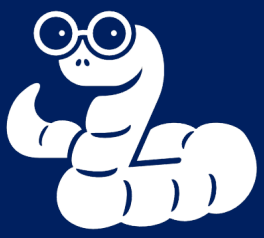

WORKing papers in Management Science

WORMS/24/01

Why Would I Bother? A Qualitative Study on Perceptions of Renewable Energy Communities by Polish Photovoltaic Installation Owners

Anna Kowalska-Pyzalska[1]
Ewa Neska[1]
Maksymilian Bielecki[2]

[1]Department of Operations Research and Business Intelligence, Faculty of Management, Wrocław University of Science and Technology
[2]SWPS University, Warsaw

WORMS is a joint initiative of the Management Science departments of the Wrocław University of Science and Technology,
Wyb. Wyspiańskiego 27, 50-370 Wrocław, Poland

Why Would I Bother? A Qualitative Study on Perceptions of Renewable Energy Communities by Polish Photovoltaic Installation Owners

Abstract

Renewable energy communities (REC) are pivotal in fostering decentralized, sustainable energy systems by empowering local stakeholders to collectively generate, share, and manage renewable energy resources, promoting community resilience and environmental stewardship. Within our study, we analyzed diversity of incentives and social barriers to participation in REC and identified actions to increase the willingness to participate in REC initiatives with particular consideration of the role of the understudied local Polish context. Hence, we present the results of the 16 in-depth interviews with Polish current and prospective prosumers and discuss the main drivers and barriers to participation in future REC. Our findings - interpreted against a broader backdrop of existing research and Bronfenbrenner's socio–ecological model - indicate that successful policies regarding REC have to consider the unprecedented growth rate of domestically installed photovoltaics and the specificity of Poland's historical, political, social, and economic conditions. We discuss the implications of the results for future policymakers and stakeholders responsible for REC implementation, along with some methodological remarks concerning the importance of accounting for heterogeneity and stronger embeddedness of research practices shaping policy design.

Keywords: renewable energy community, prosumers, Poland, drivers, barriers, in-depth interviews, Bronfenbrenner's socio-ecological model

1. Introduction

Currently, climate change stands as one of the most significant global challenges. To mitigate the adverse and lasting consequences of climate change, an energy transition is essential, in which renewable energy sources and energy efficiency play a crucial role [1, 2]. Furthermore, recently, due to the difficult geopolitical situation in Eastern Europe, energy security and affordability have received special attention from EU countries, which relate their increase in energy independence to, among others, renewable energy technologies such as photovoltaics (PV), wind turbines and green hydrogen [3].

Among the proposed solutions, the idea of the **Renewable Energy Community (REC)** emerged as one of the responses. REC applies the latest digital technologies to unlock the potential of renewables and create an environmentally friendly ecosystem, in which the community can produce, store and consume energy locally [4, 5]. As a nascent entity, REC has the potential to reshape prevailing electricity market models by transitioning passive consumers into active prosumers.

Moreover, the REC concept has the potential to be not only innovative but, more importantly, an impactful solution for society as a whole, not just individuals [6–8].

1.1. Existing studies on REC participation

Participation in REC, both actual and declared, has been studied from various points of view [9]. Most of the studies focus on initiatives that already exist [10–16] or theoretical concepts of REC [17–24].

Until now, several incentives and barriers have prevailed in analytical and empirical studies [8, 25–27]. The factors identified in the literature that impact the decision on participation in REC can be mapped with the Bronfenbrenner's socio-ecological model. As shown in Figure 1, these factors occur at all levels of the model, ranging from the individual level to the macrosystem. The Bronfenbrenner's socio-ecological model is explained in subsection *2.1 Data Collection and Analysis*.

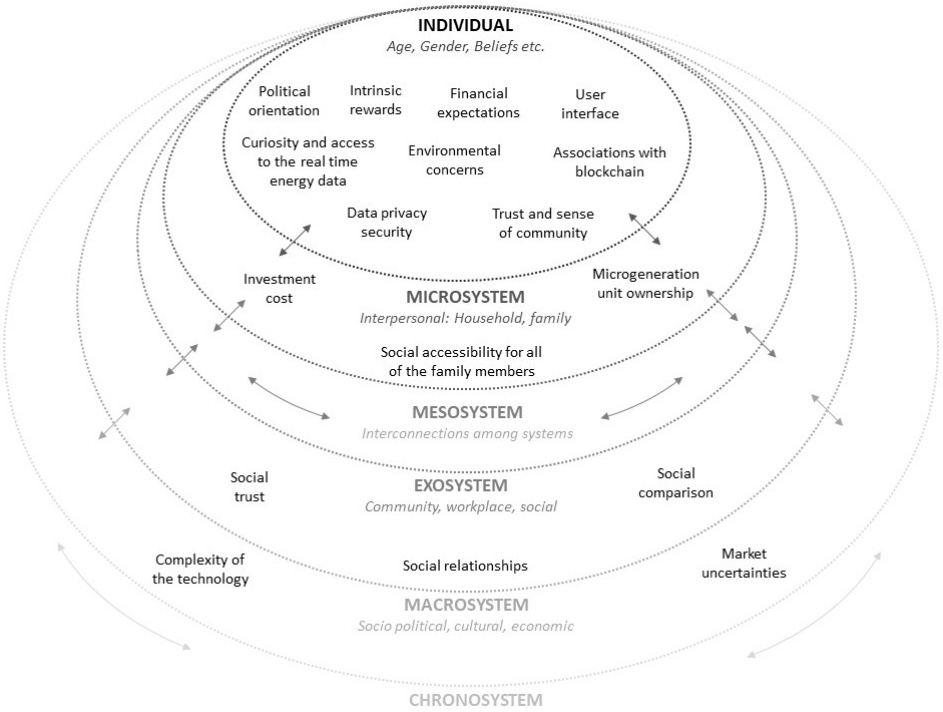

Figure 1: Factors from the literature influencing the decision to accept REC mapped with the Bronfenbrenner's socio-ecological model

The perception of barriers and incentives to participation in the REC depends, inter alia, on the setup of the REC market. Establishing an arrangement of an electricity supplier, consumer, and third-party entity that fits the goals and constraints of the community is crucial when building a community. The study of [9] summarizes different possible REC setups. It seems that peer-to-peer models (P2P), aggregator models, and those based on collective prosumer installation, are the most common.[20, 27–30].

1.2. The specificity of Polish context

Even though there is a vast literature on various aspects of REC in Western and Northern European countries [13, 31, 32], as well as outside Europe [33, 34], the issue of consumer approaches to REC in Central and Eastern Europe seems to be understudied [35]. However, the formative experiences, understanding, and awareness of the need for the energy transition, as well as needs and motivations can vary greatly both between and within countries - even if we limit our considerations to the area of the European Union [36]. Both of these aspects - specificity in comparison to other countries and internal diversity - are also represented in the case of Poland, the largest country in Eastern and Central Europe. Its distinguishing characteristics are numerous and result from diverse temporal-scale processes. Some factors, such as the symbolic heritage dating back to the times of communism or the vivid memory of the 'wild capitalism' of the early years of transformation, remain perceptible even after multiple decades [37, 38]. Some others are relatively recent phenomena, such as extremely sceptical discourse towards the European Union introduced during recent years by the right-wing coalition government, direct experience of the migration crisis caused by the war in Ukraine unfolding just beyond Poland's borders, or the exceptional intensification of political polarization translating, among other things, into attitudes towards climate issues [39, 40].

Regardless of economic, social, or cultural changes, in the last 5 years there has also been a change that is - from the perspective of the topic of the study - absolutely fundamental. That is, Poland has witnessed an unprecedented revolution in photovoltaic installations among households, leading to an enormous increase in photovoltaic panels installed on roofs [41, 42]. It makes Poland an exception in all Europe because such growth rates in the number of PVs have not been observed in any other country [43]. To understand the Polish energy market, it is worth noting that according to the IEO research agency, photovoltaics remain the market leader and the main growth engine in the renewable energy sector in Poland since 2019 [44, 45]. At the end of 2022, the cumulative installed PV capacity exceeded 12.4 GW, up from 2021, according to data from the Energy Regulatory Office. 7.7 GW signifies a record-breaking rise in new capacity of over 4.7 GW and a record-breaking 61% market growth. By 2023, the number of micro-installations owned by consumers has risen to 1,275,736, giving 14,739.4 MW of installed capacity in domestic photovoltaic panels [44].

Several key factors contributed to this dominance of PVs in Poland, including subsidies obtained from Regional Operational Programs and government funding under the 'My Current' program. The program financially supports prosumers who have built a backyard photovoltaic installation with a power between 2 and 10 kW. The funding provides for a partial return on the invested capital in photovoltaic installations. Furthermore, the change in the financial settlement method in April 2022 from net-metering into net-billing, was responsible for the peak in PV investments in the first half of 2022 [46]. Nowadays, Polish individual investors still decide on PV installations to secure themselves from the further increase of electricity prices and to ensure the supply of electricity for their own needs in case of future blackouts or other technical problems [42].

At the same time, however, Poles have almost no experience with RECs, limited to some energy cooperatives and clusters, mainly involving small and medium companies and housing associations, rather than individual electricity consumers [35, 47]. On the other hand, the experience of being a prosumer significantly modifies user behavior and enhances their awareness and knowl-

edge regarding the use of electricity [48]. Concurrently, this same group will play a pivotal role in the success of the transition and the introduction of RECs in Poland. Therefore, we posit that an in-depth understanding of the barriers and motivations within this population and a reflection on the theoretical frameworks that can be utilized to organize this research area are crucial for shaping future policies concerning energy transformation.

1.3. The aim and research questions

We established two main objectives for our study. The first was to analyze prosumers' understanding of RECs, incentives, and barriers to participation, using previous experiences and knowledge about PV installations as an essential part of the decision process. The second was to discuss the implications of the results for future policies, taking into account various aspects of the specific Polish context and, simultaneously, a broader problem of the limited utility of research and analyses that abstract from the locality in its historical, social, cultural, and economic dimensions. The general study objectives were translated into the following key research questions: What did the decision-making process associated with the purchase of PV look like and how is it influencing the perception of REC? How is the concept of REC understood? What are the barriers and motivations of future REC participants? What are potential implications concerning the optimal way to introduce REC, warranting attention, interest, and acceptance? What are the methodological implications of the obtained results, and what kind of framework could facilitate the recognition of the contextual factors in further research on energy transition?

The paper is organized as follows: Initially, we outline our methodological approach and provide a detailed sample description. Subsequently, we present and critically discuss the findings. Lastly, we offer conclusions and acknowledge the study's limitations.

2. Methods

2.1. Data collection and analysis

To address these research questions, our study involved two main steps. In the first one, 16 semi-structured, in-depth interviews with current or prospective prosumers, each lasting between 50 and 75 minutes, were conducted by the study authors between May and June 2023. The interview structure closely matched the scope of the research questions presented above and focused on the following issues:

- Respondents' knowledge, experiences, and narratives regarding the sources of electrical energy and its consumption, monitoring, and optimization, along with the associated household costs;
- The decision-making process, motivations, and barriers related to (past or planned) becoming a prosumer;
- Assessment of the REC concept (obtained before and after the presentation of a brief standardized description provided by the moderator);
- Barriers and drivers related to participation in REC and evaluation of the presented variants of REC implementation.

The full interview script is available in Appendix 1.

In the second step, all the interviews were carefully transcribed and, in this form, submitted as input for the thematic analysis [49] facilitated by MAXQDA software [50]. The first version of a two-level coding scheme designed to identify the key themes and their relevance for the research questions resulted from a collaborative effort from the authors' team. Later, the tree and any coding ambiguities were iteratively refined as the coding process progressed. Finally, the empirical material was integrated, interpreted, and contextualized within a comprehensive framework that considered historical, socio-cultural, economic, and psychological factors. Finally, the main conclusions regarding the barriers and motivations of prosumers in the context of REC have been organized through the lens of Bronfenbrenner's Ecological Systems Theory (EST, [51]). Bronfenbrenner's theory - initially used to understand better forces shaping individual's development - describes the environment as a set of embedded systems ranging from individual characteristics through immediate settings like family or neighborhood to broader societal and cultural contexts (see Section 1.1, Figure 1). Such approach has proven to be fruitful in organizing knowledge about various social phenomena - including issues related to renewable energy (for example: [52]).

2.2. Sample description

Participants invited to the study were decision-makers or co-decision-makers regarding their household investments in renewable energy sources. They varied in socio-demographic characteristics (age, gender, size of the place of residence, level of education) and were typical as (potential) users of PV. In the case of Poland, this primarily means residing in a detached or semi-detached house.

To better map the diversity of narratives and attitudes towards the REC concept from the perspective of experiences related to renewables, the recruitment process took into account the range of experiences related to PV by identifying the following groups:

1. Individuals who had been prosumers for at least two years, settling accounts within the net-metering system (interviews marked with codes L1-L5).
2. Individuals who had been prosumers for less than two years (interviews marked with codes S1-S5) - in this group, four respondents settling accounts under net-billing.
3. Individuals at various stages of planning to purchase PV installations - from deliberation to signed contracts to be implemented in the coming weeks (interviews marked with codes P1-P6).

In all cases, the owned or planned PV concerned micro-installations and energy production exclusively for the household's needs. Thus, the power of the installations ranged from 3 to 8 kW, with the scale of declared annual energy consumption oscillating around 2-3 kWh. The study participants, both in terms of household characteristics and owned installations, could be described as prototypical members of the future REC. Detailed information on the characteristics of the respondents and their households is available in Table 1.

3. Results

The research findings were organized in the following way: first, issues related to experiences and decisions associated with PV are discussed, then the understanding of the REC concept with

Table 1: Respondents' characteristics (N=16)

Label	Gender	Age	Education	Occupation	Residence	House
L1	M	56	S	Production Manager	ST	DH
L2	F	54	H	Teacher	V	DH
L3	F	30	H	Farmer	V	DH
L4	F	42	S	Medical Services	T	SdH
L5	M	58	S	Transport Services	V	DH
S1	M	35	H	Manager in Mining Industry	ST	DH
S2	M	42	H	Teacher	T	DH
S3	M	55	H	IT Specialist	V	DH
S4	M	38	H	Production Manager	ST	SdH
S5	M	34	H	Lab Technician	T	DH
P1	M	32	S	Catering Activity	T	SdH
P2	M	33	H	Physiotherapist	ST	SdH
P3	M	49	H	Business Analyst	V	SdH
P4	M	39	S	IT Specialist	LC	DH
P5	F	42	S	Clerk	V	DH
P6	M	40	H	Logistics	ST	DH

Note: Gender: M - male, F - female, Age (years), Education: H, higher education, S, secondary education; Occupation (as listed by the interviewee); Place of living: V - a village; ST - a small town (with less than 30,000 inh.), T - a town (with more than 30,000 but less than 100,000 inh.), LC - a large city (more than 100,000 inhabitants); Type of house: DH - a detached house, SdH - a semi-detached house.

a particular focus on the role of entities involved in their creation and trust in them, and finally - the motivating factors and barriers to participation in REC. Therefore, the findings are instrumental in addressing the first four research questions posited at the outset of this study. The final research question, focusing on contextualizing these findings within a systematized model, will be discussed in the latter part of the paper, following this section.

3.1. Experiences with the PVs

We summarise these experiences by describing four main meta-themes: the drivers and barriers within the decision-making process, post-purchase satisfaction among PV owners and the sources of knowledge concerning the operation of PVs. Before proceeding, it is worth noting that all the experiences related to PV discussed here are primarily considered as an important context shaping the way of thinking about REC.

3.1.1. Decision-making process regarding PV installations - drivers

Economic incentives emerged as the predominant drivers for PV installation purchase. Direct stimuli such as state-subsidized programs significantly influenced decisions, often being time-sensitive and encouraging prompt action. The gradual yet steady increase in energy prices played a pivotal role in household economics, compelling homeowners to consider PV installations as a viable long-term investment. The anticipation of further price hikes, spurred by EU policies, underscored the importance of such investments. Thus, the decision to adopt PV technology was not only based on immediate financial relief but also on a strategic forecast of energy costs.

Social factors also played a considerable role. Rapid local development of PV installations created a social momentum, where geographic and social proximity led to concurrent decisions

among community members. This phenomenon of social proof, where individuals were influenced by their peers' choices, significantly impacted the decision-making process [53]. Moreover, the proactive sales strategies of installation companies effectively reduced the complexities associated with such purchases. These companies not only facilitated the technical and administrative aspects of installation but also provided comprehensive services that eased the process, thus making PV technology more accessible to the average consumer.

It is noteworthy that environmental considerations, while present, were not the primary motivators. Only a three the respondents cited ecological reasons as a factor, and these were never mentioned as the primary driver for purchasing PV systems.

3.1.2. Decision-making process regarding PV installations - barriers

For most households, investing in installations is a significant expenditure (even considering the various forms of financing the state offers). Simultaneously, this decision is fraught with considerable risk, stemming from the insecurity associated with the dynamics of energy prices and regulatory and legislative uncertainty (also related to low trust in state institutions that influence it). An essential component of this uncertainty is the previously described change from the net metering system to net billing. P4: *"The number of these regulations, which regulate even the issue of electricity sales, when you receive any kind of sale contract from the power plant, I don't know. I read these contracts, so I am a bit more aware of what I am committing to"*. This change is perceived as disadvantageous for prosumers and – at the same time – leads to a less transparent and understandable settlement system. Respondents assess that an investment in a PV installation should pay off over a multi-year perspective (up to 10 years). Still, its profitability is difficult to estimate even a few months after the installation of PV. S4: *"People who think this is a quick return from it, they are wrong because, in reality, it is a minimum of 10 or more years"*. (...) *"I think you have to wait about a year for the year to close. Only then will I have some opinion"*.

Doubts and concerns regarding technological aspects often accompany economic uncertainty. They relate to the sizing of the installation, choice of supplier, and technical limitations associated with the specific infrastructure of buildings. They are also accompanied by doubts in procedural matters (obtaining permits, access to state sources of installation funding, etc.). This results in the necessity to cooperate with external advisors or sales representatives. Consumers with greater awareness and technical knowledge also point to problems related to the energy infrastructure, which – during peak production periods – often does not allow for feeding energy into the grid due to the problem of energy curtailment.

The themes that appeared much less frequently are privacy-related issues, i.e., the fear of external entities accessing personal data and information about the activity of household members, and – present only sporadically – ecological concerns related to the limited durability and the need for panel disposal.

3.1.3. Assessment of PV installations

After purchasing PV installations, users evaluate this decision, considering both the positive aspects and the problems they encountered after starting the system's operation. All respondents, without exception, felt their decision to be correct, which was primarily justified by calculations regarding profitability, L3: *"It certainly worked out for us because currently, if we did not have*

photovoltaics, we would pay 20 thousand a year for energy, while now we pay 2.5-3 thousand PLN". However, this did not preclude the presence of critical views. Some of them expressed frustration with having to incur any charges or bills after purchasing PV, L2: *"I naively imagined that once we set up the panels, that would be the end of the bills, and nothing would come anymore"*.

This voice fits into a broader theme where distributors and energy system operators are seen as institutions acting aggressively and "exploiting" prosumers.

A notable point of contention was the misconception about energy independence. Despite owning PV installations, some respondents were surprised to learn that these systems did not provide complete protection against power outages. This highlighted a significant gap in understanding both the technological aspects of PV systems and the economic logic underpinning them.

3.1.4. Education and sources of knowledge

Considering the complexity and weight of decisions related to the purchase of PV, the issue of sources of knowledge indicated by respondents is of significant importance. Three main themes relevant to that issue emerged in the interviews. First, recommendations and the possibility of benefiting from the experience of family or friends play the most prominent role. Known individuals who already use a given solution are treated as the most reliable source of proven knowledge.

Second, especially at the early stages of the decision-making process, participants turn to expertise on the Internet. These are often not only forums or articles but primarily video materials. The most convincing here are "testimonials," i.e., reviews and descriptions of experiences by "ordinary" people, who are treated as more credible (and impartial) than those professionally involved in energy. (S1*"People like me, for example, who make these videos, have a bigger impact because, in my opinion, they are very credible").*

Third, especially in the period immediately preceding the purchase, the sales departments of companies offering photovoltaics play a crucial role. Due to the dominant sales model in Poland (i.e., direct meetings with sales representatives), a significant part of the knowledge about PV installations was conveyed to respondents at such meetings. It is also worth noting that – although this topic sometimes appeared – state structures (whether governmental or at the local government level) played a less obvious role in the educational or informational dimension. Respondents only sporadically pointed to such actions carried out locally (for example, promoting programs subsidising PV).

An interesting paradox emerged regarding the educational impact of purchasing, owning, and using PV installations. In respondents' statements, themes often appeared suggesting that a significant part of misunderstandings regarding the functioning of the installation or the settlement system was clarified only after its purchase (even in matters as essential as the inability to "store" produced energy in the absence of an appropriate storage facility). This was also reflected in the accuracy of the terminology used by participants; those with PV installations made fewer mistakes in differentiating between terms like kW and kWh.

3.2. Perception of the REC concept

Although there are some energy cooperatives and energy clusters in Poland, so far no REC initiatives have been established yet. Energy cooperatives exist mainly in the largest cities and are

limited to the set of flats where photovoltaics have been installed on the roofs, on balconies, or on the side of the building. The electricity produced is used mainly to meet the common needs of this building. On the other hand, energy clusters combine distributed energy generators with small businesses and, in most cases, do not involve individual consumers [35, 47]. Hence, it was important to learn what are spontaneous associacions of the term "renewable energy community". We asked about these associations before presenting the short description of the REC concept and then, again, in a more in-depth manner after participants read this document.

3.2.1. Top-of-mind associations with the REC name

The first most common associations with the term "renewable energy community" were the following:

- **The combination of several energy sources**: mainly photovoltaics, but also heat pumps or energy storage. Many people thought of a shared photovoltaic farm, i.e. a larger installation treated as a joint investment, L4: *"The whole estate will just set up, for example, a photovoltaic or a pump and they will share this energy, yes? That it will be for all of them"* or P6: *"Together we are putting up some big photovoltaic investment"*;

- **The exchange and sharing of electricity**: L3: *"So that we share this energy with each other"*, P2: *"Everyone is together, that some produce, others use this energy (...) community, meaning that something is common, that is, shared by all"*, or P5:

- **The energy bank**: *"An exchange of electricity, that what I give away, they will have to pay me back later"*, P1: "*It is just such an energy bank that people make for themselves around their houses. It is a kind of bank of a small estate, houses and everybody has some kind of panels and uses energy from that"*, S1: *"A circle of users, where everybody gives energy and then I use it in turns"*.

Participants in the study believe that within a community linking individual households, due to the **synergy effect**, it is possible to have a stronger market position and thus negotiate better terms of cooperation with, e.g., energy distributors (S3: *"Several people like me unite together. (...) They have more power because they have a larger volume of energy. Then they can negotiate terms"*).

For some, a community is **a venture or business** that has to be profitable to make sense and have a chance of succeeding in the market: S3: "*It is the kind of business that involves someone generating energy and making a deal directly with his consumer"*.

On the other hand, the community is associated with an opportunity for distributed prosumers by uniting them in the area of energy production and purchase. It is like an energy cluster for smaller actors, P6: *"setting up some kind of cooperative, where simply one produces electricity, the other one uses it, they account for each other, or as one entity they account for the power plant"*.

Interestingly, many associations with the word energy community refer to solutions dedicated to blocks of flats or housing estates, and not to single-family houses, e.g. L2: *"housing communities can install such panels on their neighborhoods and use them jointly"*. Sporadically, the

communities were associated with the EU and an agreement between countries. This is probably because the interviewees might have heard about the energy cooperatives, which, as already mentioned, function mainly for the block of flats.

3.2.2. Understanding of the REC concept

The interviewees were then asked to read a short description of the concept of REC, as shown in the Appendix 5. After reading the description, we have observed a diversity of opinions, ranging from:

- emphasizing the advantages in terms of saving energy, not wasting it by directly transferring the excess to those in need: P2: *"Cool thing, it's like the energy is not wasted (....) is just managed wisely"* ;
- evaluating REC concept as an utopian solution, politically or market unrealistic due to opposition of large players such as power plants: P4: *"What do power plants say to this because it will be distasteful to them, that we are going to sell electricity among our neighbours"*, L4: *"It's a bit utopian, because some Kowalski said that he burns less, that he shines lights, and Iksinski probably more*, L2: *"I associate it completely with PGE, Tauron and other large energy utilities"*, to:
- treating REC as an interesting solution, but unclear on the practical side: L4: *"I don't really understand how it transfers electricity to someone else. Does it just transfer like that and someone benefits? Or how does he resell it?"*, P5: *"Terribly confusing"* , L3: *"And on what basis? Is this about these photovoltaic panels like I have?"*.

3.3. Factors driving the decision for participation in REC

During the interviews, respondents mentioned various arguments they believe would be convincing for participating in the energy community. Some of them were particularly emphasized, and we defined them as factors driving the decision about joining REC. These drivers are: 1) financial profitability, 2) fair settlement and legal formalities, and 3) convenience and time-efficiency of the solution. Additionally, important but with a lesser impact on respondents' decisions are issues related to 4) data access and 5) increase in energy independence and supply stability. Identified drivers 1-5 are elaborated in the following subsections.

3.3.1. Financial Profitability

The primary factor influencing respondents' decisions to participate in REC is financial profitability. Respondents expect that joining REC will result in a lower cost of purchasing energy or financial gains from selling excess energy they produce to other users. Some share the view of the interviewee P2:*"if participating in REC is cheaper than selling excess energy to the grid, it would be appealing. On the other hand, if it is more expensive or the same price, there would be no sense in being part of the community"*. Two groups of prosumers are identified based on how they define expected financial profitability:

- Prosumers valuing savings: This group equates financial success with the elimination of electricity costs in annual settlements. Anticipating increased future energy demands, such as from electric vehicles or heat pumps, these prosumers see RECs as a pathway to mitigate rising expenses.

- Prosumers seeking profit and additional earnings: Here, the focus is on leveraging REC participation as a means of generating income through energy sales. The willingness to expand photovoltaic (PV) installations for greater financial returns reflects this perspective.

In the financial context, optimising the production and consumption of locally generated energy is considered important. Respondents see REC as a chance to reduce energy losses and efficiently utilise locally produced energy, resulting in financial benefits. The expectation is that local energy trading within RECs could lead to reduced distribution network upgrades, fewer intermediaries, and consequently, lower energy bills. They also notice that REC, as a larger customer, can negotiate better pricing terms with the energy distributor than an individual customer.

Indirect financial incentives, such as tax benefits and extended warranties for renewable installations, also play a role in the decision-making process. Participants expressed the need for detailed financial calculations, including installation costs, insurance, and maintenance, to evaluate the profitability of joining an REC comprehensively. Additional aspects that respondents often pay attention to are the initial costs associated with connecting to REC or investing in a shared installation. High initial costs would be a barrier to joining REC, while low costs could be an opportunity for those who cannot afford their own renewable energy installation in the current system. What is more, respondents would like clarity on subscriptions and the principles of their calculation. We note that the presence of dues may be controversial— some respondents would accept the obligation of paying subscriptions, some would not, and one respondent believes that fixed and variable subscriptions should be introduced.

3.3.2. Fair Settlement System and Legal Formalities

Another key driver for respondents is the creation of a fair settlement system between REC members. Respondents are concerned about potentially unfair distribution of benefits among REC participants and fraud, so they emphasise that it is crucial for the solution to be *"well thought out so that one does not benefit more while the other benefits less"* (L1). Emphasized is the necessity for REC operations to be founded on transparent, understandable regulations, ensuring equitable energy exchange and consumption.

Additionally, the legal formalization of RECs garners significant attention. This includes defining community competencies, formalizing agreements, and instituting governing and supervisory structures to ensure lawful operations. The importance of clear, unambiguous laws that eliminate interpretative flexibility is underscored.

3.3.3. Convenient and Time-Efficient Solution

The desire for a comprehensive, hassle-free REC experience is prominent among respondents. They envisage a scenario where the organization and management of the REC, including documentation, permits, equipment selection, and maintenance, are handled by a competent, qualified entity.

Respondents expect that participation in REC will not be time-consuming and demanding, functioning *"from the level of an application, not from the level of local meetings"* (P2). They expect REC to provide convenience, time savings, and task facilitation, such as electronic payment for energy and the avoidance of installing and maintaining domestic heating boilers. According to P3, participants in REC might even be willing to pay extra for convenience.

The interviewees expect that the mobile application through which they will participate in REC will be clear and easy to install and use. P2: *"Either someone will come and take his phone and install an app for him, or there will be some very simple instructions for using it, either in the application or on YouTube"*. If the installation and initiation of operation are more complex and require synchronization with other devices, it is essential to provide appropriate support to users.

Some respondents go a step further and would like to have the ability to automate buying and selling transactions through the mobile application. They believe that such functionality will save users time and effort associated with constantly making decisions. However, the extent of automation should be customizable, considering varying levels of trust in technology among users.

3.3.4. Data Access

Interviewed prosumers respond very positively to the idea of being provided with data on energy production, consumption, and conducted transactions. They believe that accessing data through the application would be more convenient compared to receiving bills in the current forms (paper or electronic). P5: *"Now I have to go outside, open the mailbox, calculate the average for the month, and I know how much I pay in a day. In the application, I would have it up to date, with statistics, from a specific day, from daytime hours, nighttime hours"*. Some respondents note that this would give them a sense of peace and control, L1: *"everything in the app, you see how much energy you have consumed, how much you have sold and so on. If you had that control, you would be calmer"*.

The necessity for a user-friendly and credible presentation of data is emphasized. Prosumers express the desire for an interface that is not only appealing but also intuitive, presenting crucial information in a visual and straightforward manner. The potential for such detailed data to influence user behavior is noted, with suggestions that visual representations like hourly consumption bars could encourage more energy-conscious decisions.

However, there is a distinct lack of interest in functionalities that would enable comparison of energy usage with neighbors. Respondents do not view such features as beneficial and express concerns about the potential for causing discord or conflict within the community. The focus remains firmly on personal management and control of energy data rather than on comparisons with others.

3.3.5. Increase in energy independence and supply stability

One of the key arguments for joining REC is to increase the energy independence of the community and ensure energy supply stability. The adoption of REC is perceived as a strategy to mitigate risks associated with large-scale power plant failures or grid instabilities. The notion is that REC can provide a safeguard for local businesses and, by extension, employment stability within the region.

The importance of community size in achieving energy independence is emphasized. A larger REC is seen as more capable of accumulating energy reserves, thereby ensuring resilience during periods of low energy production, such as on cloudy days. The interviews also reveal an interest in integrating energy storage solutions within REC. Such systems would allow for more effective utilization of personal renewable energy installations, reducing dependence on external weather conditions. P3: *"By sharing a common energy storage with other REC participants, I will be able to make better use of my PV installation. Currently, I cannot always count on the availability of energy from PV because the sun is not always shining"* .

Further, the idea of diversifying energy sources within RECs is highlighted as a key to increasing energy independence. Respondents advocate for a mix of renewable energy sources, including solar farms, wind farms, and hydrogen production facilities, to create a robust and resilient electrical system.

3.3.6. Other aspects supporting REC

While not universally recognized as primary drivers, certain aspects emerged during the interviews as potential motivations for joining REC. These following factors, while only noted by a few respondents, add depth to our understanding of the diverse incentives for REC participation:

- Minimization of technical exclusion: RECs are seen as a solution to technical and financial barriers that prevent individual renewable energy installations. For residents with constraints like roof warranty concerns or limited space in urban settings, RECs offer an alternative pathway to renewable energy utilization. Additionally, individuals with oversized photovoltaic (PV) installations view RECs as an opportunity to efficiently distribute excess energy within the community.

- Decision making and control: Despite a preference for REC's comprehensive design and management, participants express a desire for a sense of control and agency within the community. The construction of REC should allow members to feel involved without being burdened by organizational responsibilities. Moreover, the flexibility to join or leave REC at regular intervals, such as every three months, is desirable. Respondents emphasize that REC is a new solution, and before making a decision to join, they would like to see how such a community operates and check if other people, including neighbors and friends, are satisfied.

- Ecological considerations: Few respondents referred to aspects related to ecology and environmental care in the context of REC. Several of them declared that ecology would be one of the supporting arguments for REC, but economic benefits play a much more significant role in decision-making regarding REC. L2: *"For me, the second, and even the first argument, is ecology, but I realize that for the majority of people, financial matters are still the most important."*. P3: *"The solution is timely because we have generators, energy storage etc. We are very environmentally friendly. However, in the end, the economic calculation, the real one, matters"*. The low weight of environmental arguments means that even individuals with radically different views, who do not see their role in combating global warming, may be interested in joining REC due to financial benefits.

- Economic patriotism: A preference for locally-based or national companies managing RECs is noted among some participants. This sentiment is rooted in a desire to support the national economy and skepticism towards foreign enterprises. Trust in REC management is influenced by perceptions of corporate nationality and geopolitical views.

3.4. Barriers

During the interviews the respondents expressed their concerns about joining REC and identified factors that would certainly discourage them. Among the frequently mentioned barriers that significantly influence the decision are: 1) the novelty and complexity of the solution, 2) a decrease in energy security, stability of energy supplies, and associated financial losses, 3) technological barriers, as well as 4) neighbour disputes and a sense of dependency on others. Last but not least is 5) the lack of trust and access to new technologies. The identified key potential barriers are described in the following subsections.

3.4.1. The novelty and complexity

One of the key barriers mentioned by respondents is the novelty of REC and the inability to test it. S4: *"I feel uncertain because it is something that does not exist at the moment, I have not encountered it, and it would be a challenge to overcome"*. Additionally, the concept of REC is intricate and difficult for respondents to imagine. They emphasize the need for a pilot project to see how REC actually functions. They do not fully understand the purpose of the formation of REC. L1:*"What is the purpose of these cooperatives? I currently have an arrangement with the energy company and settle with them on favorable terms. (...) Who would benefit from this, and who would lose out?"*. S1:*"The idea is cool and definitely developmental, but there a lot to coordinate (...) Honestly, I do not entirely see how it can work. The concept is nice, but for now, I do not really know why, in the end"*.

3.4.2. Decrease in energy security, stability of energy supplies, and associated financial losses

Respondents unanimously express the need to secure energy supplies. They expect the availability of the energy backup in case of a shortage of energy produced locally. S5:*"How does REC operate during the winter when PV does not generate energy? REC should connect to power plants during the winter season."* Additionally, respondents would like to know how prepared REC is for various emergency scenarios. Some individuals, drawing on their experiences with PV installations, are concerned that REC installations may operate defectively and cause an increase in voltage in the grid. They also emphasize the importance of proper safety devices for REC installations.

Respondents are also concerned about interruptions in electricity supply when switching to a backup energy provider or during the exchange of electricity between neighbors. They are worried about associated financial losses – when participants, instead of using their own PV, would be supplied with more expensive energy from the backup service provider.

What is more, the respondents fear that, while being in REC there will not be sufficient locally produced energy for them. The concern relates to both (1) a financial aspect - P5: *"I would like it to be based on selling excess production, not current production, because it is of great importance. Because why do we install photovoltaics? To reduce costs at home, not to reduce costs for the*

neighbor", as well as (2) to energy security - P3: *"The downside is that someone could switch entirely to such a solution, and it would not be enough electricity for me"*.

3.4.3. Neighbor disputes and a sense of dependency on others

Respondents strongly prefer individual installations over communal ones. This gives them a sense of independence, control, and helps avoid conflicts. P3:*"We Poles are more like... when we have our own, we have our own. So here I am rather conservative, and I think I would rather have my own PV."* Moreover, a significant portion of the respondents sees the emergence of conflict situations as a barrier to creating a REC community, related to:

- differences of opinion among participants – L2:*"That is how it is - two Poles mean three opinions"*,
- envy from neighbors, suspicion, mistrust, or the desire to act against the group by individual participants – L1:*"People are naturally suspicious. One wants more than the other. Envy sometimes affects behavior in different ways"*,
- frauds and dishonest division of benefits among REC members – P5:*"How to divide this electricity so that it is enough for everyone, and no one has complaints? (...) I would be afraid that when electricity is free, people will start overusing all kinds of electronic devices and equipment"*,
- ineffective communication – L1:*"Later, it can turn out that I thought one thing, and the other meant something else"*.

One of the respondents point to well-crafted laws and operating principles for REC as a remedy for conflict situations.

3.4.4. Technological barriers

Some respondents argue that the current electricity grid infrastructure is not prepared for solutions such REC. P4:*"Our electricity grids should undergo a thorough change. They are absolutely not ready for an electrical boom. We would simply have a blackout all the time because overcurrent is harmful"*. The implementation of energy community solutions would require significant investment, and with the current bureaucracy, it would take a lot of time. P1: *"The infrastructure is not ready for this. Because, after all, all members have to connect everywhere. It will be expensive, someone will have to pay for it, and that will be the biggest problem"*. Additionally, respondents anticipate resistance from energy monopolists or utility companies since (1) they may lose customers and profits, and (2) REC may bother them in terms of organizational and technical issues.

Furthermore, respondents anticipate challenges in managing energy flows for community members with similar patterns of energy consumption and production throughout the day. They also highlight the issue related to an excess of energy production from PV installations that the grids are unable to accommodate. According to the respondents, a solution could involve the installation of energy storage facilities or the diversification of REC member groups, such as the inclusion of small businesses or establishments with higher energy consumption during the day. The recurring

theme in discussions is that not only residents but also local businesses could participate in the community.

3.4.5. Lack of trust and access to new technologies

During the interviews, some respondents pointed out generational differences, stating that older individuals may face barriers related to access to and trust in new technologies. L3:*"Different people will want to use it, including older individuals. Not every phone has the function to have an application (...) I think older people are less open to such solutions. Because they are afraid of being cheated."*. P4:*"People are not ready for this type of change. Looking at the mentality of my neighbors, I believe it would take another forty years for such changes"*. We also observed that some respondents aged 50 and above negatively associate the energy community with communism or Marxism. L1:*"I am from the 1960s era, where we underwent transformations like cooperatives and similar things, state agricultural farms, and all that did not work out"*.

The interview outcomes reveal that individuals with less trust in technology may feel the need to verify data showed in a mobile application. They would like to undergo the change gradually instead abruptly resigning from previous, well-known standards, such as receiving paper bills. L3:*"At the beginning of participating in REC, I prefer paper bills, to make sure that there are no differences or mistakes. It looks more credible to me (...) If I am convinced, then definitely the app"*. People of this kind require time to familiarize themselves with new solutions and build trust in them. On the other hand, another group of respondents has greater trust in new technologies and assumes that the data in the application are correct, with no need for additional verification. P2:*"An app would be completely sufficient for him"*.

3.4.6. Other barriers and concerns

During the interviews, several additional concerns emerged, emphasized by individual respondents, which may also constitute potential barriers to participation in REC. One of such concerns relates to energy justice. Two respondents, P4 and S5, note that an increase in the number of individuals who decide to disconnect from the electricity grid and transition to off-grid solutions will result in higher prices for conventional energy supply, including the technical maintenance of electricity grids, for the remaining users. Similarly, this could apply to REC – individuals outside the community may pay higher energy bills than at present since fewer people will "contribute" to the maintenance of the infrastructure. According to the respondents, this is a reason why current energy laws do not permit the energy trading between individual consumers and prosumers.

Some of the respondents also point to the lack of appropriate legislation as a potential barrier for REC. They note that current Polish law does not allow for the sale of excess energy between energy community participants. They also believe that Polish regulations are too complicated to successfully implement REC legally. P4: *"The complexity of Polish regulations partly results from the mentality of Poles, who look for loopholes in the law"*.

Another potential barrier for REC mentioned by some respondents is high prices and the lack of available land in cities. Respondents living near Warsaw point out that landowners in suburban areas, which prices are high, would find it much more profitable to sell the plot to developers than to lease it for a REC installation. This could pose a potential threat to the development of energy

communities, and for this reason, REC should utilize space that is difficult to access for other investments, such as roofs of houses or apartment buildings.

3.5. Trust in various institutions and key stakeholders

A distinguishing aspect of the perception of key institutional and business partners potentially engaged in the development of REC is ambivalence. Distrust of all institutions, including the state and those in power, comes to the fore on the one hand, and the need for the state to provide legislative solutions and financial support and promotion of REC-type solutions on the other. Some respondents are of the opinion that the solutions proposed by those in power will not be beneficial to the end users.

Many respondents are sceptical about the role of Europe, including Poland, in reducing CO_2 emissions globally by switching to renewable energy sources, saving energy and making efforts to improve energy efficiency. They believe that as long as similar measures are not initiated globally (by, for example, India, China or the USA), Europe alone will not be able to do much to combat climate change, L1: *"Big countries like China, India, America, Africa and so on, are not worried about this climate, because there is such pollution there. And all of us in Europe are in favour of the fact that we are going to save the world"*.

In the case of national government, we also see a lack of trust, P1: *"wherever the state has its fingers, it is clear that they want money and nothing else"*. On the other hand, local government, if well run and depoliticised, is a good place that could be tasked with supporting the creation of RECs, P6: *"The state should then regulate and support the development of such communities"*. The role of local governments is to take care of local residents. At the same time, respondents are of the opinion that it is the local authority and not the government or companies that should be in charge of setting up RECs, L5: *"That it would be credible. They would be more trustworthy. Than some private company, somewhere, I don't know, a bush ...or something came into existence and .... and you don't know who, what (...) It seems to me that if it came out of the local authorities, it would be more credible"*. This is due to the fact that, on the one hand, they are the guarantor of stability (they do not go bankrupt, even if they have a financial deficit), and, on the other hand, they represent the local community, knowing its needs.

The role of companies, both public and private, is perceived differently. In the case of private companies, some respondents fear not only the pressure to maximise company profits at the expense of them - the consumers - but also that the company will fail and they themselves will be deprived of technical, administrative or financial support, S4: *"I would like it to be a monopoly like a power company, or some, I don't know, kind of a state-shifted entity. Safer, as it were? (...) because, let's assume, I put a lot of money into such an investment, and suddenly they disappear. And then what?"*. At the same time, some people believe that firms installing PVs could play a vital role in creation of RECs, L3: *"The companies that deal with photovoltaics know the most. And they should be the ones to create such communities"*.

Some believe that that state-owned energy companies should create RECs because they are more reliable than private ones, they have the infrastructure, know-how, and experience in the energy industry, L5: *"the big energy companies should be in charge of that. It doesn't make sense to set up another private company, because you know, maintenance costs"*.

4. Discussion and conclusions

This paper primarily aimed to examine the motivations and obstacles for Polish current and prospective prosumers to participate in REC. Additionally, we sought to systematically understand and structure this knowledge, hence, providing a better-informed foundation for discussions on the implementation of REC policies in Poland. The discussion has the following structure: We will first present summaries of barriers and drivers regarding REC, which we will then present in the context of Bronfenbrenner's model. We discuss the specificity of the Polish socio-cultural context, and finally, based on these results, we undertake a broader reflection on methodological issues and limitations of our study.

4.1. Drivers, barriers and expectations towards participation in REC

Throughout the interviews, participants highlighted several persuasive reasons for engaging in the energy community, emphasising what we identified as key factors influencing the decision to join the REC, including financial profitability, fair settlement and legal procedures, and the convenience and time-efficiency of the proposed solution. Additionally, considerations related to data access and the enhancement of energy independence and supply stability were deemed essential but had a relatively lesser impact on the respondents' decision-making process.

On the other hand, participants of the survey voiced apprehensions regarding their participation in REC and pinpointed factors that would unequivocally dissuade them. Notably cited barriers exerting a substantial influence on the decision-making process include the perceived novelty and complexity of the solution, concerns about diminished energy security, instability in energy supplies, related financial setbacks, technological hurdles, potential conflicts with neighbours and perceived reliance on others. Lastly, a lack of trust and limited access to new technologies were underscored as crucial barriers.

4.2. The need for systemic analysis of the decision-making environment

The results obtained in the study clearly indicate the value of a systemic approach in reconstructing the decision-making and motivational processes shaping the behavior of future REC users. Although the users' statements most often concerned their individual and personal history or beliefs, their analysis allows us to reconstruct a field of motivational, social, and cultural forces acting on them at all levels of the hierarchy proposed by Bronfenbrenner. Some of the identified motivations and barriers operate at the individual level – for example, technological knowledge or beliefs about environmental protection. Others belong to the microsystem, i.e., the closest relationships surrounding the individual – such as factors related to the family or household's economic situation. At the macrosystem level, factors related to the broader socio-economic context shaping user behavior are located. This is where, for example, experiences (positive or negative) with companies operating in the PV sector or related to local government, which respondents project onto their future decisions regarding REC, should be placed. At the next level, we can identify elements of the macrosystem shaping the decision-making environment, such as characteristics of Polish socio-cultural life like the intensifying political-ideological polarization and associated Eurosceptic or Euro-enthusiastic narratives present in the media space. Finally, a series of elements directly related to the chronosystem appeared in the users' narratives, i.e., factors correlated with

time and significantly shaping the respondents' environment. This is where phenomena such as the outbreak of war in Ukraine in 2022 and its consequences for the Polish energy market or changes in EU energy policies and – associated with them – the rise in energy prices migth be located.

A complete listing of the key variables identified in the interview analysis, along with their classification according to Bronfenbrenner is presented in Figure 2. This listing will also serve as the starting point for further in-depth discussion of the obtained results.

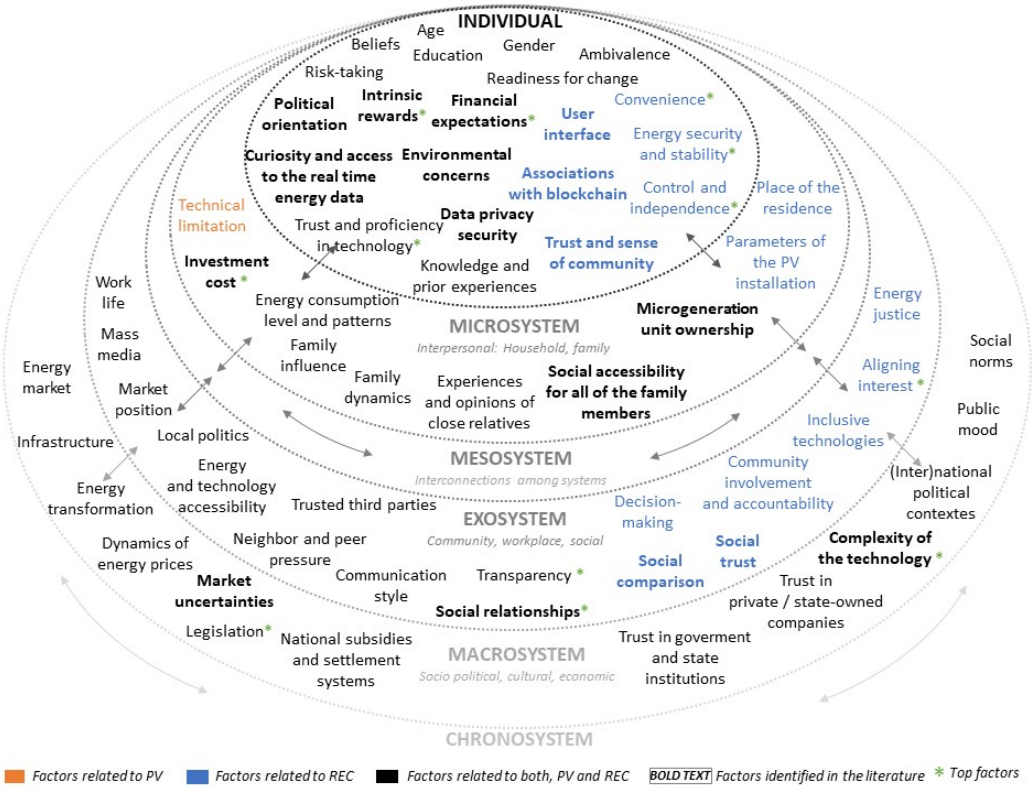

Figure 2: Identified factors impacting the decision to invest in PV or participate in REC classified according to the Bronfenbrenner's socio-ecological model

4.3. The role of specific socio-cultural factors

Regardless of the complexity revealed in the systemic analysis, the obtained results clearly indicate that the effective explanation of the way of thinking about REC (Renewable Energy Communities) is a result of what is universal and mechanisms that are of a local nature. This locality is expressed in many different interconnected dimensions – specifically the Polish economic context, cultural idiosyncrasies or customs, and finally, the specifics of legal or political frameworks. A recent publication [54] suggested that the humanities and social sciences play an instrumental role in understanding energy transformation. Our results clearly support this observation, showing that an in-depth understanding of the variables determining the effectiveness of implementing REC requires drawing on knowledge and methodological tools of social sciences and humanities. This phenomenon is so complex that – even within the context of our study – it could be subject to a

separate analysis. However, here we will refer to a few illustrative examples. The first two of these will refer to issues that constitute axes of polarization and differentiation of respondents characteristic of the Polish situation. The remaining two – factors that seem to connect all respondents and have an internally universal character, but at the same time are distinctive when compared with the situation of other countries – even those geographically and culturally close to Poland.

Firstly, a series of statements obtained indicates – observed in the past or anticipated – difficulties in establishing REC stemming from marked ambivalence in the perception of potential stakeholders, including such essential groups as local government or distribution network operators. Addressing these types of concerns is a key condition for the success of REC implementation – in interviews, there was a strong expectation that REC operators would guarantee stability and energy security. At the same time, the issue of the perception of individual stakeholders is a function (highly polarized in the case of Poland) of political and ideological beliefs determining, among other things, the level of trust in business, local authorities representing certain parties, etc. [55].

Another example of significant, local conditions constituting a characteristic axis determining reactions and attitudes is the diversity in levels of trust in the EU institutions and policies. This aspect of polarization is, as indicated by studies, significantly shaped by top-down factors and associated with a significant intensification of populist and divisive discourse appearing in power elites [56, 57]. These discrepancies, of course, translate into the perception of ecological issues and the EU Green New Deal policies. The discourse on energy has been politicized and has become a hostage of political conflicts [39, 58].

Compared to Western countries, in Poland, the topic of climate catastrophe, although gradually becoming more significant, is not currently at the strict center of public discourse [59]. On one hand, this may be due to historical and political conditions related to the rapid (and relatively recent) systemic transformation after the fall of communism [60]. At the same time, however, economic factors related to Poland's current, particular situation, as a country neighboring the war in Ukraine and simultaneously experiencing a very rapid increase in energy prices and its carriers, are also significant. The dominance of economic motivations over ecological ones was, after all, one of the most apparent patterns present in the data obtained in our interviews.

Finally, the last highly distinctive phenomenon important for the future of REC and at the same time highly characteristic of Poland is the educational influence of the PV revolution. It can be said that the ubiquity of experiences related to PV - not only the fact of owning it but also making purchase decisions, contact with sales departments, the presence of this topic in discussions and everyday life in recent years has been a very important experience shaping knowledge about energy, drawing respondents' attention to the principles of the energy system, etc. Due to its ubiquity and the fact that for many people, considering and using PV is their first experience in citizen energy. The results of our interviews clearly indicate that opinions of how REC may operate are significantly based on experience with PV, including issues of trust in information sources, economic expectations, cost-benefit analysis, etc. In this sense, the specific trajectory of renewable energy has become a formative experience for the future of REC in Poland. The clarity of this assertion is further enhanced when considering the synthesis of results depicted in Figure 2. Beyond the financial constraints identified as an obstacle exclusively for Photovoltaic (PV) systems, and not for Renewable Energy Communities (REC), there are also unique concerns like diminished

trust in organizations, apprehension about neighborly disputes, and the reported efficiency of REC solutions – aspects not associated with PV. All other identified barriers and motivators show consistency across both PV and REC systems. Notably, adopting PV systems plays a crucial role in educational contexts and equips Polish citizens for future involvement in RECs.

4.4. Implementing and communicating REC - Strategic insights

As explained in Section 4.3, barriers and drivers to participation in REC may appear at different levels of Bronfenbrenner's socio-ecological model. Based on the feedback received from respondents, we assert that the operational model of REC should be flexible and individually tailored to the characteristics of each group and region, in order to most accurately meet the users' needs and be appealing to them. For example, location-based differences such as land availability in urban or rural areas, as well as variations in the lifestyles of different user groups, along with their associated diverse preferences for additional services offered by REC, will dictate the most suitable REC model for specific regions. This implies that when planning REC in a selected region, a thorough examination of all technical, economic, and social aspects is essential.

In the context of implementing energy communities in Poland, effective change management is crucial. This is due to the fact that REC solutions operate in a manner fundamentally distinct from the existing retail electricity market, are novel and difficult for Poles to conceptualize. A significant aspect of change management will involve appropriate communication regarding REC.

Depending on generation (age) PV owners look at RECs differently (neoliberalism). We may observe cohort effect - i.e. generational change and different environmental awareness (trends in distribution of environmental attitudes). Prosumers may become advocates of REC solutions in Poland, different target groups so tailored message needed, different narrative (generational effects).

In Poland, communication concerning REC should not base on arguments related to ecology or global warming. Our research indicates that such arguments may not be compelling and could even deter certain audiences. If we intend to construct a message based on ecology and environmental conservation, it should be targeted specifically to a chosen audience group.

Furthermore, from our observations, it is evident that a significant and highly desirable action in communicating REC would be an implementation of a pilot project in Poland. Such a project would address current respondents' difficulties by providing them with the opportunity to comprehend how REC operates, test the solution, and understand its benefits and limitations.

4.5. Broader methodological considerations

Regardless of the detailed recommendations for effectively implementing Renewable Energy Communities (RECs), our findings also yield broader insights. These insights pertain to the challenges of generalizing our results in the context of developing REC-related policies and, more expansively, in studies concerning energy transformation. This topic certainly warrants further in-depth examination. Within the scope of this discussion, we summarize these insights through four key learnings.

First and foremost, our research underlines the importance of adopting a systemic perspective when studying energy transformation processes. An approach that exclusively focuses on a single

dimension – be it macroeconomic, social, or psychological – is likely to result in oversimplifications. Such a narrow lens can lead to critical omissions, ultimately diminishing the explanatory and practical value of the resulting models. This multidimensional approach is essential to capture the complexity and interconnectedness inherent in energy transformation studies.

Secondly, although the list of factors we have revealed as significant for attitudes towards RECs is in many points tangent to the conclusions of studies conducted in other countries, it is, at the same time, in many aspects, strongly conditioned locally. This shows that abstracting from the specific context of the research - cultural, social, political - can also lead to significant misunderstandings or oversights. The subject of decision in the area of consumer energy is people - and therefore it is crucial to be immersed in an environment that also includes the local, rooted in collective historical memory or cultural patterns.

The third crucial finding stresses the importance of acknowledging individual differences and the diversity within the populations studied when designing policies and interventions. Although the variables impacting attitudes towards RECs appear relatively consistent across our interviewees, there was notable variability in perspectives within the group. This ranged from technological expertise to lack thereof and from advocates of cooperation to proponents of laissez-faire approaches. In the case of the FMCG market or typical services, the issue of diversifying target groups is completely natural and embedded in the communication and marketing processes used for decades. In the case of introducing solutions such as RECs, effectively addressing the needs of many different user groups with radically different worldviews, attitudes, or levels of technological competence remains a much greater challenge. This is partly due to the fact that REC-type solutions are introduced systemically, at the national level, and the possibilities of their effective individualization or personalization are significantly limited.

Finally, our analysis of the Polish context reveals a crucial, albeit less apparent, aspect of implementing Renewable Energy Communities (RECs): their significant unpredictability, especially when viewed over a multi-year timeline. The Polish case illustrates how various factors, often unforeseen, can profoundly shape prosumer beliefs and attitudes. These include the establishment of financial support mechanisms for prosumers, leading to the rise of commercial entities engaged in highly effective sales and educational activities.

Additionally, external events like a military conflict near Poland's borders, causing substantial shifts in energy and raw material prices, have played a role. This series of events has resulted in a 'perfect storm', catalyzing the rapid expansion of photovoltaic (PV) systems and thereby sculpting the landscape for any future citizen energy solutions. It's important to highlight that the prosumer revolution in Poland, a notable differentiator from neighboring markets and a pivotal factor in shaping its energy future, did not emanate from a top-down strategy. The growth in PV installations has consistently outpaced forecasts, largely driven by unexpected positive feedback loops rather than deliberate policy actions. This phenomenon underscores the dynamic and often unpredictable nature of energy transformation, particularly in the context of citizen-led initiatives like RECs.

4.6. Limitations and future work

The present study, while making a reasonable choice of methodology given the complexity of the studied problem, is not without its inherent limitations. One notable constraint arises from

the limited sample size employed in our analysis. While this sample size was deemed appropriate given the intricacies of the research question, it remains a potential limitation in terms of generalizability. Another noteworthy aspect is the need for quantitative verification, a concern that is already acknowledged within our project framework. Incorporating robust quantitative methods will enhance the reliability and validity of our findings.

Furthermore, the dynamics of the current situation in Poland introduce additional challenges and potential limitations. The political turmoil and geopolitical instability, particularly the situation in Ukraine, co-determine the context in which our study unfolds. These external factors may introduce fluctuations and uncertainties that could impact the accuracy and applicability of our results. Recognizing this, future research should consider incorporating real-time data and adjusting methodologies to account for the dynamic nature of the geopolitical landscape in the region.

In the future, it is imperative to address these limitations and strive for a more comprehensive understanding of the subject matter. Expanding the sample size, implementing rigorous quantitative measures, and adapting research strategies to accommodate the ever-changing geopolitical climate will contribute to the robustness and relevance of our findings. Additionally, exploring avenues for collaboration with experts in political science and international relations could provide valuable insights into the broader contextual factors influencing the dynamics under investigation.

Acknowledgments

This work was supported by the National Science Center (NCN, Poland) with grant no. 2022/45/B/HS4/0380

5. Appendix

5.1. Interview Script

In the following, we present the interview script that was used while conducting the interviews with the partcipants of the survey.

I. Introduction to the principles and purpose of the interview; Introduction to the interview facilitator

II. Introduction of the interviewee (5 min)

- Could you tell me a little about yourself and your household?
- What do you do for a living? Do you work from home or drive to work?
- What is the composition of your home? Do you live alone or with your family?

III. Home and electricity (20 min)

1. Could you describe your house or flat?
    - What sources of heat and air conditioning do you use in your home?

- Do you use appliances such as heat pumps, photovoltaics, energy storage?

2. Block of questions for prosumers
   - Can you tell us something about how you became a photovoltaic user? (When? What is the capacity of your PV?
   - What was the decision-making process like? (Who did you talk to? Who did you advise?
   - What convinced you? What were your motivations?)
   - What was the process of selecting a contractor like?
   - What were the sources of knowledge/advice in this process?
   - Were you influenced in any way by people close to you or neighbors?
   - What expectations did you have from setting up the installation (financial and other)?
   - How do you evaluate this decision now? Have these expectations been met?
   - Does the energy from RES cover your energy needs?
   - What happens to excess energy that is not used for your own needs?
   - Would you make the same decision to invest in an installation again? Would you change anything?
3. Block of questions for non-prosumers

   - Are you planning or have you planned to set up photovoltaics?
   - What do you think? What are the arguments for and against?
   - What has convinced you? What could convince you?
   - What are your sources of knowledge on the subject?
   - When do you plan to set up the installation?
   - What expectations do you have/have of the installation (financial and otherwise)? How would you like it to work?
   - Do you think RES energy will cover your energy needs?
   - What will happen to this excess energy that is not used for your own needs?
4. Block of questions for all participants

   - What do your electricity bills look like? Can you give examples of values?
   - On what do these values depend? What do they consist of?
   - How much is your electricity consumption and/or production usually?
   - Do/how do you try to reduce electricity costs (e.g. by reducing consumption)?

- How does the use of PV compare financially? What would change if you set it up - what do you think? Or what has changed since you had it? How do you know this? What is the billing process for the energy produced?

IV. Renewable energy communities (20 min)

Now I would like to talk about a topic that is new - it is a solution that does not actually exist in Poland yet but will probably appear in the future. What do you associate the phrase "energy community" with?

1. Questions **before reading** the REC description
   - What do you think it could be?
   - Who participates in something like this?
   - What might it be? And how does it work?
   - Even if you don't know, what associations do you have here?

   Now I would like to show you a short description showing what energy communities are. I will be curious to hear your opinions [shown].
2. Questions **after reading** the REC description
   - What do you think of this solution? Is there anything that puzzles you or surprises you?
   - How do you think it could become popular? Why? What advantages might it have?
   - And what might make it difficult to do such a thing? Why? What could be the problems here? Difficulties? What disadvantages might it have?
   - If such a solution appeared in your area, would you be interested? Why? Under what conditions?
   - Would you have specific financial expectations about your participation? What would be important to you? When would you consider it worthwhile for you?
   - If there were an opportunity to donate additional unused electricity free of charge, would you be prepared to do so? To whom? To whom would they sell energy at the 'normal' price? To whom would they sell energy at a 'promotional' price?
   - And what do you think about the possibility of transferring energy to, e.g. neighbors for some additional benefits, products or services? What / what would be interesting here?
   - How do you imagine who could create such communities? Does it fit with local authorities or local government? Or energy distributors? Perhaps photovoltaic companies?
   - Would it make any difference to your decisions on who forms such a community?
   - Do you think that the state should regulate and support the development of energy communities? Why yes/no? In what way? What would be important here?
   - If such communities had already emerged, where would you look for information on this topic? Who would be reliable to you as a source of information? In what form? What could be done to better inform people that such a thing has appeared?

3. Questions about the names There are possible different translations of the English term used to describe this solution. In Polish, names such as energy community, energy cooperative, and energy cluster are used.
    - What do you think about them?
    - What associations do they evoke?
    - Does any name appeal to you more? Why?

V. Thanks and closing (5 min)

- Do you have any more points to add/add?
- If you had to write 3 pieces of advice for someone who wants to introduce such a solution and wants it to be successful, what would they be of all the things we have talked about?
- Thank you for participating in the survey.

5.2. Description of REC

The REC (Renewable Energy Community) concept aims to:

- increase energy efficiency through the consumption of electricity, as close as possible to where it is produced,
- increasing the production of energy from renewable sources,
- involving households in conscious electricity management.

REC can be implemented under one or a combination of the following options:

1. part of the energy produced from renewable sources (e.g. solar PV) within a household can be transferred to another household, a public organisation or a private organisation. Transactions take place within agreed administrative boundaries (e.g. neighborhood, village, city, county), with or without pre-agreed benefits - depending on the arrangements.
2. Households can use a shared installation for local production and / or storage of renewable electricity for their own consumption. Examples of installations: photovoltaic farm, wind farm, hydrogen energy production installation, energy storage.
3. To a predetermined extent and at a predetermined time, a household's electricity consumption (e.g. electric heating, air conditioning) can be regulated remotely by a management entity. This is done in return for a pre-agreed benefit.

In each case, a device will be installed in the household to measure the consumption and (if applicable) the production of electricity. All activities such as energy sales/purchases or remote consumption management will be recorded electronically. Each household will have access to a mobile app where it will find information about its energy production and consumption, as well as transactions between it and other REC participants. All transactions related to energy exchange/management are carried out from within this app.

References

[1] B. Koirala, Y. Araghi, M. Kroesen, A. Ghorbani, R. Hakvoort, and P. Herder, "Trust, awareness, and independence: Insights from a socio-psychological factor analysis of citizen knowledge and participation in community energy systems," *Energy Research & Social Science*, vol. 38, p. 33–40, 2018.

[2] D. Gielen, F. Boshell, D. Saygin, M. Bazilian, N. Wagner, and R. Gorini, "The role of renewable energy in the global energy transformation," *Energy Strategy Rev.*, vol. 24, pp. 38–50, 2019.

[3] Y. Zhang, S. Y., X. Zheng, C. Wang, Y. Guan, J. Yan, F. Ruzzenenti, and K. Hubacek, "Energy price shocks induced by the Russia-Ukraine conflict jeopardize wellbeing," *Energy Policy*, vol. 182, 2023.

[4] EC, "Directive on common rules for the internal market for electricity." European Parliament, Council of the EU, Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944from=EN, 2019.

[5] EC, "Directive on the promotion of the use of energy from renewable sources." European Commission, Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001from=en, 2018.

[6] A. Caramizaru and A. Uihlein, "Energy communities: an overview of energy and social innovation." European Commission, JRC Science for Policy Report (accessed 19th January 2022, 2020.

[7] I. Otamendi-Irizar, O. Grijalba, A. Arias, C. Pennese, and R. Hernández, "How can local energy communities promote sustainable development in European cities?," *Energy Research & Social Science*, vol. 84, 2022.

[8] V. Brummer, "Community energy – benefits and barriers: A comparative literature review of community energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces," *Renew. Sustainable Energy Rev.*, vol. 94, pp. 187–196, 2018.

[9] E. Neska and A. Kowalska-Pyzalska, "Conceptual design of energy market topologies for communities and their practical applications in EU: A comparison of three case studies," *Renewable and Sustainable Energy Reviews*, vol. 169, 2022.

[10] F. F. González, E. Sauma, and A. H. van der Weijde, "Community energy projects in the context of generation and transmission expansion planning," *Energy Economics*, p. 105859, 2022.

[11] "Mobilising European Citizens to Invest in Sustainable Energy." REScoop MECISE Horizon 2020 project; https://www.rescoop.eu/ (accessed on 17th March 2022), 2020.

[12] "Gridflex webinar on a local and sustainable energy market." Univeristy of Twente, https://www.utwente.nl (accessed 16th, December, 2021), 2020.

[13] C. Milchram, R. Künneke, N. Doorn, G. van de Kaa, and R. Hillerbrand, "Designing for justice in electricity systems: A comparison of smart grid experiments in the netherlands," *Energ Policy*, vol. 147, p. 111720, 2020.

[14] L. F. Van Summeren, A. J. Wieczorek, and G. P. Verbong, "The merits of becoming smart: How Flemish and Dutch energy communities mobilise digital technology to enhance their agency in the energy transition," *Energy Res. Soc. Sci.*, vol. 79, p. 102160, 2021.

[15] A.-L. Vernay and C. Sebi, "Energy communities and their ecosystems: A comparison of France and the Netherlands," *Technological Forecasting and Social Change*, vol. 158, p. 120123, 2020.

[16] V. M. Reijnders, M. D. van der Laan, and R. Dijkstra, "Energy communities: a Dutch case study," in *Behind and Beyond the Meter*, pp. 137–155, Elsevier, 2020.

[17] H. Busch, S. Ruggiero, A. Isakovic, and T. Hansen, "Policy challenges to community energy in the EU: A systematic review of the scientific literature," *Renew. Sustainable Energy Rev.*, vol. 151, 2021.

[18] N. van Bommel and J. Höffken, "Energy justice within, between and beyond European community energy initiatives: A review," *Energy Reseach & Social Science*, vol. 79, 2021.

[19] S. Impram, S. Varbak Nese, and B. Oral, "Challenges of renewable energy penetration on power system flexibility: A survey," *Energy Strategy Rev.*, vol. 31, 2020.

[20] Y. Parag and B. Sovacool, "Electricity market design for the prosumer era," *Nature energy*, vol. 1, pp. 16032–16053, 2016.

[21] B. Koirala, E. Koliou, J. Friege, R. Hakvoort, and P. Herder, "Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems," *Renew. Sustainable Energy Rev.*, vol. 56, pp. 722–744, 2016.

[22] A. Caramizaru and A. Uihlein, "Energy communities: an overview of energy and social innovation."

EUR 30083 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-10713-2, doi:10.2760/180576, JRC119433, 2020.
[23] F. Coenen and T. Hoppe, *Renewable Energy Communities and the Low Carbon Energy Transition in Europe*. 2021.
[24] K. R. Hamann, M. P. Bertel, B. Ryszawska, B. Lurger, P. Szymański, M. Rozwadowska, F. Goedkoop, L. Jans, G. Perlaviciute, T. Masson, I. Fritsche, T. Favaro, A. Hofer, I. Eisenberger, C. Gutschi, C. Grosche, J. Held, U. Athenstaedt, and K. Corcoran, "An interdisciplinary understanding of energy citizenship: Integrating psychological, legal, and economic perspectives on a citizen-centred sustainable energy transition," *Energy Research & Social Science*, vol. 97, 2023.
[25] S. Soeiro and M. Ferreira-Dias, "Community renewable energy: Benefits and drivers," *Energy Reports*, vol. 6, pp. 134–140, 2020.
[26] D. Coy, S. Malekpour, A. Saeri, and R. Dargaville, "Rethinking community empowerment in the energy transformation: A critical review of the definitions, drivers and outcomes," *Energy Research & Social Science*, vol. 72, 2021.
[27] D. Botelho, B. Dias, L. de Oliveira, T. Soares, I. Rezende, and T. Sousa, "Innovative business models as drivers for prosumers integration- Enablers and barriers," *Renewable and Sustainable Energy Reviews*, vol. 144, p. 111057, 2021.
[28] I. Reis, I. Gonçalves, M. Lopes, and C. H. Antunes, "Business models for energy communities: A review of key issues and trends," *Renewable and Sustainable Energy Reviews*, vol. 144, 2021.
[29] A. Cielo, P. Margiaria, P. Lazzeroni, I. Mariuzzo, and M. Repetto, "Renewable energy communities business models under the 2020 Italian regulation," *Journal of Clean Production*, vol. 316, 2021.
[30] S. Norbu, B. Couraud, V. Robu, M. Andoni, and D. Flynn, "Modelling the redistribution of benefits from joint investments in community energy projects," *Appl. Energy*, vol. 287, 2021.
[31] B. Bonfert, "We like sharing energy but currently there's no advantage: Transformative opportunities and challenges of local energy communities in Europe," *Energy Research & Social Science*, vol. 107, 2024.
[32] L. V. Summeren, A. Wieczorek, and G. Verbong, "The merits of becoming smart: How Flemish and Dutch energy communities mobilise digital technology to enhance their agency in the energy transition," *Energy Research & Social Science*, vol. 79, 2021.
[33] H. Vallecha, D. Bhattacharjee, J. Osiri, and P. Bhola, "Evaluation of barriers and enablers through integrative multicriteria decision mapping: Developing sustainable community energy in Indian context," *Renewable and Sustainable Energy Reviews*, vol. 138, 2021.
[34] R. Williamson, "Energy communities: a U.S. regulatory perspective." In: Energy Communities, Editor(s): Sabine Löbbe, Fereidoon Sioshansi, David Robinson, Academic Press, 2022.
[35] J. Jasinski, M. Kozakiewicz, and M. Sołtysik, "Energy cooperatives' development in rural areas — Evidence from Poland," *Energies*, vol. 14, 2021.
[36] A. Janik, A. Ryszko, and M. Szafraniec, "Determinants of the eu citizens' attitudes towards the european energy union priorities," *Energies*, 2021.
[37] M. Kubow, "The solidarity movement in Poland: Its history and meaning in collective memory," *The Polish Review*, vol. 58, p. 3–14, 2013.
[38] P. T. Kwiatkowski, *Pamieć zbiorowa społeczeństwa polskiego w okresie transformacji*, vol. 2. Wydawn. Nauk. Scholar, 2008.
[39] P. Żuk and K. Szulecki, "Unpacking the right-populist threat to climate action: Poland's pro-governmental media on energy transition and climate change," *Energy Research and Social Science*, vol. 66, p. 101485, 2020.
[40] R. A. Huber, T. Maltby, K. Szulecki, and S. Ćetković, "Is populism a challenge to european energy and climate policy? empirical evidence across varieties of populism," *Journal of European Public Policy*, vol. 28, pp. 998 – 1017, 2021.
[41] B. Igliński, G. Piechota, U. Kiełkowska, W. Wojciech Kujawski, M. Pietrzak, and M. Skrzatek, "The assessment of solar photovoltaic in Poland: the photovoltaics potential, perspectives and development," *Clean Technologies and Environmental Policy*, vol. 25, p. 281–298, 2023.
[42] M. Dzikuć, A. Piwowar, and M. Dzikuć, "The importance and potential of photovoltaics in the context of low-carbon development in Poland," *Energy Storage and Saving*, vol. 1, pp. 162–165, 2022.

[43] M. Rataj, J. Berniak-Woźny, and M. Plebańska, "Poland as the EU leader in terms of photovoltaic market growth dynamics—behind the scenes," *Energies*, vol. 14, 2021.
[44] IEO. Instytut Energetyki Odnawialnej Rynek fotowoltaiki w Polsce 2021" https://ieo.pl/pl/raporty access date 05.04.2022, 2022.
[45] IEO. Instytut Energetyki Odnawialnej Rynek fotowoltaiki w Polsce 2022" https://ieo.pl/pl/raporty access date 10.02.2022, 2022.
[46] M. Łuszczyk, K. Malik, B. Siuta-Tokarska, and A. Thier, "Direction of changes in the settlements for prosumers of photovoltaic micro-installations: The example of poland as the economy in transition in the european union," *Energies*, vol. 16, 2023.
[47] D. Dragan, "Legal barriers to the development of energy clusters in Poland," *European Energy and Environmental Law Review*, vol. 29, pp. 14–20, 2020.
[48] P. Żuk and P. Żuk, "Prosumers in action: the analysis of social determinants of photovoltaic development and prosumer strategies in Poland," *International Journal of Energy Economics and Policy*, vol. 12, pp. 294 – 306, 2022.
[49] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative research in psychology*, vol. 3, no. 2, p. 77, 2006.
[50] V. Software, "Maxqda 2022." [computer software], 2021. Available from: https://www.maxqda.com.
[51] U. Bronfenbrenner, "The ecology of human development." Harvard University Press: Cambridge, MA, USA, 1979; ISBN 10 0674224574., 1979.
[52] C. Vigurs, C. Maidment, M. Fell, and D. Shipworth, "Customer privacy concerns as a barrier to sharing data about energy use in smart local energy systems: A rapid realist review," *Energies*, vol. 14, 2021.
[53] R. B. Cialdini and R. P. Jacobson, "Influences of social norms on climate change-related behaviors," *Current Opinion in Behavioral Sciences*, vol. 42, pp. 1–8, 2021.
[54] S. Krupnik, a. O. V. A. Wagner, T. Rudek, R. Wade, M. Mišík, S. Akerboom, C. Foulds, K. S. Stegen, Adem, S. Batel, F. Rabitz, C. Certomà, J. Chodkowska-Miszczuk, M. Denac, D. Dokupilová, M. Leiren, M. F. Ignatieva, D. Gabaldón-Estevan, A. Horta, P. Karnøe, J. Lilliestam, D. Loorbach, S. Mühlemeier, S. Nemoz, M. Nilsson, J. Osička, L. Papamikrouli, L. Pellizioni, S. Sareen, M. Sarrica, G. Seyfang, B. Sovacool, A. Telešienė, V. Zapletalová, and T. von Wirth, "Beyond technology: A research agenda for social sciences and humanities research on renewable energy in Europe," *Energy Research & Social Science*, vol. 89, 2022.
[55] P. Radkiewicz and T. Jarmakowski-Kostrzanowski, "Liberals versus communitarians: Psychosocial sources of the conflict over democracy in today's Poland," *SAGE Open*, vol. 11, 2021.
[56] H. Worzecki, "Poland: A case of top-down polarization," *The ANNALS of the American Academy of Political and Social Science*, vol. 681, pp. 97–119, 2019.
[57] I. Cinar and M. Nalepa, "Mass or elite polarization as the driver of authoritarian backsliding? Evidence from 14 Polish surveys (2005-2021)," *Journal of Political Institutions and Political Economy*, vol. 3, pp. 433–448., 2022.
[58] T. Herudziński and P. Swacha, "Energy transformation in Poland–the perspective of the discourse network analysis of political party manifestos and the social perception of changes in the energy sector," *Studia Politologiczne*, vol. 64, 2022.
[59] T. Herudziński and P. Swacha, "Poles towards energy transformation and energy sources–sociological perspective," *Przeglad Polityczny*, vol. 3, pp. 81–93, 2022.
[60] J. Chodkowska-Miszczuk, K. Rogatka, and A. Lewandowska, "The anthropocene and ecological awareness in Poland: The post-socialist view," *The Anthropocene Review*, vol. 10, 2021.