out among the coordinators of 50 energy clusters that received the Ministry of Energy Certificate, the main reason for taking part in the competition for a Pilot Energy Cluster Certificate was to increase the chances of obtaining funding from external sources. The coordinators also wanted to subject their cluster development strategies to the evaluation of specialists. However, as many as 60% of respondents said that the certificate received did not ultimately bring many benefits to the clusters.

Introduction to the selected SIE-initiative 2

Zgorzelec Renewable Energy Sources Development and Energy Efficiency Cluster (ZKlaster) was established in March 2017. The cluster is widely regarded as one of the most successful energy clusters in Poland. For example, the Government Plenipotentiary for Renewable Energy Sources Ireneusz Zyska recently announced the creation of 300 energy self-sufficient areas, indicating an energy cluster from Zgorzelec as a model example. Moreover, the cluster's coordinator is also the president of the National Chamber of Energy Clusters (an economic self-regulatory

¹⁹ <https://www.gramzielone.pl/trendy/27229/dofinansowanie-dla-klastrow-energii-wkrotce-nabor-wnioskow>

²⁰ https://www.er.agh.edu.pl/media/filer_public/3a/8b/3a8b28a9-fc5a-4ecc-b1e2-cac18288e49a/11_00_jgadecki_1306.pdf

organization established in April 2020, representing the economic interests of its affiliated entities, entrepreneurs and their unions, operating within energy clusters). Initially the cluster had 32 partners, now there are over 100 of them (according to one of the interviewees, about 40% of the partners are inactive).

The ZCluster functions on the territory of Zgorzelec County, where an open pit mine and coal-fired power plant in Turow have been operating for many years. Recently, the representatives of the Cluster signed a Declaration of Cooperation with local governments in order to obtain funds from the Just Transition Fund for the process of moving away from coal in the region. Also, on the initiative of the ZKlaster, an expert analysis was created, presenting the concept of replacing the Turów power plant with energy from renewable sources. However, the cluster also supported the petition to the President of the European Commission, opposing the closure of the power plant within next 10 years (which is a demand of environmental activists), claiming that such rapid changes would have a negative impact on the local economy and energy security of the region.

Numerous research activities, development and testing of new technologies are conducted in the ZCluster. Within its structure, there is a start-up E-Power Control, conducting experiments in the field of energy storage technology, and the Innovation Hub, in which Innovation AG created Poland's first off-road electric vehicle Sokół 4x4. Currently the cluster is building the largest photovoltaic farm in Poland. A 50 kWh microgrid project is also being developed, which is currently in the pilot phase with 10 clients involved.

According to the coordinator of the ZCluster, their strategy is to gradually develop various elements of the cluster: first, constructing energy generation sources, and then, developing energy distribution and sales, also outside the cluster²¹. The ultimate goal is to build the most efficient local energy market. According to one of the interviewees, the success of the ZCluster results from the fact that from the beginning it has been conceived as a business venture based on private capital.

²¹ <https://www.wnp.pl/energetyka/albert-gryszczuk-udowodnilismy-ze-rozwoj-klastrow-energii-jest-mozliwy-bez-specjalnych-regulacji,348582.html>

Its funders consider it to be the most effective model that makes the cluster "*the strongest entity*" (Interviewee 1). As the interviewee observed, it positively distinguishes the ZKlaster (as well as another cluster in Oława indicated by the interviewee) from other Polish clusters. The second important factor is the engagement of people with previous business or technical experience. The third success factor is the ability to network efficiently.

The ZCluster has played a very important role in the context of negotiations with the owner of a mine and power plant in Turow, PGE GiEK SA (Polish joint-stock company, a leader in the lignite mining industry in Poland and the largest national electricity producer), and local communities on the need for a green transition of the region. Seemingly, the most difficult thing to do so far was to "*influence the social awareness, where three generations were brought up on a coal culture*" (Interviewee 1). Recently, PGE publicly announced a plan for a gradual transition from fossil fuels to RES. According to the interlocutor, this is to a large extent "*the effect of the ZCluster's work. We conducted comprehensive activities: we hired PR agencies, wrote articles, made websites, analyses, organised conferences, and finally established the Transformation Committee (...) and in spring also PGE joined it*" (Interviewee 1).

According to the interviewee, the Competition for Pilot Energy Clusters "*has opened the door to the world of energy*" (Interviewee 1) for local actors. The very fact of having the logo of the Ministry of Energy on the interviewee's business card and the inscription "Certified Cluster" made the local governments take a different approach to discussions on development opportunities. However, the interviewee stressed that the current law is insufficient for the effective energy clusters' development. Introduction of a statutory definition of an energy cluster is needed, providing it with a separate category on the energy market next to energy producers, distributors and consumers. This is necessary to enable effective energy balancing.

"Now the experiment is over, and the necessary regulations must be introduced." (Interviewee 1)

According to Scott, institutions are „multifaceted, durable social structures, made up of symbolic elements, social activities, and material resources” and they „comprise regulative, normative and cultural-cognitive elements that, together with associated activities and resources, provide stability and meaning to social life.” (2014, 56-57). One of the SONNET’s objectives is to understand how regulative, normative and cultural-cognitive elements of the dominant outside institutions influence the emergence and development of SIE, i.e. their social relations and patterns of doing, organising and thinking. (D3.1, 18) The ‘doing’ aspect of a SIE is defined in SONNET as referring to practices related to the physical composition of the energy system. ‘Organising’ relates to governance and organisational structures within SIE-initiatives and the energy system. Finally, the ‘thinking’ aspect refers to all forms of knowledge and normative framings, including values and perceptions (D3.1, 15).

The **regulative pillar** of institutions relates to rules, laws, policies, standards, and sanctions that are the key elements and mechanisms of compliance in these institutions (D1.2, 21). In the case of energy clusters, this institutional pillar manifests itself through its absence or incompleteness, rather than as a guide on “action and perspectives by coercion or threat of legal sanction” (Hoffman 1999). The main barrier to cluster development is the current law. The definition of a cluster is too general, the benefits of joining a cluster for individual entities are unclear, relations between clusters and distribution network operators are unregulated and there is a lack of financial incentives. Furthermore, energy law and the functioning of the energy market are overregulated. Therefore, according to the majority of the interviewees, the current energy policies should be modified, as they represent a serious barrier to the achievement by clusters of their primary objective, namely, achieving energy self-sufficiency (i.e. the ‘doing’ aspect of SIE).

The **normative pillar** of institutions takes the „form of rules-of-thumb” (Hoffman 1999) with regard to values, social norms, duties, and role expectations in a particular field (Scott 2001). Actors adhere to these guidelines, as their actions and beliefs are guided forms of social

obligation and professionalization (D1.2, 21). The EU was the first to send out a signal that civil society has a shared responsibility for implementing the climate and energy policy guidelines. Before acknowledging it in the Polish national strategic documents, municipalities and NGOs, by taking part in EU projects and receiving European grants, learned that they are expected to be actively involved in finding and testing new solutions in the context of energy saving, renewable energy production or energy self-sufficiency. This, however, has posed significant challenges. For example, cities need to develop a new language of communication with citizens treating them as equal partners, as well as new methods of operating within the office based on cooperation between departments (i.e. the 'organising' aspect of SIE). However, according to the interviewees, there is still a lack of vision in Poland that would indicate how to involve citizens in the energy transition, particularly in the form of energy communities' development. Creating a vision of this process's social dimension is necessary for the new solutions to be not only economic or technological in nature but also to support the new paradigm that radically changes the role of local communities from passive energy consumers to active and conscious prosumers.

The **cultural-cognitive** pillar of institutions refers to the socially constructed, shared conceptions of reality, binding expectations and common beliefs with which the world is interpreted or meaning is given, such as symbols, discourses and cultural categories (D1.2, 22). The shift towards the dispersed energy production based on RES prosumerism and increased energy efficiency is not possible without changing the dominant social discourse determining who can demand to take part in the discussion about the direction of the Polish energy sector development. In the conventional approach, only large energy companies and the national government are seen as competent actors who should make all decisions on behalf of the whole society. However, the development of the SIE-field shows that more and more local actors are engaged in the search for new energy solutions that best meet local needs. This is due to, among other things, the growing public awareness of the challenges posed by the climate crisis and the environmental, financial and health damage associated with running 'business as usual' in the Polish energy system (i.e. the 'thinking' aspect of SIE).

PHASE 3: KlastER Project – conducting pilot projects and taking stock of the experiment

As both the empirical findings and document review indicate, in many cases, energy clusters have been established and received a Certificate from the Ministry of Energy, but in the scope of the clusters' activities related to energy balancing and trading, progress is not there yet. The only area of operation that is somewhat more advanced is the generation of electricity, but it is not necessarily the result of clusters' establishment. The current law does not provide any advantages to a cluster's members in terms of connecting their facilities to the DSO (Distribution System Operators) network. So far, it takes place on the same principles as in the case of other, non-clustered consumers or producers (Borowiak et al., 2018).

As already mentioned, the RES Act leaves quite a lot of freedom to formulate the rules of functioning of energy clusters, including mutual rights and obligations of its members. The key and largely decisive factor determining whether the concept of energy clusters will succeed is the shape of future regulations concerning the organisation of clusters, rules of their operation and a clear incentive for consumers to receive electricity from producers belonging to a cluster. The legislator must answer the question about who should benefit from an energy cluster's creation, and in what ways specifically²². Therefore, in order to fully exploit the potential of the distributed energy, it is necessary to overcome organisational, regulatory, technological, economic, and legal barriers, so that all parties are provided with favourable conditions for their development.

These and other problems are to be addressed within the project "Development of distributed energy in energy clusters (KlastER)" carried out in 2019-2021 by a consortium composed of the Ministry of Energy (leader), AGH - University of Science and Technology (the second-best Polish technical university, located in Kraków and established in 1919) and NCBJ - National Centre for Nuclear Research (the largest research institute in Poland, established in 2011). The project is implemented as a part of the strategic programme "Social and economic development of Poland in the conditions of globalizing markets - GOSPOSTRATEG". The main objective of the Programme is

²² <http://psew.pl/czy-klastery-energetyczne-uzdrowia-sektor-oze-w-polsce/>

to increase the use of social and economic research results in shaping and implementing national and regional development policies by 2028. The long-term effect of the programme assumes an increase in social capital and wider involvement of Poles in various forms of public activity. The budget of the Programme for 2017-2020 amounted to 120 million euros²³.

According to some of the interviewees, the aim of the KlastER project is to create a strategy for the further development of energy clusters in Poland based on analyses and pilots conducted in the selected clusters. Representatives of energy clusters and leading experts work together on identifying barriers to the clusters' development and indicate ways of overcoming them. The project includes research on technical, legal, economic and social conditions and barriers to the development of energy clusters. On this basis, some socio-technical innovations are developed: tools that support designing and evaluating the profitability of clusters; technological solutions supporting clusters' management; a set of good practices concerning legal, organisational and technological solutions facilitating the creation of new clusters²⁴.

Power and power relations

In SONNET, power is understood as the relational and structural (in)capacity of actors to mobilise resources and institutions to achieve a goal. Power relations in SIE refer to (a) actors having different kinds/levels of power to mobilise SIE-related resources and/or to achieve SIE-related goals, (b) actors having power over others in SIE-related processes, and (c) actors having power with other actors to achieve collective goals (D1.2, 44).

'Power with'

The story of the field's development shows that initially, multi-actor experimental formats had been developing on a micro-scale, initiated by different local actors with the support from various European programs. Developing and testing novel energy solutions allowed for the previously powerless and unconnected actors to learn from each other (as in the case of PNEC projects based on cooperation between entrepreneurs, citizens and municipalities) for the

²³ <https://www.ncbr.gov.pl/programy/programy-strategiczne/gospostrateg/>

²⁴ <https://www.er.agh.edu.pl/projekt-klaster>

benefit of each partner (e.g. an increased awareness of Warsaw residents about energy saving in the Step by Step project or real financial savings of people participating in the Energa Living Lab). Later, when the government launched the Competition for the Certificates of the Pilot Energy Cluster and the KlastER project, other forms of cooperation emerged. Actors at different levels (local, regional, national) and from different sectors (entrepreneurs, politicians, scientists) started a joint debate on the challenges related to the development of distributed energy in Poland and possible ways of solving the identified problems.

'Power over' → 'Power to'

The experiments described in the report allowed the involved actors to search for new energy solutions that best suit their specific local needs and make the most efficient use of available resources. This is a significant change from the conservative paradigm in the energy sector, according to which only large energy companies and the government should decide on the direction of the sector's development and impose the systemic rules on smaller players, exposing them to damages related to, among others, higher energy prices, black-outs, air pollution or environmental and climate risks. Moreover, the KlastER project has allowed local entrepreneurs, local governments, scientists and independent experts to influence the shape of the strategy of further development of energy clusters, also in a legislative context.

According to the information given on the project's website²⁵, the KlastER Research Phase started in February 2019 and lasted 18 months, during which the analysis of needs (organisational, technical, social, legal) was performed and technological solutions supporting energy clusters management were developed. In 09.2020, the Preparation for Application Phase was launched, aimed at the pilot implementation of the developed technological solutions in selected clusters, pilot launch of an information and educational platform, verification of the activities undertaken and development of a coherent strategy for the development of energy clusters in Poland.

The pilots in selected energy clusters have been carried out by a team from NCBJ. According to one of the interviewees, their aim is to develop optimisation tools for planning a local energy mix and for

²⁵ https://www.er.agh.edu.pl/media/filer_public/d0/e1/d0e1f64f-463b-4fa8-bfde-8c3579caa19d/10_30_skopec-12ix2019.pdf

managing the existing infrastructure of an energy cluster. As the interviewee observed, the biggest challenge has been to find proper ways of implementing solutions that had been applied in large-scale power systems in the context of the distributed energy.

"We are looking for synergies between clusters and the network so that savings and system benefits can appear and so these clusters can pay for themselves. To this end, we are conducting agile or research activities, that is to say, testing hypotheses as to what specific business models could bring this added value." Interviewee 2

The team is guided by the principle of developing innovations in close cooperation with local partners who test technologies in real-life settings. Zefir, the most advanced tool developed as a part of the KlastER project, can be used to create an energy transition plan in a municipality (depending on the objectives set, e.g. reduction of smog or savings in heating) and to facilitate communication between the municipality and its inhabitants. According to the interviewee, this is an important aspect of the process, because when local authorities plan a certain direction of development, they should be able to communicate the value and specific benefits to the citizens. Pilots of Zefir have been conducted in Żywiec and Zawiercie. The interviewee observed that when selecting partnering cities for running the experiments, the most important factors are: the authorities' willingness to cooperate and access to a detailed data (e.g. on energy consumption in a municipality or energy efficiency of buildings).

In addition to the piloting of new technological solutions dedicated to energy clusters, the launch of regulatory pilots is planned for the next year: among the recommendations developed within the KlastER project is testing of legal solutions in the regulatory sandboxes formula. As one of the interviewees stated, this solution is important and necessary, because, in the context of the currently very complicated legislation in the Polish energy sector, introducing changes at the national level is associated with years of working on new regulations. What is more, it is impossible to predict the consequences of introducing such a new law (for example, how it will be interpreted). Therefore, the regulatory sandboxes are needed so that the necessary legal solutions can be worked out quickly, being developed in an isolated space. The proposed first topic is financial incentives that

would provide the best motivation to operate within an energy cluster for partners from various sectors.

Institutional work conducted by the field actors

One of the SONNET's aims is to gain a deeper understanding of sustainability transitions in which actors create, maintain or transform dominant institutional arrangements within the energy systems to prevent threats such as climate change and resource deprivation (D1.2, 20). Actions conducted by institutionally embedded individuals or organisations in order to increase their power by „creating, supporting, or modifying institutions” (Lawrence & Suddaby, 2006: 215) are conceptualised as institutional work.

The empirical findings show that the SIE-field-actors have been engaged predominantly in creating institutions. Institutional scholars have identified various types of institutional work (e.g. Phillips and Lawrence, 2012). In this case, the SIE-field-actors have been conducting mainly three types of institutional work: boundary work (by redefining the conservative stance about who can be an active player in the Polish energy sector: not only state-owned energy companies and the national government, but also local authorities, small companies, NGOs, citizens, cities etc.), strategy work (the main aim of the project KlastER is to develop a new strategy for energy clusters in order for them to become a cornerstone for the dispersed energy sector's development in Poland), practice work (day-to-day work on developing novel governance or organisational arrangements), and material work (development and testing of novel technologies in energy production, storage and distribution).

As stated above, the ultimate goal of the KlastER project is to develop a strategy for the development of energy clusters. The recommendations are supposed to be included in the amendment of the RES Act and the final version of PEP2040. This shows that the action of SIE-field-actors can have a real impact on legislation at the national level. To date, an analysis of barriers to the development of energy clusters has been carried out, and appropriate changes

to the legislation have been proposed. Among the recommendations prepared in extensive cooperation with the stakeholders, the most important ones are the following:

- clarification of legal provisions concerning energy clusters;
- extending the definition of an energy cluster to allow participation of housing communities and to include energy storage in its scope of activities;
- establishment of a list of "registered clusters" with dedicated privileges;
- clarification of the rules for cooperation with a distribution network operator;
- establishing specific rules for the acquisition of energy generated in a cluster;
- facilitation of obtaining concessions for electricity trading for clusters;
- facilitating the creation by cluster members of their own network infrastructure;
- setting a special energy distribution tariff for energy clusters.

Apart from the direct attempts to influence the regulations, institutional work led by the SIE-actors might also have some unintended consequences. According to the authors of the „The Concept of Energy Clusters Functioning in Poland" (Ministry of Energy, 2017) establishing an energy cluster has certain positive consequences that go far beyond the municipality, often emanating across the country. This means that, intentionally, members of the cluster are only able to implement objectives of an individual or local character, which, however, translates into the implementation of broader (and often convergent) regional and national objectives. What is more, the most benefits of energy clusters were identified by the authors at the national level, for example:

- local energy production reduces the load on the large transmission systems, improving energy quality and reliability of energy supply, which - on the principle of connected vessels - has also a regional and national impact, i.e. increases the national energy security;
- increasing the share of RES in the national energy mix and fulfilling Poland's obligations resulting from the EU membership;
- the increase in innovation, development of new business models and growth of technical culture is associated with the stimulation of national economic development and the improvement of competitiveness of the Polish economy.

Diversity, contestations and relations between actors

Local authorities have a very important role to play in the development of distributed energy. Their activity is a result of the growing competence of local governments in creating legal, spatial and investment foundations of the local energy market (Maśliński, 2017). The Minister of Development Jadwiga Emilewicz recently stated there have been already some actions taken to extend the prosumer status to local government units, which will make it profitable for them to invest in RES and encourage them to become more active players in the energy market²⁶.

According to the Deputy Mayor of the City of Krakow, the city is an excellent laboratory for the development of a distributed energy system. Appropriate state policy should support close cooperation between municipal authorities and local communities²⁷. For example, in the Wałbrzych Energy Cluster, the city of Wałbrzych is the cluster's leader, which – according to one of the interviewees – positively influences its functioning. As the interviewee observed, the personality of the President is of great importance, as he enjoys general recognition among partners. However, the local government mustn't dominate the rest of the partners. This can be observed in these clusters where the received EU funds have not been distributed among all actors involved in a cluster but rather taken over by the municipal office (Interviewee 6).

The existence of such a risk is confirmed by another interviewee, who believes that it is very difficult for energy clusters run by local governments to achieve their objectives as: *“they have a desire in their DNA to use the money to consolidate their local government institutions, not to develop distributed energy”* (Interviewee 1).

According to another interlocutor, local governments can play an important role in those clusters which, before the certification, had social or technical capital on which they could build (e.g. RES infrastructure or engagement in environmental protection). The local government can play an important role in the continuation of previously undertaken operations. On the other hand, in cases where obtaining a pilot energy cluster certificate was seen primarily as an

²⁶ <https://www.er.agh.edu.pl/wydarzenia/forum-energetyki-rozproszonej/>

²⁷ II Distributed Energy Forum <https://www.er.agh.edu.pl/wydarzenia/ii-forum-energetyki-rozproszonej/>

opportunity to receive funds for the implementation of *ad hoc* projects, local governments are seen as an unnecessary burden in conducting technological or business endeavours.

Similar challenges concern a cluster-like initiative “Nasza Energia” (Our Energy) that had been established in 2014 before any Polish legislation regarding energy communities was enacted. In the beginning, the very ambitious plans of its founders – the Bio Power company from Zamość – could not be realised because of the lack of commitment and support from the local government. The founders planned to build the largest autonomous energy region in Europe, based on an integrated network of 15 agricultural biogas plants, each with a capacity of 0.5 - 1 MW. A unique technical solution was designed in the form of so-called energy nodes, consisting of three biogas plants, mutually reserving their power. The electricity and heat produced would be distributed through the owned low-voltage power lines to public buildings and households. The benefits would be cheaper energy, activation of local agriculture, creation of jobs, access to highly efficient manure, reduction of pollution and improvement of power supply safety in the areas of eastern Poland, which are most at risk of black-outs. Despite the numerous benefits, it was not possible to implement this project, because the local governments decided not to offer financial support. They were only involved in the search for suitable locations for biogas plants. In this situation, the founders tried to find partners among private companies, but they were afraid to invest in such an uncertain project.

The important role of the local government in such initiatives was well expressed by Ireneusz Zyska, Deputy Minister of Climate and Government Plenipotentiary for Renewable Energy: *„The participation of local government increases the level of trust of the local community in this initiative. (...) which has a great chance and even a mission to provide stable, high-quality energy for the whole area of the municipality and the district in the future. The support of the local government is of great importance here”²⁸.*

Bio Power is currently advising private investors who are building three biogas plants in the region. The commercial activity is to raise funds for the original plans of the initiative (Interviewee 5).

²⁸<https://wroclaw.tvp.pl/49767897/chcemy-by-klastry-byly-waznym-elementem-bezpieczenstwa-energetycznego>

6 Summary, synthesis and conclusions

6.1. How have the SIE and SIE-field emerged, developed and institutionalised over time?

Most important **SIE-field-actors** (actors who work on SIE) behind participatory experimentation and incubation in Poland **at the early stage** of its development were local entities such as local governments and networks of local governments (e.g. Energy Cités), NGOs, companies and citizens were the first to start experimenting with new solutions on the ground. Some of these activities were enabled through participation in various European projects, but also through purely bottom-up creativity and the search for new, sustainable solutions that are more environmentally friendly and increase energy independence. Examples of the action driven by participation in EU projects are experiments on energy efficiency, such as the “ICE-Wish” and “Step by Step” experiment run by the City of Warsaw or actions animated by Association of Municipalities Polish Network “Energie Cités” (PNEC). Example of bottom-up, independent nich experiment is provided by “Osada Twórców” aiming and creation of the off-grid autonomous “village”. Company’s involvement is demonstrated by Enspirion company, which via “Energa Living Lab” tested solutions based on demand management service among 300 households.

At the later phases, new actors gain prominence: the Ministry of Energy through the Law on Energy Clusters, and the certification of energy clusters, which facilitated local collaboration between municipality-owned entities (such as e.g. units responsible for water and sewage or residential heat), local enterprises, and incumbent energy distribution companies. At the last stage, the presence of academics and researchers, mainly with engineering background, become more prominent. It is clearly signalled by the development of research and policy consultancy project KlastER, run together by the AGH University of Science and Technology, NCBJ - National Centre for Nuclear Research and IDEA Interdisciplinary Department of Energy Studies and the Ministry of Energy. At this stage, a few energy clusters gained some prominence by being able to create collaborations which produced and exchanged energy. Zgorzelec Renewable Energy Sources Development and Energy Efficiency Cluster (ZKlaster) is one of the examples. However, it is important to stress that the vast majority of clusters which gain the Ministry’s certificates were not able to start their

operations. It soon turned out that practically all clusters have shown great difficulty in pursuing their primary objective, namely, to achieve energy self-sufficiency. That is mainly due to the regulatory impediments. The National Chamber of Energy Clusters is one of the new actors aimed at lobbying for favourable legislation, as well as networking and exchange among energy clusters.

In order to verify which legal, technical, economic and organisational means would support fulfilling this ambitious task, the KlastER Project was initiated by the Ministry in cooperation with two important scientific institutes at the last phase of the SIE-field development. The project is aimed at developing a strategy for the effective development of energy clusters through experimentation with new solutions and exchange of knowledge between actors involved on both local and national scale. That shows the growing role of experts and academics in the field. However, it is important to stress that the project has a wide and transparent formula: its meetings are recorded and available online (likely, this process was strengthened by COVID19 pandemics), and run with the participation of representatives of different sectors (governmental, municipality, business).

Other field-actors (who enable and/or impede SIE) are different groups lobbying for energy transition based on renewable and dispersed energy who enable participatory experimentation and incubation in Poland by spreading the belief - both in public opinion and among decision-makers - that this is the most probable and profitable path for energy development in Poland. Here, we can list coalitions of NGOs (e.g. Polska Zielona Sieć, WWF Poland), not formalized social movements (such as Climate Strike), or educators (such as the group responsible for running the website Nauka o Klimacie, naukaoklimacie.pl). Another important group is constituted by academics, mainly representatives of technical science, who build an argument that Polish energy system without fossil fuel is possible to construct. An example of a prominent group active in this field is gathered around prof. Jan Popczyk from Silesia Technical University and his think-tank Stowarzyszenie Klaster 3x20 (Association Clusters 3x20). Finally, the available funds and subsidies for the development of RES impact which actions are financially viable.

Changes to the roles of SIE-field-actors and other-field actors over time reflects that the renewable and dispersed energy system slowly is getting recognition in the Polish energy strategy and the relevant legislation, and is accepted as a likely prominent element of the future Polish energy landscape.

We distinguished three phases of the SIE development, illustrating how new activities have been undertaken to answer the possibility created by changing circumstances. At the **first phase**, 'EU-(co)-funded projects enable first local multi-actor experiments in the field of energy' (2011-2016), before launching governmental strategies supporting the energy transition towards the decentralised energy system in Poland, the local actors tried to development of novel solutions related to energy efficiency and/or RES technologies. For example, the Infrastructure Department of Warsaw City Hall participated in two EU projects: 'ICE-WISH' and 'Step by Step' aimed at conducting experiments to find new ways for improving energy efficiency among the inhabitants of Warsaw. Most of the experiments took place in the urban context. Example of a different approach provides the eco-village 'Osada Twórców' has experimented with energy self-sufficiency in rural context. At the **second phase**, 'Competition for the Pilot Energy Clusters Certificates and emergence of the first energy clusters' (2016-2018), the changing legal conditions allowed for the process of developing energy clusters and initiated the process of building a dispersed energy system in Poland, with the participation of different local entities such as municipal entities, local enterprises, and energy incumbents, but with limited participation of individual citizens/inhabitants. Interestingly, these actions were especially intensive in small and medium towns size, even if some of the biggest cities also tried to establish their energy clustres. At the **third phase**, 'KlastER Project - conducting pilot projects and taking stock of the experiment' (2019-2020), with the launch of the project "Development of distributed energy in energy clusters (KlastER)" by a consortium consisting of Ministry of Energy, AGH University of Science and Technology and National Centre for Nuclear Research, the new actors joined the field and focused on production of knowledge for decision-making, using both their expertise, and creating the platform for dialogue for different stakeholders. It aims at delivering a coherent Strategy for the development of energy clusters in Poland. The center of these actions is in Cracow, but due to Covid-19 pandemics large parts of the meetings have been organized remotely.

The SIE-field-actors have been involved in a **diverse set of activities**, for example, planning and implementing experiments focused on energy efficiency and behavioural changes in the municipality and taking part in these experiments, developing energy clusters: building networks of collaboration on the local level which includes municipality's entities, local enterprises, and energy incumbent, experimenting with local off-grid solutions for eco-villages, lobbying for favourable legal conditions for energy communities, engaging in research and expert debate on the most important

obstacles for more dynamic development of participatory initiatives and desired changes in legislation, and finally crafting the regulatory conditions supporting the development of participatory experimentations (like Law on Energy Cluster).

These activities changed from one phase to another, reflecting the growing importance of the concept of the dispersed energy system, relying on local solutions. At the **first phase**, most activities were focused on energy efficiency and financed through European funds. Municipalities and networks of municipalities played the main role, mobilizing the inhabitants to take part in energy experiments. At the **second phase**, local communities led by representatives of local government or local business started to build energy clusters, often to find that under the current legislative condition, it is very difficult to fulfil its goals - that is, locally produce and balance the energy. What is important, the interest in the topic and the attempt to build and develop energy clusters show that for a growing number of local communities, the future of their local community is connected to the investment in renewables. Often, this is perceived also as a solution for the problem with air pollution. At the **third phase**, the most important novel activities are focused on research, expert debates, and lobbying for new regulatory solutions.

Importantly, the story of the field's development shows how the new paradigm of the 'socialised', dispersed energy sector has been shaped. Multiple actors operating on the local level (NGOs, municipalities, citizens, local entrepreneurs) got involved in the process of finding new solutions in the energy sector, which has been unthinkable in the paradigm of a system based on large-scale energy. That shows that their very actions were possible due to the widespread acceptance of the **novel narratives** presenting the future of the energy system as radically different than present: with the strong presence of the actors such as municipalities and local companies, previously acting as energy consumers' only. Additionally, at the third phase, SIE-field actors are particularly engaged in the creation of expert narratives on the possible role and conditions for the dispersed energy in Poland, with the participation of a wide array of stakeholders from the business and municipality sector.

However, **power issues** are rarely explicitly problematized in the SIE-field. Still, we can interpret the struggle of the newcomers in the energy sector to take their place and play a role previously accessible only for the energy companies as an example of power struggle. Indeed, the relations

between entities from municipalities and (non-energy) business on the one hand, and incumbent companies responsible for energy distributions on the second hand, are one of the most burning issues in the negotiation of the shape of the future legislation for energy communities/energy clusters in Poland. That is, by participating in the actions aimed at developing energy system based on dispersed, locally owned, and renewable sources, SIE-field actors implicitly take part in the power struggle.

The experiments described in the report allowed the involved actors to search for new energy solutions that best suit their specific local needs and make the most efficient use of available resources. This is a significant change from the conservative paradigm in the energy sector, according to which only large energy companies and the government should decide on the direction of the sector's development and impose the system's rules on smaller players, exposing them to damages related to, among others, higher energy prices, black-outs, air pollution or environmental and climate risks. Moreover, the KlastER project has allowed local entrepreneurs, local governments, scientists and independent experts influence the shape of the strategy of further development of energy clusters, also in a legislative context. However, citizens have so far no voice in the debate on creating new solutions in this area, and local communities do not engage in activities conducted by energy clusters in local settings.

On the other hand, citizens have been largely involved in experiments described in Phase 1, led by NGOs or municipalities. These initiatives have taken place only on a small scale, and without a viable potential for scaling up. Therefore, it can be concluded that there is a need to find ways of including civil society in local experiments conducted in a Triple-Helix manner, which should be enabled by the experience already gathered by citizens, municipalities and NGOs when testing novel energy solutions on a smaller scale.

The empirical findings clearly indicate that relations between SIE-field actors and other field-actors (who enable and/or impede SIE) are based mainly on cooperation. In Poland, the creation and maintenance of the new **relations based on collaboration** between SIE-field-actors within the SIE-field was one of the most important aspects of the participatory experimentation and incubation. Indeed, the effectiveness of the SIE-initiatives aimed at developing and testing new solutions in energy is tightly connected to the ability of various actors to establish an agreement and conduct

coordinated joint action. This cooperation has engaged actors on different levels of aggregation (e.g. individuals, communities, districts, municipality, region, country), but also from different societal spheres (e.g. citizens, local authorities, entrepreneurs, scientists, politicians) (Avelino and Wittmayer, 2016). Experiments conducted within energy clusters, some of which as a part of the KlastER project, have been based on the Triple-Helix model, i.e. engaging actors from public, scientific and private sectors. It has been recognised in the literature (e.g. Dresler, 2019) that the Quadruple-Helix model, which is created by introducing civil society representatives to a collaboration, allows for making innovations more sustainable in economic, political and social ways.

6.2. How do SIE-field-actors and other field-actor interact with the 'outside' institutional environment and thereby co-shape the SIE-field over time?

The **regulative pillar** of institutions relates to rules, laws, policies, standards, and sanctions that are the key elements and mechanisms of compliance in these institutions (D1.2, 21). In the case of energy clusters, this institutional pillar manifests itself through its absence or incompleteness, rather than as a guide on “action and perspectives by coercion or threat of legal sanction” (Hoffman 1999). The main barrier to cluster development is the current law. The definition of a cluster is too general, the benefits of joining a cluster for individual entities are unclear, relations between clusters and distribution network operators are unregulated and there is a lack of financial incentives. Furthermore, energy law and the functioning of the energy market are overregulated. Therefore, according to the majority of the interviewees, the current form of energy law should be modified, as it represents a serious barrier to the achievement by clusters of their primary objective, namely, achieving energy self-sufficiency (i.e. the 'doing' aspect of SIE).

The **normative pillar** of institutions takes the „form of rules-of-thumb” (Hoffman 1999) with regard to values, social norms, duties, and role expectations in a particular field (Scott 2001). Actors adhere to these guidelines, as their actions and beliefs are guided forms of social obligation and professionalization (D1.2, 21). The EU was the first to send out a signal that civil society has a shared responsibility for implementing the climate and energy policy guidelines. Before this becoming the norm in Poland, cities and NGOs, taking part in EU projects and receiving European grants, learned that they are expected to be actively involved in finding and testing new solutions in the context of

energy saving, renewable energy production or energy self-sufficiency. This, however, poses significant challenges, e.g. for cities which need to develop a new language of communication with citizens treating them as equal partners, as well as new methods of operation within the office based on cooperation between departments (i.e. the 'organising' aspect of SIE). However, according to the interviewees, there is still a lack of vision in Poland that would indicate how to involve citizens in the energy transformation. The creation of a vision of the social dimension of this process is necessary for the new solutions to be not only economic or technological but also to support the development of a new energy paradigm that radically changes the role of an individual from a passive energy consumer to an active prosumer.

The **cultural-cognitive pillar** of institutions refers to the socially constructed, shared conceptions of reality, binding expectations and common beliefs with which the world is interpreted or meaning is given, such as symbols, discourses and cultural categories (D1.2, 22). The shift towards dispersed energy production based on RES prosumerism and increased energy efficiency will not be possible without changing the dominant social discourse determining who can demand to take part in the discussion about the direction of the Polish energy sector development. In the conventional approach, only large energy companies and the national government are seen as competent actors who should make all decisions on behalf of the whole society. However, the development of the SIE-field shows that more and more local actors are engaged in the search for new energy solutions that best meet local needs. This is due to, among other things, the growing public awareness of the challenges posed by the climate crisis and the environmental, financial and health damage associated with running 'business as usual' in the Polish energy system (i.e. the 'thinking' aspect of SIE).

The **policy and regulatory context** have a key impact on the SIE-field "Participatory experimentation and incubation" in Poland. As the policy impulses for more ambitious energy and climate policy come from the level of EU, the state-level regulations have the most direct impact for the specific initiatives. We identified the **growing pressure on ambitious climate and energy policies from the EU** and the withdrawal of the most important institutions from financing investments in fossil fuels as the most important trend that made it necessary to seek novel solutions in the Polish energy sector. Distributed energy has been identified as an important direction of the sector's development, which assumes the need to test social and technological innovations at a local level.

Most important decisions on the EU level includes the Directive 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (RED II), which sets targets for the consumption of renewable energy sources from 2021 to 2030, and the Directive 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity. These directives introduce concepts such as RECs (Renewable Energy Communities) and ECs (Energy Communities), highlighting the importance of energy sustainable areas, which is particularly important for the development of energy clusters and energy cooperatives. Members of energy communities cooperate in energy production, consumption, distribution, storage, sale of energy from renewable sources or provision of other energy services. Their main objective is to provide environmental, economic or social benefits. The implementation of RED II to the Polish legal system, expected in June 2021, will likely open new chapter for the participatory experimentation and incubation

As for the state regulations, The Polish RES Act entered into force on 20.02.2015. It clarifies the principles, conditions and benefits of energy production from RES and defines some important definitions, e.g. of a prosumer. The definition of an energy cluster and an energy cooperative was introduced into the Polish legal order by the Act of 22 June 2016 amending the Act on RES, allowing for the creation of energy clusters. However, the specific legal solutions made it very difficult for energy clusters to operate efficiently.

6.3. What are the enabling and impeding factors for the SIE-field-actors and other field actors to conduct institutional work and change the 'outside' institutional environment?

The empirical findings show that the SIE-field-actors have been engaged predominantly in **creating institutions**. Both in case of small-scale urban experiments with energy efficiency and more recent experiments with energy clusters, SIE-field actors struggle to build new forms of cooperation and try to maintain these relationships despite difficulties caused by the legal environment in which they operate. New entities such as the National Chamber of Energy Clusters, created to learn from each other and strengthen the voice of the clusters' representatives provide another example.

In this case, the SIE-field-actors have been conducting mainly four types of institutional work: **boundary work** (by redefining the conservative stance about who can be an active player in the Polish energy sector: not only state-owned energy companies and the national government, but also local authorities, small companies, NGOs, citizens, cities etc.), **strategy work** (the main aim of the project KlastER is to develop a new strategy for energy clusters in order for them to become a cornerstone for the dispersed energy sector development in Poland), **practice work** (day-to-day work in developing novel governance arrangements), and **material work** (development and testing of novel technologies in energy production, storage and distribution).

Apart from the direct attempts to influence the regulation, institutional work led by the SIE-actors might also have some **unintended consequences**. According to the authors of the „The Concept of Energy Clusters Functioning in Poland" (Ministry of Energy, 2017) establishing an energy cluster has certain positive consequences that go far beyond the municipality, often emanating across the country. This means that, intentionally, members of the cluster are only able to implement objectives of an individual or local character, which, however, translates into the implementation of broader (and often convergent) regional and national objectives. What is more, the most benefits of energy clusters were identified by the authors at the national level (e.g. contributing to the national energy security, increasing the share of RES in the national energy mix, stimulating the national economic development).

Individuals engaged in institutional work are usually representatives of specific institutions who have direct stake in the energy transition: 1) members of energy clusters (municipalities, municipal entities, local business, energy grid operators and providers of technologies for energy clusters; 2) expert and academics involved in research and consulting, e.g. in KlastER project; 3) policy-makers responsible for regulation of the SIE-field; 4) dedicated networks of municipalities, such as Energy Cities.

We can see that the involvement of individual citizens (or their associations) is rather marginal. This, however, poses significant challenges, e.g. for cities which need to develop a new language of communication with citizens treating them as equal partners, as well as new methods of operation within the office based on cooperation between departments. However, according to the interviewees, there is still a lack of vision in Poland that would indicate how to involve citizens in the

energy transformation, particularly in the form of energy communities' development. Creating a vision of this process's social dimension is necessary for the new solutions to be not only economic or technological in nature but also to support the new paradigm that radically changes the role of local communities from passive energy consumers to active and conscious prosumers, engaged in various forms of collaborations aimed at experimenting with new, energy-efficient developments. In creating the vision, important contribution comes from other SIE-field actors, engaged in lobbying for energy transition.

One example of important activities aimed at **creating institutions** is the KlastER project. The ultimate goal of the **KlastER project** is to develop a strategy for the development of energy clusters, and thus, the transformation of Polish energy system to accommodate renewable, dispersed energy sources. The recommendations are supposed to be included in the amendment of the RES Act, which shows that the action of SIE-field-actors can have a real impact on legislation at the national level. To date, an analysis of barriers to the development of energy clusters has been carried out and appropriate changes to the legislation have been proposed. The dominant activities were: research from the domain of social science (including law) to diagnose the current situation of energy clusters and to identify main barriers; review of international best practices; creation of the broad network of expert and practitioners; organization of the cycle of open seminars and conferences with the broad participation of expert and practitioners to discuss the specific problems and features of Polish energy clusters, but also to build and strengthen existing networks.

Another example of **creating institutions** is provided by the specific energy cluster, that is, **Zgorzelec Renewable Energy Sources Development and Energy Efficiency Cluster (ZKlaster)** that was initiated in 2017. The cluster is widely regarded as one of the most effective energy clusters in Poland. Its coordinator is also the president of the National Chamber of Energy Clusters. Numerous research activities, development and testing of new technologies are conducted in the ZCluster. Within its structure, there is a start-up conducting experiments in the field of energy storage technology, and the Innovation Hub that created Poland's first off-road electric vehicle. Currently the cluster is building the largest photovoltaic farm in Poland.

At this stage, the SIE-actors engaged also intensively in work aimed at **creation of new networks** and developing new knowledge and skills, as visible in two examples discussed above: KlastER

project and ZKlaster. That, in turn, helped them to address the main impending factor: the unfavourable legislation. Again, the impulse from the EU (RED II directive, which implementation is planned for June 2021) may amplify the impact of their activities.

We can see that the experience with energy clusters inspired the new concept in the Polish energy policy, that is, a creation of 300 energy self-sufficient areas, signalled recently by the policy-makers. By 2030, it is expected that 300 energy self-sufficient areas based on the energy cluster model will be established in Poland, becoming fields for experimentation and creation of innovative solutions.

7 Recommendations for our city partners, national and EU policy makers and SIE practitioners

SIE practitioners

Practitioners of energy-related pilot projects or experiments should be aware of the greatest risks, which might include: difficulties in obtaining sustainable financing (during or after the project, which makes it impossible to continue activities); Polish law that does not encourage the development of initiatives aimed at achieving energy self-sufficiency on a micro and small scale; difficulties in scaling up solutions. Among the enabling factors, one could point, above all, to the supporting activities of EU institutions, rapidly developing technologies and the dynamically growing public awareness of the need to move away from large-scale energy in order to protect the health, environment and climate, but also for financial reasons. It can be predicted that in the next few years, a further increase in the importance of these factors will cause the situation to improve significantly, and the market for RES and microgrids will grow dynamically, facilitating the implementation of various initiatives in this area.

SONNET city partners

Local authorities have a very important role to play in the development of distributed energy. Their activity is a result of the broad competence of local governments in creating legal, spatial and investment foundations of the local energy market. There are even actions undertaken to extend

the prosumer status to local government units, which will make it profitable for them to invest in RES and encourage them to become more active players in the energy market.

To a large extent, the popularity and success of local, collaborative experiments rely on the degree of municipalities' involvement. The participation of local or regional authorities can positively influence the image of such initiatives and encourage various actors, such as business or citizens, to join in. Municipalities can bring their experience, know-how and municipal real estate to the project.

City partners should bear in mind that local governments can play an important role in energy clusters, especially in those that, before the certification, had social or technical capital on which they could build (e.g. RES infrastructure or engagement in environmental protection). The local government can play an important role in the continuation of previous operations. On the other hand, in cases where obtaining a pilot energy cluster certificate was seen primarily as an opportunity to receive funds for the implementation of ad hoc projects, local governments are seen as an unnecessary burden in conducting technological or business endeavours. It is also important that the local government does not dominate the rest of the partners.

National and EU policymakers

The energy transformation needs to be enabled by developing and testing new social and technical solutions at the local level, primarily within energy clusters. Their further development should be supported by the legislation that would stress the following aspects: a) the need to seek new solutions tailored to specific regional conditions, responding to the actual needs and using available resources, b) reducing the costs of energy distribution and making it more efficient by responding to current real demand, c) balancing the levels of production and consumption of energy within energy clusters in order to relieve the national energy distribution system and to increase national energy security.

There is considerable potential of social capital at a local level to be used to develop a dispersed Polish energy system. However, so far, it has been largely untapped due to: a) unclear, unstable, and unspecific law, b) prevalent strong technocratic approach, c) lacking a coherent vision of the energy transition's social dimension and effective mechanisms for involving local communities in the cooperation hitherto taking place under the Triple-Helix model. All of these issues should be

addressed in the future national legislation based on social consultations and broad public discussion.

Another barrier is a lack of technologies related to storage and smart management of energy. Adequate legislation defining the concept of energy storage should be introduced and a subsidy programme should be created to support research work in this field.

Polish law should also explicitly indicate support for RES development in the local community as a task of the municipality. Only then will municipalities have a legal basis for active involvement in the development of distributed energy.

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9 Annex

Methodology

As the sole researcher investigating this embedded case study, I am not formally related to the field being investigated, i.e. I am not a member of any of the SIE-initiatives. Prior to the study, my

knowledge of the field was minimal. I believe that I managed to reach a diverse group of the field's representatives and familiarise myself with a variety of documents. I reviewed documents of various kinds, but mostly research papers and policy documents referring to the energy clusters and energy transition process. I also relied heavily on information from relevant websites and news releases. Taking into account the time constraints of working on the project, I think I have managed to cover the subject adequately. However, I am sure the research would have been enriched by conducting more interviews, especially with energy clusters' coordinators. In order to find appropriate persons to conduct the interviews with, I used the snowball sampling, asking my interviewees for further recommendations. As a result, a range of interviewees included representatives of pilot energy clusters, project KlastER, City of Warsaw, eco-village "Osada Twórców", as well as the Ministry of Energy. As far as participatory observation is concerned, due to the Covid-19 pandemic, I could only conduct an online observation, which has its obvious limitations (such as observation of participants' reactions or the possibility of conducting interviews with people participating in the event). The advantage was the possibility to participate in webinars on very different topics, regardless of their location. Overall, during this 1.5-month research, I was able to conduct 8 in-depth interviews, review in-depth around 11 documents, and participate in 5 online conferences and webinars. See tables below in this section for more details.

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List of interviewees

Code	Role of the interviewee	Duration of the interview (min)
Interviewee 1	President of the National Chamber of Energy Clusters, coordinator of the Zgorzelec Renewable Energy and Energy Efficiency Development Cluster, president of the Association for the Development of Energy Innovation in Zgorzelec	60

Interviewee 2	Project KlastER, NCBJ, IDEA	90 = 45 + 45 (first part of the interview was conducted by Agata Stasik)
Interviewee 3	Founder of the Cohabitat Foundation and the eco-village Osada Twórców	70
Interviewee 4	Head Economic Unit of Infrastructure Dept., City of Warsaw	60
Interviewee 5	President of Bio Power - coordinator of the energy cooperative Nasza Energia	30
Interviewee 6	Director of the Office of the Wałbrzych Energy Cluster	30
Interviewee 7	Chairman of the social affairs team in the Social Network Competence Group for Distributed Energy, KlastER Project	45
Interviewee 8	Former Deputy Minister of the Environment	135

List of meetings and events attended

- VI Congress of Polish Energy Clusters, 9-10 November 2020, online streaming: <https://energia.rzeszow.pl/index.php/554-9-10-listopada-vi-kongres-klastrow-polskich>
- How to release the local energy? I Forum of Dispersed Energy, 25.03.2019 r., organised as a part of the KlastER Project (KlastER), online streaming: <https://www.er.agh.edu.pl/wydarzenia/forum-energetyki-rozproszonej>
- Clean energy for everyone. I Forum of Dispersed Energy, 25.11.2019 r. organised as a part of the KlastER Project (KlastER), online streaming: <https://www.er.agh.edu.pl/wydarzenia/ii-forum-energetyki-rozproszonej>
- 28-30.08.2020 - "Green Days in Sokolowsko" (Pol. „Zielone dni w Sokółowsku”) organised by the Polish Greens, MEP Jakop Dalunde, the Green Zone Foundation (Pol. Fundacja Strefa Zieleni), and the Heinrich Boell Foundation Polish office

- 14.05.2020 - webinar 'Energy transition in Poland - challenges and dilemmas' (Pol. 'Transformacja energetyczna w Polsce - wyzwania i dylematy') with PhD Andrzej Kassenberg, organised by the Workshop for All Beings

10 Annex 2

Detailed SIE-field timeline and its actors over time

DATE/ TIME	TYPE OF EVENT	DESCRIPTION OF EVENT
2009	Policy 'event'	The so-called "3 x 20% package" is adopted, committing Poland to reach 15% of RES energy by 2020
PHASE 1: EU-(co)-funded projects enable first local multi-actor experiments in the field of energy		
2011	SIE-initiative event	The ICE-WISH experiment with residents on energy-efficiency is initiated by the Infrastructure Department of Warsaw City Hall
2015	SIE-initiative event	The Step by Step experiment with residents on energy-efficiency is initiated by the Infrastructure Department of Warsaw City Hall
2015	SIE-initiative event	"Energia Living Lab" experiment with residents on energy efficiency is initiated by Enspirion company
2015	SIE-initiative event	Multi-actor pilots to develop and test innovative technologies, financing tools and energy-efficient solutions are initiated by the Association "Energie Cités"
2016	SIE-initiative event	Eco-village "Osada Twórców" starts its socio-technological experiment to become energy self-sufficient
PHASE 2: Competition for the Pilot Energy Clusters Certificates and emergence of the first energy clusters		
2015	Policy 'event'	The RES Act introduces the definition of a prosumer
	Policy 'event'	The Paris Agreement is signed to keep the increase in global temperature to well below 2 °C above pre-industrial levels

2016	Policy 'event'	The amendment of RES Act provides definitions of energy clusters and energy coops
2016	Policy 'event'	The government introduces a law that hinders investments in wind energy, the so-called "Anti-wind turbines Act"
2017	Policy 'event'	The "Strategy for Responsible Development" is published by the government, stressing the need to create proper regulations for energy clusters
2017	SIE-field event	The first competition of the National Fund for Environmental Protection and Water Management for EU funding, which will support investments implemented within energy clusters
2017	SIE-initiative event	Zgorzelec Renewable Energy Sources Development and Energy Efficiency Cluster (ZKlaster) is initiated
2017	SIE-field event	The first competition for a Pilot Energy Cluster Certificate is initiated
2018	SIE-field event	Working Groups for Energy Clusters are established to determine the topics of pilot implementations
2018	External trend	Electricity prices rise due to increasing prices for CO2 emissions
2018	Policy 'event'	The "My Electricity" program is initiated, subsidising PV installations in households
2018	SIE-field event	The second competition for a Pilot Energy Cluster Certificate is initiated
2018	Policy 'event'	During COP24, the Katowice Climate Package is signed in order to implement the Paris Agreement
PHASE 3: KlastER Project – conducting pilot projects and taking stock of the experiment		
2019	SIE-initiative event	Research Phase of the project "Development of distributed energy in energy clusters (KlastER)" is initiated
2019	Policy 'event'	The European Green Deal is announced with the aim to reach climate neutrality in EU by 2050
2020	SIE-initiative event	Preparation for Application Phase of the project "Development of distributed energy in energy clusters (KlastER)" is initiated
2020	Policy 'event'	The "Poland's Energy Policy until 2040" announces the creation of 300 energy self-sufficient areas by 2030

Key actors and their networks & relations

Actor name	Type of actor	SHORT DESCRIPTION OF MAIN ROLE, AIM, EXAMPLE OF MAIN ACTIVITY	SHORT DESCRIPTION OF RELATIONS TO OTHER ACTORS
PHASE 1: EU-(co)-funded projects enable first local multi-actor experiments in the field of energy			
Infrastructure Department of Warsaw City Hall - 'ICE-Wish' and 'Step by Step' projects)	SIE-initiative	Coordinator of the Polish team in two EU-funded projects involving experiments with citizens on energy efficiency	The City of Warsaw is a part of the Covenant of Mayors for Climate and Energy led by the Association of Municipalities Polish Network "Energie Cités"
Enspirion company - Energa Living Lab	SIE-initiative	The first company in Poland providing electricity demand management services, offering its customers remuneration for shifting consumption. The "Energa Living Lab" experiment tested similar solutions among 300 households	
Association of Municipalities Polish Network "Energie Cités" (PNEC)	SIE-field actor - intermediary/ SIE-initiative	NGO that since 1994 has been cooperating with local actors to develop and test new solutions for the local low-carbon economy, efficient energy and renewable energy use.	Serves as the official Supporting Organisation of the Covenant of Mayors for Climate and Energy
Osada Twórców	SIE-initiative	Established in 2016 as a socio-technological experiment, based on co-existence in the community, permaculture, natural construction, and energy microsystems	
PHASE 2: Competition for the Pilot Energy Clusters Certificates and emergence of the first energy clusters			
Ministry of Energy	Field actor - enable	Initiator of the competition for a Pilot Energy Cluster Certificate, and of the project "Development of distributed energy in energy clusters" (KlastER)	Cooperates in the KlastER project with AGH University of Science and Technology, NCBJ - National Centre for Nuclear Research and IDEA

			Interdisciplinary Department of Energy Studies; supports Polish energy clusters
Zgorzelec Renewable Energy Sources Development and Energy Efficiency Cluster (ZKlaster)	SIE-initiative	Energy cluster established in March 2017. The cluster is widely regarded as one of the most effective energy clusters in Poland. It functions on the territory of Zgorzelec County, where an open pit mine and coal-fired power plant operate. It runs experiments with energy storage technology and microgrids.	Its coordinator is also the president of the National Chamber of Energy Clusters; cooperates with other energy clusters and with experts from the KlastER project. The cluster negotiates the terms of the regional energy transition with PGE GiEK SA
PGE GiEK SA	Field actor - impede	State-owned Polish energy company that owns several open-pit mines and power plants, e.g. in Turów; a leader in the lignite mining industry in Poland and the largest national electricity producer	Involved in negotiations with the ZKlaster about energy transition of the region
National Chamber of Energy Clusters	Field actor - enable	Economic self-regulatory organization established in April 2020, representing the economic interests of its affiliated entities, entrepreneurs and their unions, operating within energy clusters.	Run by the coordinator of the energy cluster ZKlaster; supports energy clusters across the country and cooperates with the KlastER project experts
PHASE 3: KlastER Project - conducting pilot projects and taking stock of the experiment			
AGH University of Science and Technology	Field actor - enable	The second best Polish technical university, located in Kraków and established in 1919	Cooperates in the KlastER project with the Ministry of Energy, NCBJ - National Centre for Nuclear Research and IDEA Interdisciplinary Department of Energy Studies
NCBJ - National Centre for Nuclear Research	Field actor - enable	The largest research institute in Poland, established in 2011	Cooperates in the KlastER project with the Ministry of Energy, AGH University of Science and Technology and IDEA Interdisciplinary Department of Energy Studies

<p>IDEA - Interdisciplinary Department of Energy Studies</p>	<p>Field actor - enable</p>	<p>A part of the National Centre for Nuclear Research in Poland; develops tools and services for the energy sector, applying optimization, artificial intelligence, and other advanced mathematical modeling techniques</p>	<p>Cooperates in the Klaster project with the Ministry of Energy, NCBJ - National Centre for Nuclear Research and AGH University of Science and Technology; runs pilot projects in chosen energy clusters (e.g. Zywiec Energy Cluster)</p>
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