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Going beyond frontiers in household energy transition in Poland—a perspective

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Transition towards a cleaner and more sustainable environment is mainly driven by co-participation of households, whereas the residents' transformation willingness is determined by various factors, including an environmentally-friendly attitude and greater public awareness. Simultaneously, the global push for a climate-neutral economy fuels the increasing emphasis on eco-consciousness and promotion of green investments. However, Poland still heavily relies on coal for energy production, despite the opportunities provided by the EU. Poland faces challenges in transitioning its households to cleaner energy sources, particularly due to historical conditions and the dominance of solid fuel boilers. This article shed light on the inefficiency of the energy transition process in Poland, presenting legal, economic, and social aspects. Despite multiple efforts, energy transition in Poland is not as buoyant as in other EU countries. Among the reasons for this phenomenon are the adverse behavior of residents, or government policies that favor the carbon-centric nature of the economy resulting in the low use of EU and state funds. This may lead to a continuation of the slower pace of change and eventually reaching the Frontier of development in Poland's energy transition. The multitude of campaigns and initiatives encouraging Poles to switch to green energy should be underscored, but due to their scant ecological awareness and orientation towards economic rather than ecological considerations, existing measures should be reviewed. In view of the above, to ensure an effective transition, it is necessary to recognize and clearly define the incentives that would induce Polish households to use climate-neutral energy sources.

Foreword: Monetary data has been standardized and, in view of this, the paper uses the euro (EUR) currency, including in places where the original data was given in a different currency. The exchange rate as of 12 June 2023 was used.

KEYWORDS

energy transition, hard coal, renewable energy sources, household energy, low-carbon society

1 Introduction

Situation of households is one of the primary axes in the energy transition toward a cleaner and more sustainable environment. The willingness to carry out a transformation in an individual's own household results from a number of simultaneously interacting determinants. Environmentally-friendly attitude is considered to be a key influencing

factor (Horbach and Rammer, 2018), which stems from taking the environmental aspect into account and the greater environmental awareness of the public. The eco-friendly attitude contributes to greater concern for the natural habitat (Douenne and Fabre, 2020), and becomes a considerable driving force for green investments (Graczyk et al., 2023). As a result, a transformation toward a climate-neutral economy is taking place, as society not only cares about the environment itself (either bottom-up or guided by supranational directives), but also expects an emphasis on sustainability aspects from other private and state actors. Such a prospect is highlighted on a global scale, with global investment in the energy transition amounting to EUR 1.03T in 2022 (up 31% from 2021), of which total expenditures by European Union (EU) countries (if treated as a single bloc) account for 16% of the total (ca. EUR 167B in new investment in 2022; Bloomberg, 2023).

Poland is a beneficiary of these green investments, although it still derives a considerable proportion of energy from coal (41.84% in 2022; BP, 2022). Nevertheless, the trend in its use as an energy source is declining (down 33.5 percentage points from 1990), which is a feeble pace compared to other EU countries (BP, 2022). The most popular heating source in Poland is a solid fuel boiler (just over 1/3 of all heat sources), of which as much as 55.6% are stoves fired by coal and coal-like products (as of 26 April 2023; Główny Urząd Nadzoru Budowlanego, 2023). This situation primarily stems from historical conditions. The Polish coal industry historically fueled economic growth and urbanization in regions like Lower Silesia and Upper Silesia. Following World War II, the implementation of central planning and nationalization resulted in diminished efficiency, restricted market access, and ultimately led to a dysfunctional coal sector by the 1980s (Szpor and Ziolkowska, 2018). The transition from central planning to a free market economy in Poland led to the restructuring of the coal sector, including workforce reduction and closure of unprofitable collieries. Despite a significant drop in production, Poland still remains the largest hard coal producer among EU member states, making the country's energy sector carbon-centric. Poland's EU accession in 2004 brought in funds for energy transformation, however, in spite of having access to the same EU resources (both funds and knowledge) as other member countries, the momentum of the energy transition has not been as buoyant as in other EU states. This translates into the imperative to better comprehend this issue and this paper responds to that need.

The lack of effectiveness of the policies pursued so far has resulted in reaching a hardly transcending Frontier in terms of the dynamics of change. Embracing a distinct perspective, though, will make it turn from an insurmountable Frontier into a challenge to accomplish, if only changes in energy transition policy are triggered. This study is designed to delineate the novel perspective adopted by its authors. The purpose of the paper is to outline the context of household energy transition in Poland within three macroeconomic areas: legal, economic and social. The study investigates the deployment of EU directives, governmental programs along with financial support measures, and public campaigns to encourage energy-efficient upgrades. In addition, giving the proper context allowed the identification of potential reasons for the ineffectiveness of the energy transformation in Poland, and thus it provided a perspective on a different approach to Poland's household energy transition. The presented

research is pertinent since offering an outlook on the course of the transition towards greener energy in a single EU country offers more understanding of the entire situation in the European Union. This is due to the fact that Poland's state of affairs can be considered a sort of "litmus test" of the whole region.

2 EU vs. Poland's energy strategy: implications and controversies

The EU's climate and energy policy has a significant imprint on the composition of Poland's energy strategy for it was the EU directives that shaped the foundations of the "Poland's Energy Policy until 2040" (Ministry of Climate and Environment, 2021). Climate policy goals in the EU are declarative, and individual countries may commit to smaller values, as in the case of Poland. For example, Poland has managed to achieve the possibility of a 14% increase in emissions in 2020 compared to 2005 in sectors not covered by the European Emissions Trading System (EU ETS), as well as a reduction in the minimum level of energy from renewable sources to 15% in 2020 instead of 20% (European Parliament, 2021). As a result, the country's energy policy until 2040 calls for reducing coal's share of electricity generation to 56% in 2030 from the current level of just under 70%. At the same time, households will cease to be coal-fired in cities by 2030, and in the countryside a decade later (Ministry of Climate and Environment, 2021).

The point of contention on the Warsaw-Brussels line remains the "Fit for 55" deal. It is intended to provide a coherent and balanced framework for achieving the EU's climate goals and ensure that the transition is socially equitable. Furthermore, it is geared toward maintaining and enhancing the innovation and competitiveness of EU industry, while ensuring a level playing field with non-EU players and strengthening the EU's position as a leader in the global fight against climate change. Notwithstanding, for this reason Poland's Minister of State Assets Jacek Sasin announced that he (along with the government) will take steps to ensure that the package does not come into force (Ministry of State Assets, 2023a). It is also confirmed by the words of Minister of Climate and Environment Anna Moskwa (Lemaniak, 2023). Sasin also adds that for a long time to come, coal will be the main source of energy in Poland (Ministry of State Assets, 2023b). Nevertheless, efforts are being made at various decision-making levels to reduce the role of coal for selected user groups.

Since 2016, almost all Polish voivodeships¹ (14 out of 16) adopted anti-smog resolutions, which prohibited the use of fossil fuels and solid fuel-based heating sources (Sokołowski and Bouzarovski, 2021; Flaga-Maryańczyk and Baran-Gurgul, 2022). Restrictions on the sorties used by households also result from laws adopted at the national level (Dziennik Ustaw, 2006 [Act]; Dz. U. 2022 poz. 2856, 2022). By statutory law, eliminating from the market products that pose the greatest threat to the environment, such as coal silt, coal flotation concentrate and lignite, and specifying in a regulation the minimum quality parameters to be met by coals allowed on the market.

¹ Equivalent to a province (NUTS-2 classification level).

Regrettably, the Polish government, in view of the situation in the hard coal market that has taken place since the escalation of the war in Ukraine in 2022, until 31 July 2023, waives the requirements set forth in the regulations issued on the basis of Article 3a (2) of the aforementioned Act of 25 August 2006 on the system for monitoring and controlling fuel quality (Dz. U. 2023 poz. 835, 2023). Concurrently, the situation in the market for energy carriers caused by the war in Ukraine, including the need to become independent of fossil fuels imported from the Russian Federation, led the Council of Ministers on 29 March 2022 to adopt assumptions for updating Poland's EPP2040 strategy. Under it, the use of domestic coal deposits may be increased periodically when the country's energy security is threatened, and the rate of reduction in coal mining and use may decrease slightly.

3 Financial supporting of household energy transition in Poland

There are a substantial number of programs to financially support household energy transition—whether from the EU, government or local authorities. The Polish government has introduced programs, such as “Clean Air” and “My Heat,” along with other proposals, to encourage households to participate in carbon sequestration activities through subsidies, tax credits, and thermal upgrading. The “Clean Air” program is a nationwide subsidy program for the replacement of old stoves and insulation of single-family homes. Financial support can be received for an energy audit, interior surfaces insulation, replacement of an old furnace, installation of central heating and hot water, mechanical ventilation with heat recovery and micro photovoltaic installation (as part of the integration with the “My Electricity” program; Gov.pl, 2023). Implemented since 2018 and with a view to 2029, the program aims to reduce emissions of PM10, benzo- α -pyrene, and carbon dioxide. The scheme offers grants, partial loan repayment, pre-financing, and municipal loans for beneficiaries at different levels of financing. The latest update of the program reveals that its total budget is EUR 23.16B, with EUR 18.73B coming from grants and EUR 4.5B of the part allocated to loans from banks cooperating with the provincial fund for environmental protection and water management. In 2021, the program's allocated subsidies for replacing heat sources (excluding bank loans) amounted to EUR 215.71M, rising to EUR 403.44M million in 2022 (an increase of 87% year-on-year). The total value of subsidies under the “Clean Air” program until the end of 2022 was EUR 828M, which accounted for 4.42% of the state budget funds (own calculations based on the Program Czyste Powietrze, 2023a).

In addition, a taxpayer who is the owner or co-owner of a single-family residential building has the opportunity to take advantage of a thermal modernization tax credit of up to 11,916 EUR. The allowance consists in deducting from the tax assessment basis (income—in the case of a flat tax) the expenses incurred for the implementation of a thermal modernization project in a single-family residential building. Grants under the “Clean Air” program can be combined with the tax credit, as they are treated as independent instruments (Program Czyste Powietrze, 2023b).

Another priority program is the “My Heat” program, implemented with funds from the EU Modernization Fund. The program supports

the purchase and installation of heat pumps for new single-family buildings. The purpose of the scheme is to support the development of individual heating and the development of pro-consumer energy. Investment co-financing is provided for the purchase/installation of ground source heat pumps, air/air heat pumps with accessories, and air/water heat pumps with accessories. The budget for the program's goal is up to EUR 134.91M. The program runs from 29th April 2022 to 31st December 2026 or until the funds are exhausted. As of 23 May 2023, 16% of the budget has been used, from which 11,840 applications have been subsidized (Moje Ciepło, 2023).

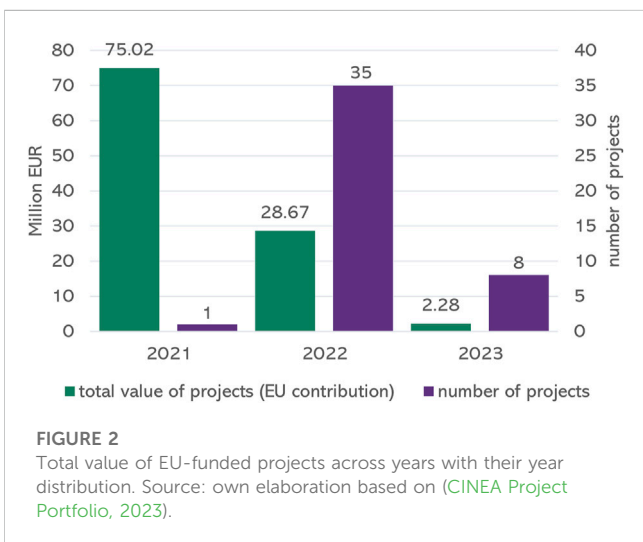
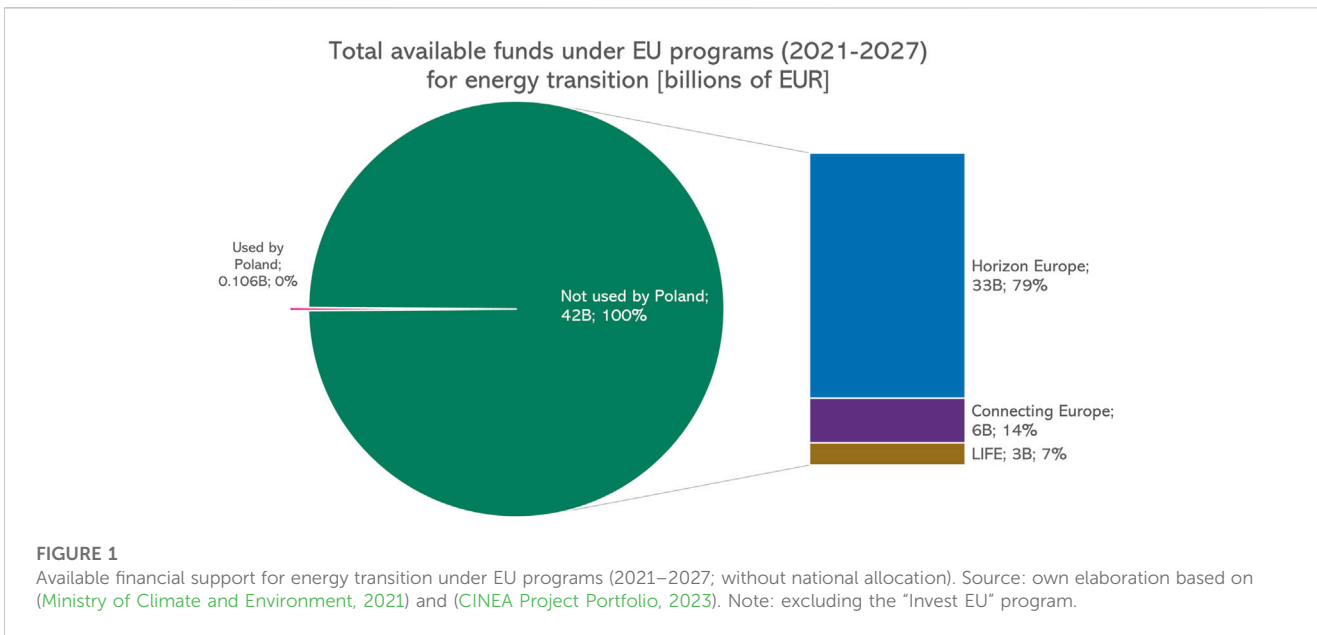
There are also programs targeted at specific groups of recipients. An example of them is the “Stop Smog” program, which is aimed at municipalities located in the area where the so-called anti-smog resolution (described in more detail in Section 2) is in force, as well as their residents. The program is aimed at replacing or eliminating high-emission heat sources with low-emission ones, as well as thermo-modernization of single-family residential buildings, and connection to a district heating or gas network. The program's budget is EUR 157M and the implementation period is assumed to be 2019–2028 (Program Czyste Powietrze, 2023c).

The “Warm Housing” program is another scheme focused on household energy transformation. Although it is executed by communes, the final beneficiary is an individual with a legal title arising from ownership or a limited right in rem to a dwelling, located in a multi-family residential building. The funds are earmarked for projects at end-beneficiaries concerning the replacement of all inefficient heat sources with energy-efficient ones for heating a dwelling or connection to an efficient heat source in the building. The program's budget is EUR 314.78M and is to be implemented from 2022 to 2026 (Program Czyste Powietrze, 2023c).

In addition to domestic programs, Poles can obtain financing through European Union funding. Programs supporting the energy transition are “Horizon Europe”, “LIFE”, “Connecting Europe”, or “Invest EU”. Under these programs, funding of EUR 46B is available for the period from 2021–2027. Figure 1 shows the available financial support for energy transition under the aforementioned EU programs (Polish Electricity Association, 2022). Figure 2, in turn, illustrates the percentage of funds for completed energy transition projects in Poland by EU program.

At the same time, it should be mentioned that as of 9 June 2023, Poland has so far implemented projects with EU financial support for energy transition with a total subsidy value of only EUR 105.76M. This subsidy is well below the possibilities offered by the EU, which is 0.25% of all available funds accruing to Poland. In the 3 subprograms of the European Climate, Infrastructure and Environment Executive Agency (CINEA), i.e., CEF Energy, Horizon Energy, and LIFE Clean Energy Transition, only 62 Polish participations were submitted, and 44 projects received funding, accounting for about 1% of all projects. In comparison, Spain received funding for 175 projects out of 485 participations for a total of EUR 214M.

Data from the European Commission indicates that there is an exceptionally low utilization of EU funds among Poles. In addition, there is a decreasing trend of committed EU funds in CINEA projects for Poland, i.e., CEF Energy, Horizon Energy, and LIFE Clean Energy Transition. In 2021, the EU provided EUR 75.02M for 1 project that is still “ongoing.” In 2022, there were 35 projects that received funding, although there was a significant drop in the value of project funding,



as only EUR 28.67M was provided then (more than 60% less than the previous year). As of 9 June 2023, the committed EU funding in Poland is only EUR 2.28M, which is spread over only 8 projects, while the total EU funding is EUR 105.76M distributed over 44 projects. Details are illustrated on Figure 2.

4 Promoting energy transition in Poland: public awareness and engagement

There are a number of public campaigns in Poland to encourage energy consumers to make the energy transition, aiming to raise public awareness and promote sustainable energy. In addition to the programs described in Section 3, which aim not only to provide monetary support but also to promote green solutions, there are educational initiatives and programs geared toward educating and

engaging consumers in green activities. Such initiatives build public awareness of the benefits of going green, energy transition and conservation, and renewable energy. There are also institutions and organizations that offer free or low-cost energy consulting services for households (like national Energy Consultancy project; Energy Consultancy, 2023). Energy consultants help identify areas where energy can be saved and choose appropriate green solutions, such as installing photovoltaic panels or thermo-modernizing a building.

One of the initiatives promoting the energy transition is the “All you need is . . . RES” campaign (All You Need Is OZE, 2023) which promotes renewable energy in Poland. It provides information on solar, wind, and biomass energy sources and encourages investment in these solutions. The campaign’s creators believe RES is as vital as love, hence the slogan referencing The Beatles’ chart-topping hit. As this project is a joint venture of several commercial and non-profit organizations, a significant number of campaigns to promote ecology among Poles are carried out by NGOs. One such NGO is the Polish Our Earth Foundation (pol. Fundacja Nasza Ziemia) that focuses on environmental and civic education (Fundacja Nasza Ziemia, 2023). They run programs like “Clean Up the World” and work on waste management, preserving biodiversity, and saving natural resources.

Another initiative is the “Our Climate” campaign under the Ministry of Climate and Environment’s “Ecological Education” project (Edukacja Ekologiczna, 2023). Its main goal is to raise the public’s environmental awareness of individual actions that can be taken to protect the climate. Its slogan “The climate is made by people” articulates and accentuates the role of the individual and their impact on the climate. The project’s activities include the provision of educational packages for schools or information and education materials for municipalities. However, Poles do not have properly developed pro-environmental attitudes, according to the results of the initiative’s survey (Edukacja Ekologiczna, 2022). It showed that although Poles consider themselves to follow ecological principles, it appeared that this is not reflected in practice. Furthermore, the poll shows that if Poles exhibit pro-

environmental behavior, it is more due to economic reasons. Thus, for example, (Edukacja Ekologiczna, 2022):

- 61% of respondents unplug unused chargers for economic reasons, while only 42% for ecological ones;
- 61% are guided by price when buying food products, while just 11% are motivated by the presence of organic certificates;
- when buying cleaning products, 62% are guided by effectiveness, while merely 26% pay attention to the eco-friendliness of the product.

The aforementioned indicates that pro-environmental efforts may not always succeed in convincing the Polish population to take even more care of the environment. Polish consumers are not visibly driven by the environmental impact of their consumer decisions and altruistic motivations, but more by their egoistic reasons. This is confirmed by a study by Mazurek-Łopacińska et al. (2021) conducted on a representative group of Poles. Despite the fact that Poles rate their green attitude as good, it can be noted that consumers most often do not make optimal choices, but simply satisfying ones with absolutely minimal effort (Thøgersen et al., 2012). Furthermore, consumers face high upfront costs when switching to a green energy source. In order for consumers to take the desired green action, their perceived benefit-cost ratio must be much more favorable than for alternative choices (Gleim et al., 2013). Poles pay attention to the economic aspect of their decisions, and when making ecological choices, the factor that most limits their consumption of environmentally friendly products is the overly high price (Hermaniuk, 2018). For Poles, the most important factor to consider when making a country's energy transition is the price of energy and its cost to citizens, with environmental benefits listed only second (Herudziński, 2021). The historically influenced determinants of the choice of the type of heat source in the home are pointed out by Hanmer and Abram (2017), who also emphasize the importance of maintenance costs, but also highlight labor savings.

Solid fuel prices are becoming increasingly less profitable. In Poland, according to a joint report by the CEM Institute for Market and Public Opinion Research and the Institute for Economics and the Environment, between January 2021 and January 2023 in the traditional channel (Polski Alarm Smogowy, 2023).

- hard coal prices increased by 181% (from EUR 198 per metric ton at the beginning of the study period to EUR 557 per metric ton at the end of the study period),
- wood pellet prices increased by 173% (from EUR 207 per metric ton at the beginning of the study period to EUR 565 per metric ton at the end of the study period),
- firewood prices increased by 237% (from EUR 48 per cubic meter at the beginning of the survey period to EUR 162 per cubic meter at the end of the survey period).

The same report indicates a 29% increase in the price of eco-pea coal (from April 2022 to January 2023). The increase in prices can be identified with the Russian invasion of Ukraine, which caused uncertainty in the fuel market and shortages in the availability of energy or the compromised security of its flows. Currently, there are a number of government subsidies for the purchase of fossil fuels, and although obtaining energy from renewable sources is still the

most cost-effective, the momentum towards green transition is poor. For example, according to Port PC Association data (Zieniewicz, 2023), the annual cost of heating a 100-square-meter house (including government subsidies for Q1 2023) is EUR 795 if insulated with a coal-fired boiler, and EUR 585 if insulated with a heat pump additionally powered by a photovoltaic system.² Nonetheless, it is worth noting that state subsidies for fossil fuels are temporary, so in the long term the profitability of green fuels will become even more apparent. With all parameters unchanged, but without taking into account government subsidies, the annual cost of heating the same house would be EUR 1,465 for heating with a coal-fired boiler, while with a heat pump additionally powered by a photovoltaics system the cost would be unchanged.

Transition towards green energy can also take place at the level of housing development. Following historical lessons from the example of energy transformation in the United Kingdom (Hanmer and Abram, 2017), it is worth noting that maintaining green home heating and energy supply proves to be cheaper and saves labor inputs, which is socially desirable. In the face of the climate crisis, it is worthwhile to review the existing technical conditions for the construction of residential buildings and considering whether to force designers to incorporate the power supply of the building using (at least a large part of) renewable energy sources.

It should be stressed that it is not only central regulations that have an impact on the quality and pace of the energy transition, but also smoothness of processes within supply chains, including the sale of green products at sales representatives (Wade et al., 2016). Their awareness and knowledge of the green transition gained from verified sources can contribute to better promotion of green energy supplies and accelerate the momentum of the transition. Sales representatives are a source of information perceived as credible and thus influence the final product choice.

Increasing public awareness and creating social responsibility regarding green energy can increase willingness to pay for green energy sources (Hojnik et al., 2021). This should be accompanied by government promotion of the transition to low-carbon, high-efficiency power sources (Cheng et al., 2019). At the moment Poles do not show high willingness to adopt a fully green lifestyle.

5 Discussion and concluding remarks

The multifaceted implementation of the country's energy transition policy to date, together with changes in environmentally-driven conditions, including the presence of social campaigns promoting the transition and green lifestyles, the increase in the price of energy carriers, opportunities to subsidize the change of energy sources to green ones, or even the introduction of legal provisions, have not significantly accelerated the pace of energy

² It was assumed that 4 people live in a house with an area of 100 square meters, and that the house is in the standard of the technical conditions of housing of the Polish Ministry of Infrastructure and Construction for 2008. It was also assumed that the coal boiler has an average efficiency of 84%, and that the radiators have a temperature of 55 Celsius degrees. In addition, it was assumed that the heat pump is of the brine/water type, SCOP = 4.49, the underfloor heating set at 35 Celsius degrees, and the photovoltaic system has an efficiency of 3 kWp.

transition in Poland. Households maintain a significant share of energy in households that continue to be derived from carbon-intensive sources. As a result, in terms of achieving the goals of being a carbon neutral country, Poland lags far behind compared to other European Union countries. The characteristics of household energy transition measures in different EU countries may vary, due to historical circumstances, among other factors. Still, Poland has access to the same funds and knowledge resources, and the duration of both EU membership and conducting the transformation has lasted long enough to have substantial, demonstrable changes as in other states. The presented aspects show that the energy transformation of households in Poland is characterized by high inefficiency and a slew of areas that require immediate attention.

Moderation of the approach directed at the realization of the energy transition objectives is necessary, but the mirror application of policy tools utilized in other EU countries yields results below expectations. This is due to the characteristics of Poles as a society, including the lack of environmental attitudes. Such a mindset is characterized by relative permanence, and the formation of environmental awareness is a protracted process. In order to achieve the goals of the energy transition in a shorter period of time, it is necessary to take measures, including information campaigns, but referring to other values that induce Poles to venture green steps. The basic aspect that is considered in any decision is the financial dimension. Therefore, it would be advisable to accentuate even more the cost-effectiveness of carbon-neutral solutions, and not solely the ecological aspect. Going beyond frontiers of energy transition deployment in Polish households requires revisiting the state policies in place and focusing on the sources of inefficiencies in the measures underway. Widespread adoption of green solutions is not only environmentally beneficial but also cost-effective, as it can lead to long-term savings on energy expenses and reduce reliance on expensive fossil fuels. This should be the pivot of action and the stepping stone for the government to create new energy transformation policies for households in the form of incentives or public awareness campaigns.

Here it is vital to emphasize the international applicability of the article. Although the paper focuses on the context of the course of the energy transition in Poland, the challenges that the country is facing can be referred to the broader perspective of the entire European region. The problem of insufficient dynamics of change is highlighted in many European countries. In particular, this is the case in countries from Central and Eastern Europe, which, being often post-Soviet countries, are exposed to geopolitical influences (Wajer, 2021). Each EU member country has its own sovereignty, but being a signatory to ratified international agreements and thus agreeing to the imposition of supranational directives on environmental protection and sustainable development, every member must abide by these regulations, introducing appropriate policies. There are many indications that the European Union will have to take additional steps to swiftly achieve climate neutrality,³ and as Poland is also a

component of this international partnership, the country's context cannot be overlooked. Poland's case may hence serve as a lens into the entire region of Central and Eastern Europe.

This proposal is justified on its merits, however, more extensive research should be conducted to optimally target and more accurately select incentives for individual consumers in their efforts to achieve carbon neutrality. Consequently, the presented perspective can serve as a starting point for further research, especially primary exploration, examining the factors that have so far driven Poles to energy transition, as well as the barriers that hold back those who continue to use unsustainable energy sources, especially hard coal. This underscores the practical aspect of the considerations, as the inefficiency of the household energy transition in Poland is a real problem and could translate into a failure to meet international commitments.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

JK: conceptualization, methodology, writing—original draft, supervision, project administration, funding acquisition; BH: validation, visualization, investigation, writing—original draft, writing—review and editing; DK: software, data curation, formal analysis, resources, writing—original draft; KP: investigation, resources, writing—original draft; AR: investigation, data curation, resources, writing—original draft, writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

³ The Climate Action Tracker indicator as of 8 June 2023 indicates “insufficient” climate targets, policies and finance, while recommending to “Substantially increase [the EU’s] climate finance contributions, and update its strategy for reaching its net zero target” (Climate Action Tracker, 2023).

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