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Customer Capital as the Driving Force of the Energy Transformation of the Polish Economy

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Abstract:

Purpose: *The key aim of this article is to identify the place, role, and significance of prosumers in the energy transformation of the Polish economy and the associated challenges*
Design/Methodology/Approach: *In our research, we link energy transformation with an economic model in which, along with increased control over production and access to products and services by customers, the complexity of relationships within the entire energy sector increases.*
Findings: *The article finds the new perspective on the role, place, and limits of prosumer participation in the energy system, as well as in-depth studies that would identify not only the positive but also the negative effects of this market's development..*
Practical implications: *The research creates the basis for future research is essential for better understanding and recognizing the role of energy prosumers' potential in the energy transition.*
Originality: *We demonstrate that managing such relationships requires continuously solving increasingly complex multidisciplinary problems, not only at the level of individual entities but also at local and global levels. Thus, we address a research gap by emphasizing the need to find an economic model that, while promoting the development of prosumerism, ensures energy security and meets the requirements of sustainable development.*

Keywords: *Prosumers, renewable energy, climate change, energy sources.*

JEL classification: *L5, O3, Q2, Q4, Q5.*

Paper type: *Research article.*

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1. Introduction

The functioning of any enterprise is a derivative of changes occurring in its environment. This also applies to companies in the energy sector, whose distinguishing feature at the turn of the century was a monopolistic management system and reliance on natural resources such as coal or gas for production processes (Rabe, 2016).

The sharp increase in energy demand observed for many years, associated with rapid industrialization, the development of local and global transportation networks, and rising living standards in the most densely populated parts of the world, allows us to conclude that energy demand is strongly correlated with economic growth and technological advancement. This is confirmed by statistics and forecasts.

The demand for energy worldwide has been increasing continuously for over 150 years (Rosnący popyt…, 2020). Electricity production is expected to increase by 79 percent between 2018 and 2050, and by 2050, 25 percent of energy demand will be met by electricity (Rosnący popyt…, 2020; Pociovalisteanu *et al.*, 2010).

At the same time, forecasts of depleting natural resources and climate change necessitate increased energy efficiency, a change in sources, and investments in technologies. It should also be noted that the rise in environmental awareness among consumers has resulted in social pressures to use green energy that is friendly to the natural environment (Rustam *et al*., 2020; Xie *et al*., 2024).

This issue is global in nature, necessitating the creation and adherence to supranational regulations. The Polish energy sector faces similar challenges, having to ensure energy security and supply continuity on one hand, while meeting the requirements of EU directives emphasizing energy efficiency and the development of renewable energy sources on the other (Dyrektywa 2023/1791, 2023).

It should be noted that in 2022, Poland ranked first in fossil fuel acquisition, third in primary energy acquisition, and only fifth in renewable energy acquisition, while simultaneously ranking sixth among EU countries in electricity production (GUS, 2022). The limitations of natural resources and climate change drive the EU to continually increase the use of energy from renewable sources.

In September 2023, the Parliament supported a new target of 42.5% energy from renewable sources by 2030, encouraging member states to aim for 45% (Komunikat prasowy, 2023). It should be emphasized that in 2022, Poland's share of energy from renewable sources in gross final energy consumption was 16.81%, and although it increased by 8.13% compared to 2009 and 1.2% compared to 2021, it still falls significantly short of the EU target (GUS, 2023).

Renewable energy sources such as sun, water, and wind are accessible to every member of society, creating opportunities to involve customers in the process of creating value for enterprises in the energy sector, and consequently, in the process of creating the country's energy security.

We thus pose the question: Has customer capital been optimally utilized in acquiring energy from renewable sources, and if not, what are the reasons for this? We hypothesize that the main reason for the underutilization of customer capital in conducting the energy transformation is the unthoughtful, inconsistent, and unpredictable state policy regarding the renewable energy market, the shifting of transformation costs onto customers, and the associated increase in investment risk on the customer's part.

As a result, the goal of our research is to identify the place, role, and significance of prosumers in the energy transformation of the Polish economy and the related challenges. In pursuit of this goal, we define customer capital and the leading factors determining its potential in terms of capital supply, particularly in the area of co-creating value.

We characterize prosumerism as a socio-economic process and an element of the business model considering the specifics of the energy market, and we identify the renewable energy market, analyzing its development and identifying the main stimulants and deterrents to its growth.

Utilizing statistical data published by the Energy Regulatory Office, the Central Statistical Office (GUS), we demonstrate that the further development of the prosumer market will be primarily driven by business prosumers. However, increasing the role of both individual and business customers in building energy security requires a new strategy focused on creating a sustainable ecosystem for energy production, distribution, and consumption.

2. Theoretical Foundations

In the broad approach, customer capital is reduced to the relationships connecting the enterprise with its stakeholders (Payne and Frow, 2014) leading to the blurring of differences or even the identification of this capital with: relationship capital with market partners (Ricciardi *et al*., 2022), psychosocial capital (Wołowiec, 2004) or market-related capital (Bratnicki and Strużyna, 2001).

Proponents of the narrow approach, although also associating customer capital with relationship capital, limit it only to connections with customers (Butz and Goldstein, 1996; Völckner and Pirschegger, 2006; Heidemann and Hofmann, 2009; Caputa, 2020). They emphasize that the customer, as the entity purchasing and paying for the offered product, is a special stakeh,older of the enterprise. The customer's needs determine the rationale for the enterprise's existence, and their behavior determines

the possibility of achieving benefits not only for the enterprise but also for other stakeholders. However, the narrow approach to customer capital does not mean that a uniform definition has been developed. A review of the applied concepts allows for the distinction of two approaches.

In the first, the emphasis is placed on: identifying the primary factors determining the establishment and development of relationships with the customer, the manner of creating relationships, or the intangible and legal values resulting from the relationships connecting the enterprise with the customer (Völckner and Pirschegger, 2006; Khan *et al.*, 2020; Heidemann and Hofmann, 2009; Rust *et al*., 2005).

The second, quantitative approach focuses on the valuation of relationships, i.e., the final effects resulting from establishing and developing relationships with customers. Consequently, customer capital is reduced to: "the sum of discounted long-term values of all the company's customers" (Kotler, 2005), the sum of benefits brought by the customer to the enterprise (Dobiegała-Korona, 2008), or "the value of current and future cash flows resulting from the relationships connecting the enterprise with customers" (Cornelsen, 2000).

The aforementioned approaches are mutually interconnected. It is impossible to obtain capital inflow from the customer without delivering value to the customer.

Consequently, customer capital should be defined in a process-oriented manner, allowing it to be characterized as, a set of intangible assets and legal rights embedded in the current and potential customer base, whose value reflects the stream of future cash flows generated by the enterprise in connection with delivering value to the customer, throughout the entire potential duration of the customer relationship (Caputa *et al.*, 2017).

Thus, at the core of customer capital lies the dual-defined value of the customer, from both the customer's and the enterprise's perspectives. Despite the lack of a unified definition in the literature, customer value is associated with the product's utility as perceived by the customer and the experiences derived from its use (Krawczyk-Sokołowska and Caputa, 2023).

Consequently, in the concepts o Kotler and Bliemel (2005), Rust, Lemon, and Narayandas (2005), the value perceived by the customer in the product is the sum of the perceived net value: of the offer, the brand, and the relationship with the provider.

Creating these values is a challenge for the enterprise that seeks to maximize the benefits from establishing and developing relationships with desired customers, essentially aiming to acquire capital from the customer. Therefore, it is a non-economic, subjective, and dynamic category related to the customer's needs and expectations formulated under specific exchange conditions.

The customer's value from the perspective of achieving the enterprise's goals is linked to the necessity of assessing the customer's potential, i.e., their readiness and ability for direct (market) and indirect (resource) capital inflow (Völckner and Pirschegger, 2006; Caputa, 2020; Krawczyk-Sokołowska and Caputa, 2023).

In the market dimension, attention is given to the customer's readiness and ability to establish and maintain transactional relationships with the enterprise. Consequently, in the concept of Cornelsen (Cornelsen, 2000), D. Stűker'a (Stűker, 2008) this value is determined by the customer's income and growth potential, with T. Tomczak and E. Rudolf-Sipotz highlighting the potential for cross-selling and up-selling as an additional factor (Tomczak and Rudolf-Sipötz, 2006).

Undoubtedly, market potential, as a source of direct capital inflow, is a necessary condition for achieving short-term goals and thus the survival of the enterprise. It can also be a source of financial reserves that condition the enterprise's future development.

As a result, we are dealing with a new type of customer—active, educated, environmentally conscious, seeking collaboration, who readily engages in online relationships and shares experiences (Caputa, 2020). The result of this is the dynamic development of prosumer capitalism (Jakimowicz, 2022), an economic model where customers gain greater control over production and access to products and services. This capitalism is characterized by decentralization of power, individualization and personalized approaches, innovation, higher quality, and flexibility.

We assume that one of the main barriers to the development of the prosumer market is inconsistent and uncertain state policy, which increases the investment risk in partnerships and cooperation. We aim to demonstrate that, in the indicated market, the transformation of the customer from a buyer to a prosumer, and ultimately to a market partner, presents a challenge for all entities involved in the value creation process, necessitating the construction of a sustainable ecosystem for the production, delivery, and consumption of energy.

3. Empirical Research

3.1 Research Methodology

In accepting such a subject and object of research, studies aimed at achieving the goal of developing and verifying hypotheses are based on wikinomics, a concept by Toffler, which is grounded on four principles: openness, peering, sharing, and global action, with particular attention to prosumers as one of Toffler's identified business models (Tapscott and Williams, 2006; 2012).

The choice of approach is not accidental. The demand for energy is universal, affecting both institutional and individual entities. It is a component of every resource management process, regardless of whether this process is considered on a global, regional, local, or individual scale.

This process occurs, on the one hand, under the conditions of advancing digital transformation, which facilitates the development of collaborative relationships and partner engagement in the value network (Austin and Seitanidi, 2012).

On the other hand, it occurs in the context of adverse climate changes, which necessitate the search for alternative energy sources, thereby increasing interest in renewable energy sources (RES). It is worth noting that the growing interest in RES is significantly influenced by increasing ecological awareness, green energy friendly to the natural environment, which is becoming less costly, and rising energy costs.

Renewable energy sources based on water, sun, or air are available to virtually everyone. As a result, anyone can become an energy producer, provided they have access to the appropriate infrastructure. Consequently, the energy market adheres to the four principles of wikinomics and provides a foundation for developing a business model based on prosumption.

This is an open model characterized by dynamic networks of interaction, with its development translating into increased complexity. Therefore, energy transformation cannot be viewed merely as a departure from monopolies but as a complex process involving growing interdependence between key systems: social, legal, economic, and climatic. This necessitates analyzing prosumerism within the context of the continually evolving socio-economic process. The process-based approach used in the research allowed for the identification of new challenges facing the prosumer energy sector.

3.2 Research Results

Energy consumption is related to economic and social development. As a result, when analyzing changes in the energy market in Poland, it is worth paying attention to the basic data concerning the gross domestic product (Table 1).

Table 1. *GDP Value in Poland in the Years 2019-2023*

Economy	**2019**	**2020**	**2021**	**2022**	**2023**
GDP (current prices) in million PLN	2 293 199	2 338 996	2 631 302	3 067 495	3 073 630
GDP growth rate previous year = 100	108.1	102	112.6	116.6	100.2
GDP per capita	59 741	60 984	68 368	81 093	81 665
GDP per capita in purchasing power standards (PPS)	73*	76	77	79	80

Real GDP growth rate (constant prices, annual average of the previous year)	104.5	98.0	106.9	105.3	95.9
Total consumption including:	103.4	98.5	105.8	104.1	99.9
Household sector consumption (constant prices, annual average of the previous year)	102.3	96.4	106.2	105.2	99

Data: *Prepared by the author based on https://stat.gov.pl/obszary-tematyczne/warunki-zycia/dochody-wydatki-i-warunki-zycia-ludnosci/sytuacja-gospodarstw-domowych-w-2023-r-w-swietle-badania-budzetow-gospodarstw-domowych,3,23.html,*
Report: *The Best Time for Poland 1992-2022 https://zpp.net.pl/wp-content/uploads/2023/07/14.07.2023-Raport-ZPP-1992-2022.-Najlepszy-czas-Polski.pdf*
Source: *Own study.*

Between 2019 and 2023, despite the pandemic and the outbreak of the war in Ukraine, the gross domestic product (GDP) at current prices showed an upward trend. In 2023, the value of the produced GDP in Poland amounted to 3,073,630 million PLN, which represents a 34% increase compared to 2019. Following the unfavorable economic situation caused by the COVID-19 pandemic, there was a revival in the domestic economy. Each subsequent year recorded real GDP growth.

We also observe an increase in GDP calculated in purchasing power standards per capita. According to the Warsaw Enterprise Institute, in the period from 2019 to 2020 alone, GDP per capita in terms of purchasing power parity in Poland increased from 73 to 76 percent of the EU average (The Best Time…, 2023)

However, the real GDP growth rate is not as optimistic, similar to the data on total consumption and consumer demand, whose dynamics are weakening. Consumer demand, which translates into the market potential of the customer, is related to household incomes and expenditures (Caputa, 2020). During the analyzed period, the material situation of households improves.

This is confirmed by statistical data. According to the Central Statistical Office (GUS), the level of average monthly disposable income per person was higher than the income in 2022, although average nominal monthly expenditures per person in households were higher by 9.4% and real expenditures decreased by 1.8% compared to expenditures in 2022.

Expenditures on consumer goods and services were nominally higher by 9.8% and real lower by 1.5% compared to 2022. The share of expenditures in disposable income decreased from 63.5% in 2022 to 61.1% in 2023, reaching its lowest level since 2010 (Household Situation) (GUS, 2024a). These data indicate an increase in the propensity to save, which may result from growing uncertainty about the future situation. This is not a positive phenomenon from the perspective of acquiring

market capital from the customer, which is directly related to the propensity to make purchases (Caputa, 2020).

However, it should be emphasized that for many years there has been a relatively large differentiation in average monthly incomes and expenditures between different socio-economic groups of households, which does not change the fact that the highest incomes are held by a relatively small group of households, confirming the previous statement (Paździor *et al*., 2023).

In the context of the analyzed market, it is noteworthy that the share of expenditures on housing maintenance and energy carriers is increasing from period to period, averaging almost 20% in 2023 (GUS, 2024b).

Therefore, household energy costs constitute a significant component of their monthly expenditures, meaning that the price of energy is a crucial value parameter for the customer, negatively affecting their cost of satisfaction. It should be emphasized that this observation applies even more to business entities, which pay an even higher price for energy, an integral part of the production cost of market-offered products.

The increase in GDP suggests a higher demand for electricity in the economy, which is confirmed by statistical data. According to the Central Statistical Office (GUS), the compound annual growth rate of total primary energy consumption from 2012 to 2022 was 0.6%. Meanwhile, the compound annual growth rate of final energy consumption was 1.2%, indicating an increase from 64.4 to 72.4 Mtoe (GUS, 2024b). In 2022, household energy consumption accounted for 28.8% of total final energy consumption.

Final energy consumption is related to household functioning and economic activity. Consequently, a natural goal for both individual and institutional entities is to reduce energy acquisition costs. Of course, this can be achieved by the traditional method of reducing consumption. For business units, however, this would mean limiting their economic activities, thereby reducing benefits. It also does not positively affect the satisfaction level of household members.

As a result, reducing energy acquisition costs for both individual and institutional entities is linked to seeking new technologies and new sources that are expected not only to lower energy consumption costs but also to positively impact the environment. This latter requirement stems from the growing ecological awareness of society and the necessity to implement business strategies based on sustainable development.

In this context, it should be noted that for years the key direction of energy use in households has been space heating (GUS, 2024b). Its share in the energy consumption structure is decreasing year by year, which is partly due to climate

warming. Meanwhile, the share of energy consumption in other categories indicated in Table 2 is increasing.

Table 2. *Structure of Energy Consumption in Households by Usage Direction in the Years 2017–2022 (in %)*

Specification	2017	2018	2019	2020	2021	2022
Total	100.0	100.0	100.0	100.0	100.0	100.0
Space heating	66.1	68.5	66.4	66.1	65.4	62.8
Water heating	16.2	15.5	16.1	16.3	17.1	18.0
Cooking	8.0	7.4	8.1	8.1	8.3	9.1
Lighting and electrical appliances	9.7	8.7	9.3	9.5	9.2	10.1

Source: *Economic Situation of Data: Households, Central Statistical Office (GUS) https://stat.gov.pl/obszary-tematyczne/warunki-zycia/dochody-wydatki-i-warunki-zycia-ludnosci/sytuacja-gospodarstw-domowych-w-2023-r-w-swietle-badania-budzetow-gospodarstw-domowych,3,23.html*

In light of the prospect of further increases in energy prices for households, the rationale for seeking more attractive energy sources is indisputable.

For industry, compared to 2012, the final consumption of electricity, gas, heat, and other carriers increased by 18.9%, 161%, 35.4%, and 37.5%, respectively. However, the consumption of liquid fuels decreased by 6.4%, and coal by 23.1%, which significantly impacts the energy intensity of GDP (Table 3).

Table 3. *Compound Annual Rate of Energy Intensity of GDP (%/year)*

Rate of Change	2013–2017	2018–2022	2013–2022
Primary Energy Intensity of GDP	-2.010	-3.18	-2.64
Primary Energy Intensity of GDP with Climate Adjustment	-1.82	-3.10	-2.46
Final Energy Intensity of GDP	-1.54	-3.32	-2.44
Final Energy Intensity of GDP with Climate Adjustment	-1.11	-3.19	-2.16

Source: *Efficiency of Energy Use, Central Statistical Office (GUS) https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/efektywnosc-wykorzystania-energii-w-latach-2012-2022,9,7.html*

As shown in Table 3, the primary energy intensity of GDP decreased by 5.0% in 2022 compared to the previous year, while the final energy intensity of GDP decreased by 8.7%, resulting in a 0.9% increase in energy efficiency compared to the previous year.

The improvement in energy efficiency applies to both industry and households. This positive trend is confirmed by changes in the ODEX index, which dropped from 77.1% to 70.3% between 2012 and 2022 (GUS, 2024b). The compound annual

improvement rate was 0.9%. It should be noted that the fastest improvement rate (1.9% per year) was observed in the industrial sector, where the index value reached 42.2% in 2022.

In contrast, the transportation sector experienced the slowest improvement, with an annual increase of only 0.6% from 2013 to 2022. The household sector saw an average improvement rate of 0.9%, with the index value at 79.6% in 2022 (GUS, 2024b).

Energy consumption decomposition indicates that economic activity had the most significant impact on changes in consumption (Table 4).

Table 4. *Impact of Selected Factors on Changes in Final Energy Consumption in the Years 2012–2022 (Mtoe)*

Specification	Industry	Households	Transport	Services	Agriculture	Total
Change in consumption	1.4	1.3	7.3	-0.2	-0.3	9.5
FACTORS						
Activity	7.0	-	4.6	3.4	-0.1	14.9
Number of dwellings	-	1.1	-	-	-	1.1
Lifestyle	-	0.6	-	-	-	0.6
Structural changes	-1.0	-	1.0	-	-	0.0
Energy savings	-3.9	-2.0	-1.4	-0.1	-	-7.4
Weather conditions	-	0.0		-0.5	-	-0.5
Others	-0.7	1.6	3.1	-2.9	-0.2	0.8

Source: *Efficiency of Energy Use, Central Statistical Office (GUS) https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/efektywnosc-wykorzystania-energii-w-latach-2012-2022,9,7.html*

For households, the factors influencing the increased demand for energy were the rise in the number of dwellings, changes in lifestyle (larger homes), and weather conditions. Structural changes in industry contributed to a reduction in energy consumption by 1.0 Mtoe, while in transport, they increased consumption by 1.0 Mtoe. Total energy savings amounted to 7.4 Mtoe, with the largest savings achieved in industry (3.9 Mtoe). Additionally, weather conditions led to a reduction in energy consumption by 0.5 Mtoe, and other factors led to an increase of 0.8 Mtoe.

It should be emphasized that Poland ranks first among EU countries in fossil fuel acquisition and sixth in electricity production. Poland has been dependent on imports for years, which is particularly significant in the context of the outbreak of the war in Ukraine.

According to the authors of the report "Poland's Energy Transformation (Energy Transformation in Poland, 2023), Poland's dependency on energy imports is growing. In 2021, it was 43%, compared to 31% ten years earlier.

The report highlights several factors, including the radical increase in fossil fuel import costs in 2022, supply constraints of thermal coal, its rising price, the decline in electricity production from hard coal, increasing gas prices, reduced output from gas power plants, and a 0.3% rise in greenhouse gas emissions compared to 2021.

These factors indicate an increased threat to the security of Poland's energy system and the necessity for actions aimed at developing low-emission energy production within the country. Poland ranks seventh globally in terms of the unit emission intensity of the entire economy. The unit CO2 emissions of the power sector place Poland second to last in the EU, with a sector emission reduction of only 12% from 2005 to 2022 (Energy Transformation in Poland, 2023).

It is also important to note that the Polish Power System is characterized by a high degree of centralization of production capacities and their uneven distribution. As a result, the country's energy security also depends on the ability to actually deliver the generated energy to the end user.

The search for new, cheaper, and simultaneously less emissive energy sources and the reduction of issues related to their distribution and delivery force the exploration of new strategies and business models. Consequently, this leads to the inclusion of the customer in the value creation process, resulting in the presence of prosumers in the power system.

4. Prosumer in the Power System

The customer, in the role of a prosumer in the power system, is present in the renewable energy market, having access to energy sources such as solar, water, wind, and biomass. Since the beginning of the 21st century, we have observed an increase in the share of energy from renewable sources in the final gross energy consumption in Poland.

During the years of 2009-2022 the share of renewable sources in the finaal gross consumption have risen from nearly 9% tp 17% (source 8). A significant increase in the share of electricity from the discussed sources in gross energy in the power sector is primarily due to a 20.5% rise in the final gross consumption of renewable electricity and a 1.5% decrease in the final gross electricity consumption (GUS, 2023).

It should be noted that renewable energy sources (RES) in 2023 already provided nearly 25% of the annual national electricity production, an increase of 16 percentage points compared to 2018. This has resulted in a 21% reduction in CO2

emissions compared to 2015. The dynamic growth of RES is primarily due to the increasing capacity of photovoltaic installations, which grew from 0.7 TWh in 2019 to 13.2 TWh in 2023, and wind power installations, which saw an increase in capacity from 12.3 TWh to 22.1 TWh in the same period (Energy Market..., 2024)

The prosumer market in Poland is developing dynamically, with the largest share in the photovoltaic market. It is noteworthy that despite changes in the energy settlement system from net-metering to net-billing, subsidies for fossil fuels, frozen electricity prices, stagnation in housing construction, and a decline in new construction investments, the number of prosumer photovoltaic installations at the end of 2022 increased by 41% compared to the previous year. Prosumers accounted for 68% of the annual increase in installed photovoltaic capacity .

Undoubtedly, the leading factors stimulating the growth of this market are the increasing environmental awareness and concerns about rising energy prices, as well as the uncertain market, energy, and geopolitical situation, mainly due to escalating armed conflicts. The increase in installations is, to some extent, a result of consumer panic, which exhibits characteristics of moral panic.

This is also due to the introduction of the net-billing system in Q2 2022, which was perceived as less advantageous, further encouraging investors to act before the announced changes. It is worth noting that only in Q1 2022, 1698 micro-installations were installed in Poland, which, according to data collected by the IEO, is a world record (Rynek Fotowoltaiki…, 2023).

After the changes in settlements, interest in photovoltaics decreased, but the total installed capacity in prosumer micro-installations at the end of 2022 increased by 3.2 GW compared to the previous year (Rynek Fotowoltaiki…, 2023). The significant demand for installation and assembly of photovoltaics demonstrates the efficiency and capabilities of the domestic execution market and a well-developed supply chain.

Simultaneously, the perceived disadvantageous net-billing system has created incentives for better selection of installations and investments in additional equipment to increase self-consumption, which is significant given the limitations of the national electricity grid. This system has also forced both prosumers and execution entities and co-financiers to develop new rules and more efficient use of equipment.

However, the fact remains that in the target net-billing system, selling back to the grid during peak production will not be profitable. Therefore, active energy and consumption profile management are crucial, optimizing the matching of energy demand profiles with PV generation profiles and the operation profiles of other energy devices and storage. Consequently, the settlement system is not transparent for prosumers, and its use requires knowledge from the selection stage to the

utilization of the equipment. This can effectively deter individual prosumers from investing in micro-installations despite reducing the risk of disconnection from the grid during PV generation peaks.

It is also worth noting the structure of the entire renewable energy market. In 2023, PV accounted for 55%, and wind farms for 36% of all renewable energy sources. Although PV growth is higher, there is also a significant increase in onshore wind farm capacity. According to the Institute for Renewable Energy, energy production from wind farms is higher than other renewable energy sources due to higher capacity utilization factors.

Other renewable energy sources complement the green mix. The rationale for this statement is confirmed by data on the share of green energy in the National Power System (KSE). In 2022, more than half of the energy from renewable sources came from wind farms, and over 24% from photovoltaics. Generation from other sources decreased by 1% compared to 2019 (Agencja Rynku Energii, 2023)

5. Discussion and Conclusions

The energy transition, which increases the share of renewable energy sources (RES) in energy production, positively impacts the development of the prosumer market. The market's demonstrated dynamism indicates a radical change in the customer's role in energy production, evolving into active participants in the exchange.

An increasing number of customers are becoming prosumers, encompassing both individual households and institutional entities. Several factors contribute to this trend. On one hand, there is growing environmental awareness, with people paying more attention to the exploitation of natural resources and its consequences not only for current but also future generations, prompting businesses, local authorities, and governments to take protective actions.

On the other hand, the issue of environmental protection and related threats is a global problem, necessitating appropriate actions. The 2015 Paris Agreement on climate protection set a direction for collective action. Consequently, the directives of the European Parliament and the Council of the EU continuously raise targets, increasing the share of "green energy" in the European energy mix to meet these expectations (Dyrektywa Parlamentu Europejskiego…, 2018).

This influences the strategies of individual countries, prompting actions to meet these targets, which affect both households and institutional entities. For example, the introduction of carbon dioxide emission limits necessitates taking desired actions, and funding incentives encourage such actions.

Undoubtedly, the war in Ukraine, by significantly raising energy prices and highlighting the importance of energy security, has positively influenced the

willingness of customers (both individual and institutional) to take actions aimed at sourcing energy from widely available sources. Bauwens confirms this, pointing out personal and social motives driving individuals to become prosumers (Bauwens, 2016).

Personal motives include investment returns or low electricity prices and environmental awareness. Social motives include concern for the natural environment, interest in renewable energy production, and a desire to address local community issues.

Additionally, the proximity and shared values of local community members enhance the appeal of prosumerism. The main benefit of the growing number of energy prosumers using renewable technologies is the reduction of carbon dioxide emissions and the positive impact on mitigating climate change (Milčiuvienė, 2019).

The increasing significance of energy prosumers has led to significant changes in the energy sector and requires a broader perspective on the prosumption process. A key element is prosumerism, defined as a set of social behaviors and attitudes of prosumers aiming to change traditional product evaluation criteria, lifestyle standards, and quality of life (Jakimowicz, 2022). These new criteria include both material and immaterial benefits of prosumption, realized in both production and consumption processes (Szymusiak, 2015).

A significant challenge in the energy market is the flexibility of services related to solar and wind energy, as they have inherent random features due to their production at times of the day when they are not fully consumed. The difficulty in synchronizing production and consumption sizes requires investment in energy storage technologies.

As a result, the energy transition creates a highly complex system of interdependencies between society, the economy, legislation, and the environment. As its advancement deepens, this complexity increases. At the same time, societies cannot abandon the development of the green energy sector (as a remedy for global warming) or the pursuit of sustainable global economic development (as a condition for humanity's survival).

Transforming energy into a more flexible system based on renewable energy sources opens up opportunities for users. Solar and wind power become the basis of the renewable energy market, and these resources should be considered both complementary and substitutive to each other.

The increase in PV capacity is a challenge not only for the PV industry but also for energy network operators, market regulatory institutions, technology suppliers, solutions enhancing the integration of photovoltaic sources with this system, and improving the spatial integration of photovoltaic panels.

Therefore, the energy transition requires a new strategy aimed at building a sustainable and internally cohesive energy production ecosystem. This necessitates a new perspective on the role, place, and limits of prosumer participation in the energy system, as well as in-depth studies that would identify not only the positive but also the negative effects of this market's development. Future research is essential for better understanding and recognizing the role of energy prosumers' potential in the energy transition.

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