

Social and Political Barriers of Renewable Energy Development in Poland

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Abstract

Objectives: This study intends to analyze the social and political hindrance of the Polish state's renewable energy development. *Research background:* Poland, as one of the post-Soviet countries, had been heavily relying on natural gas imports from Russia. In addition, this country generates a large amount of electricity through hard coal/lignite coal combustion that engenders a great measure of greenhouse gas emissions. The EU recommends that Poland decrease its greenhouse gas emissions, and in a gradual pace to meet the EU's goals and objectives of building a sustainable environment bolstered by a successful energy transition. To Poland, energy transition is both urgent and alarming. A well-balanced energy transformation depends on technological innovation and development co-functioning with smooth and successful policy making and implementation. *Research methods:* This article applies literature analysis as its main methodological approach to examine the complexities and contradictions embedded in the paradigm of Poland's renewable energy transition. *Findings:* The study concludes that there are major social and political barriers for Poland's renewable energy development. These include dependence of coal production, discrepancies between the EU climate policy and Poland's national economic development, civil society's concerns of energy poverty and promoting local interests, and a doubted and lagged progress on low-carbon transition.

Key words: renewable energy, social and political barriers, Poland, energy transition

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Introduction

The Polish state's heavy dependence on energy production from hard coal combustion engenders a great measure of greenhouse gas emissions and environmental pollution. Under the grand influences of the European Union's climate neutrality plans and policies, Poland also institutes the state's energy transition to meet the goals and objectives of building a sustainable economy and a social environment. It is a distressing period of transition from "dirty" energy sources dominated by the coal industry to cleaner and greener energy sources such as biomass, wind, solar, biogas and others. The distressing part is due to the state's dependence on coal-based economic and social establishments. A well-balanced transition comprises factors including technology innovation, and equilibrium among the country's complex social and political aspects, as well as smooth planning, policy making, and implementation.

In February 2021, the Polish government adopted the energy policy plan till 2040, with detailed aims and targeted energy areas. According to the summary by Paska, Surma, Terlikowski, and Zagrajek (2020: p. 8), the energy plan of Poland till 2040 is comprised of the following goals: 1) a comprehensive use of the state's own energy resources; 2) improvement in electricity generation and network infrastructure; 3) diversification of sources of natural gas and oil supply, and to improve the relevant network infrastructure; 4) energy market building; 5) installment of nuclear energy in Poland; 6) the launch of better renewable energies development; 7) construction of district heating and co-generation; and 8) the enhancement of energy efficiency. And the 2040 energy plan aims at achieving certain objectives:

- a. Reducing the coal generation of electricity to a 60% share by 2030.
 - b. 21% renewable energy source (RES) in gross final energy consumption by 2030.
 - c. to install nuclear power by 2033.
 - d. improvement of energy efficiency by 23% by 2030, compared to forecasts from 2007.
 - e. reduction of CO₂ emissions by 30% by 2030 compared to 1990.
- (Paska, Surma, Terlikowski, & Zagrajek, 2020: p. 9).

However, Rosicki (2015) conducts a critical investigation of the seemingly promising energy policy of Poland till 2050 and makes somewhat pessimistic evaluations regarding the energy plan, and those points concerning renewable energy development are summarized herein: 1) Poland has a very poor system of energy diversification, though sources other than hard coal do make a small contribution to electricity generation per year; 2) coal production and consumption still holds a dominant role in electricity generation; 3) overwhelming reliance on biomass power in renewable energies innovation and difficulties in developing other renewable energies; 4) the state of electricity grids is still underdeveloped, and this could negatively affect development of diversified energy sources and the nuclear energy unit; 5) projected increase in electricity demands; and 6) the stability and security of legislation are still inadequate.

Research background and methods

Though climate change has triggered a heated and compelling global obligation to phase out coal, many countries (e.g. Australia, Colombia) still have concerns over or even reluctance towards initiating speedy actions for climate neutrality (Jakob and Steckel, 2022: p. 14). The grounding for

stable economic and social development is vindicated as a pivotal rationale behind this consideration. However, with the urgent necessity of climate action, countries like Australia, which indicated such reluctance, have also mobilized ambitious planning to phase-out the use of coal. For example, while Australia is noted for the nation's electricity production by coal combustion, and trades of coal exports, the Australian government has instituted and facilitated incentives for renewable innovations and investments in attempting to reduce its coal mining and production sectors (Christof, 2022: p. 252-253). But in Colombia, the situation regarding coal phase-out is quite different. This country depends on power generation dominated by hydropower, however climate changes have resulted in shortages and disruption of energy supply (Puerto-Chaves and Corral-Montoya, 2022: p. 260). A case study indicates three main objectives for Colombia's coal exploration policy-making: 1) improving national revenue streams from coal production; 2) sustaining energy stability and security through electricity generation by coal; and 3) establishing a steady and durable social-economic relation between the government and business sectors of coal supply (Puerto-Chaves and Corral-Montoya, 2022: p. 260).

Regarding eastern European countries, energy transition is impossible to separate from political discourse and agenda concerning Europeanization. Europeanization breeds debate, and theories of Europeanization have become popular since the 1970s. These researches are explorative to tackle and debate on how to define europeanization. Bulmer (2007) indicates that europeanization refers to impacts of the EU onto its member states and a better word for europeanization would be EU-ization. Ladrech (1994) forms a definition of europeanization as an incremental process of policy reorganization and redirection for domestic politics and national policy made under the influence of the EU's political and economic schemes. Flockhart (2010) defines europeanization as a form of spatial-temporal diffusion of European thought, customs, and procedures. And Börzel (2001) points out that europeanization is intensified when EU policy making and implementation become increasingly indispensable to its member states' political and economic dynamics. According to Kohler-Koch (2003), europeanization or european integration concerns both a power distribution at multiple levels and the gradual erosion of the boundaries of public and private spheres. The EU commission has mandated a series of ambitious policy apparatus to undertake energy transition, and eastern European countries are often positioned as backward regions in climate change mitigation. These member states encounter a dilemma as taking immediate and responsive climate actions would slow down individual states' economic-social development. Within the continent of Europe, countries are at different states of marketization and climate neutrality, but their petition to create a common market of electricity supply is also highlighted. Gaps and discrepancies exist among different member states of the EU in terms of energy transition, and it is also the case for eastern European countries. A study by Brodny and Tutak (2021) demonstrates differentiated stages of renewable energy development among eastern European countries between 2008 and 2018, with Latvia and Croatia holding the best ranking while Poland and Bulgaria are ranked the worst.

Social acceptance of renewable energies points to the significant part of governmental transparency, mutual trust between communities and the renewable developers, and distributive justice concerning fairness of renewables development's disseminating costs and benefits (Segreto, Principe, Desormeaux, Torre, Tomassetti, Tratzi, Paolini, Petracchini, 2020: p. 1-19). For example, Bourdin and Chassy (2023: 1228-1239) expound the importance of creating mutual understanding between the renewable developers and local communities, and a feasible and

reliable understanding of local communities and populations increases the social acceptance of renewables adoption (e.g. biogas). Furthermore, like Bourdin and Chassy (2023), Woźniak, Badora, Kud, and Woźniak (2021: p. 1-20) articulate statements that among the study's Polish participants there is a positive attitude to development of renewable energies, and their rationale is closely related to their concerns about energy security and conservation. Also, energy poverty is closely aligned with the social acceptance of renewable energies. A study by Simionescu, Radulescu, Belascu (2024: p. 1-15) extrapolates the correlation between energy poverty, renewable energy development, and carbon emissions; the study shows a positive connection between energy poverty and high level of carbon emissions, and a negative correlation between high carbon emissions and renewable energy progression.

Renewable energy advancement does not solely stand for technological progression but also generates great concerns for transforming the social and political aspects of a given society. Transition to renewable energy systems is faced with various regional social and political hindrances. I would like to elicit the research question of this article here. What are the social and political barriers of Poland's renewable energies development? This article intends to answer this question by providing analysis in four main sections: the politics of coal, relations with the EU commission's climate and energy agenda, influences and acceptance from Poland's civil society, and a possible pathway to low-carbon transition. There are few scholarly articles dedicated to analyzing the renewable energy transition through these four aspects of Polish society, and this article intends to fill this research gap.

The method of this article comprises mainly literature analysis. From 2021-2024, I analyzed academic materials including articles, academic reports, business reports, and policies, in close association with renewable energy development in Poland. I did systematic reviews, wrote reading notes, and conducted literature analysis of these articles, and furthermore extracted detailed viewpoints and insights from them. I formulated my hypotheses as follows: 1) Coal production has been an impediment for renewable energy development in Poland; 2) Poland is resisting EU's energy policy; 3) Renewable energy development is positively accepted by the Polish society; and 4) Poland must smooth its low-carbon transition in order to have renewable energy development facilitated.

Results

Politics of coal

The extraction and production of hard coal have dominated Poland's economic development since the late 19th century. The communist regime of Poland instituted a centrally planned governance of the national economy. The centrally planned economy placed the production of coal at the center stage of the state's economic development, as the state nationalized all large and medium sized mining and energy units (Szpor, 2019: p. 3-4; Zientara, 2007: p. 276). Under the ruling of communist regime, the mining and energy sectors became a model of socialist developmental progress. The socialist model created various benefits and privileges for workers, including additional salaries for two months per year, and financial support for schooling of the workers' children (Szpor, 2019: p. 4; Zientara, 2007: p. 276). The model also offered relevant infrastructures and social activities such as hospitals, schools, kindergartens, and sport clubs to mine workers (Szpor, 2019: p. 4). For the economic and social transformation of Poland in the 1990s, coal's role

in electricity generation played a significant role, as between 1990 to 2000, 95-96% of power production came from coal (Szpor, 2019: p. 4; Zientara, 2007: p. 277). During the first ten years of transformation, the government dictated closures of inefficient and under-productive mines, resulting in closings of nearly half of the existing mines, but in fact many closures were merely mergers with other mines (Szpor, 2019: p. 6). Though there has been major decline in coal production and employment in the coal industry, Poland's economy still relies heavily on the coal mining sector, as economic growth is strongly interlinked with electricity demand increase (Szpor, 2019: p. 7; Kaczmarek, Kolegowicz and Szymła, 2022: p. 1). But the country's economic development based on coal production and consumption is in need of higher energy efficiency (Szpor, 2019: p. 7).

The process of restructuring the coal mining sector is not easy, mainly due to three reasons: 1) the unstable state of this restructuring period creates obstructions in coherence and consistency in policy making; 2) centralized planning agenda and strategies lack participation from local governance, which it is believed would potentially have the capacity to implement more efficient restructuring measures; and 3) the geographical concentration of coal mining sectors in the Lower Silesia and Małopolskie regions of Poland has yielded resistance and hindrance for this restructuring process (Szpor, 2019: p. 12). To better protect the interests of coal miners, two social protection tools were introduced in 1993: early retirement benefits and welfare allowance. In 1998, the miners' social package (e.g. increasing early retirement from 55% to 75% of the wage, and an increase from 55% to 65% for welfare allowance) was installed enhancing the existing welfare scheme of mine workers (Szpor, 2019: p. 11-12). However, the continuing shutdown of mines led to union protests. For instance, employees went on strike against the announced closure of four under-productive mines in January of 2015 (Brauers & Oei, 2020: p. 4). The protests cease only upon the parliament's agreement for mine restructures - instead of closing the mines, but the protests restart after the announcement demanding workers benefits reduction and increase of working days (Brauers & Oei, 2020: p. 4). Restructuring the coal mines has had negative impacts on people's confidence toward renewable development, especially for people living in the mining regions.

The PiS party (Law and Justice party), with a strong inclination to coal mining and production, has won every parliament election since 2015 with a promise to secure the important role of the coal mining and production industry (Brauers & Oei, 2020: p. 4). In alignment with rulings of the PiS, there have been changes in coal mining industry ownership during the past few years: Polska Grupa Gornicza (PGG) was formed from two companies of former state ownership, the formerly privatized BOGDANKA is returning to state ownership as the state-owned company ENEA has a 65% share of its ownership, and the remaining small number of private companies have only a very small share of coal production (Suwala, 2018: p. 267). Strong connections between the coal mining and electricity sectors have been created since the PiS party's accession to state leadership, as there is more financial support for the PGG from state-owned investors PGNiG, PGE, ENEA, Energa, and TF Silesia (Brauers & Oei, 2020: p. 4).

Public opinion regarding the coal mining industry is divided: on one hand, some villages express negative views toward the opening of new mines (Widera et al., 2016) and on the other hand, other villages express general welcome to the installment of new ones (Brauers & Oei, 2020: p. 4). Factors affecting the divided opinions are in relation to the employment rate, energy prices, and

energy security (Brauers & Oei, 2020: p. 4). As a country with a long history of dependence on coal-based energy, fears that the reduction of coal production and consumption will result in rising energy prices persist and are popular among Polish people. But survey data indicate that among the Polish people, there is less support for the economic benefits of coal industry than for energy affordability and energy security, and coal energy is not the favoured choice of energy base in comparison to renewable energies (Brauers & Oei, 2020: p. 4). The social support for miners' privileges (only around 25% of support) and the coal industry (64% urge the same welfare packages for the mining industry as for other sectors) has declined in recent years (Brauers & Oei, 2020: p. 4).

Media interests and discourses in Poland are more prone to expressing support for social protection of state-owned industry, as the Polish media is mostly state-owned and receives a large portion of revenues every year from the state-owned corporations and sectors (Brauers & Oei, 2020, p. 5). Polish media highlight the importance of the coal industry for the Polish economy and energy security, while media coverage of climate change, energy transition, and of political interests in the critical connection between the coal industry and climate change are less significant as compared to the relevant situations in other EU nations (Brauers & Oei, 2020, p. 5). Social opposition to coal mines is of less interest in Poland as the only voices expressing concern over coal production and consumption are NGOs (e.g. Greenpeace, "Development YES - Open Pit Mines No!", Action Democracy or Client Earth) (Brauers & Oei, 2020, p. 5). Moreover, NGOs in Poland are rather small and are short on experience in handling EU fundings and setting EU agendas, and their influences and activities in confronting coal mining and power generation are comparatively less significant within the EU context. However, there still are some societal concerns regarding climate change and environmental problems. Intensive air pollution in Poland has engendered strong public awareness of climate change and environmental problems, as a survey (Wojciechowska-Solis & Soroka, 2018) reveals that incoherence and inconsistency in policy making and implementation regarding sustainable development have hampered Poland's air pollution reduction and mitigation.

EU Energy Policy

As regards energy transformation, europeanization may be advantageous and at the same time problematic. Nicolaides (2010) investigates the positive and negative effects of europeanization. A given member state experiences europeanization as per the beneficial effects it can achieve and the costs that inevitably occur through the process of europeanization. The national government learns to adjust its behaviours for adaptation to the EU requirements, is willing to implement correction in accordance with requirements from the EU, but also the national government can be non-compliant to the certain EU requirements and standards when there is a high tolerance from the EU.

The EU has been promoting climate change mitigation and renewable energy through agenda setting and policymaking for many years and constantly promulgates the europeanization of energy policy. Europeanization of energy policy can be defined as: creating a favorable industrial development and business environment for energy transition in the territory of the European Union; establishing convergent macro-economic systems for individual EU countries and convergent industrial policies for energy transition (Wach, Głodowska, Maciejewski, & Sieja, 2021: p. 5). Whereas regulatory function of the EU is extremely important to allocating,

redistributing, and stabilizing division of economic competences among individual member states, the energy policy is signified as a shared competence and liability between the EU and its member states (Wach, Głodowska, Maciejewski, & Sieja, 2021: p. 5).

The European Council reached an agreement in 2021 and formed carbon emission reduction target phase 4. The phase 4 target plan is aligned with the 2030 climate and energy framework, aiming for 55% greenhouse gas emission reductions (Erbach and Jensen, “Fit for 55” package, the EU, 2022). In addition, the 2030 climate and energy framework demands at least 27% increase in RES, and at least 27% increase in energy savings (Tews, 2015: p. 270). The 2030 framework also highlights that the 40% emission reduction should be dispersed among individual member states based on their individual gross domestic production per capita (Tews, 2015: p. 270).

Poland is a laggard nation within the EU and sustains its critical stance to and a strong stand against the EU’s climate and energy policy in favor of maintaining the status quo and progressing economic development (Skjærseth, 2018: p. 8). Nonetheless, the national government is making efforts to comply with the EU’s ambitious plans of mitigating climate change, for Poland loses most of the resistance cases to the EU commission (Skjærseth, 2018: p. 8). However, Poland only implements parts of 2020 climate and energy packages in alignment with the interests of the nation’s coal-based energy industry (Skjærseth, 2018: p. 8). Also, it is a come-and-go debate over feasibility and viability of reducing support for coal-fired biomass energy plants or to increase install feed-in tariffs to foster less developed renewable energies technologies of local small energy groups (Skjærseth, 2018: p. 8). The reason for Poland’s implementation of parts of the 2020 climate and energy packages is to maintain stability in national politics (Skjærseth, 2018: p. 8). Donald Tusk, chairman of the civic platform and leader of two Polish majority governments from September 2007 to autumn 2014, claims the legitimacy and feasibility of developing nuclear, coal, and shale gas in response to energy dependency and increase in demand of electricity, oil, and gas (Skjærseth, 2018: p. 8). And there is no long-term planning and policymaking targeting at climate change problems and energy system reforms among Poland’s political parties, and especially since the PiS party took power of the parliament. The PiS party declares to protect the benefits of coal miners and not to close any more mines (Skjærseth, 2018: p. 8).

One of the biggest worries of the Polish government in terms of the climate and energy policy is the third stage of the EU emissions trading system (ETS). The third stage of ETS came into effect in 2013 and determines a 1.75% annual reduction in greenhouse gas emission and 50% of emissions to be auctioned to the energy-intensive industries (Marcinkiewicz & Tosun, 2015: p. 3). In addition, Poland’s chamber of commerce, consisting representatives from over 150 business sectors, prepares an assessment of the EU climate and energy policies (EnergySys, 2012), and according to their assessment, implementation of the EU 2020 climate and energy package leads to a high rise in electricity prices which results in decreasing industrial competitiveness, lower economic productivity, and higher unemployment rates (EnergySys, 2012; cited by Skjærseth, 2018: p. 9). Also the assessment from the chamber of commerce reports that few benefits will be given to newer and greener technologies (exception: biomass technology) as the chamber does not perceive innovations and advantages in solar and wind technologies dominated by foreign capitals and technologies to be valid benefits as the majority of the costs will be laid on traditional energy industries (EnergySys, 2012; cited by Skjærseth, 2018: p. 9).

Energy Poverty and Social Acceptance

Central and Eastern European states are facing urgent requirements from the EU commission to engage in pacing energy transitions and mitigating climate change, but central and eastern European nations are peripheral states in comparison to the core European countries, given sharp differences in economic and social development. Also, as it pertains to energy transition within the EU, “rather than reducing the negative consequences of differences in economic development, changes in and the transformation of the European energy market that have taken place in the last few years have, in fact, only deepened existing differences between core and periphery countries due to the strong geographical anchoring of policies underpinning these changes and transformations. One of the reasons for this problematic station originates from an increase in household energy costs between 2007 and 2013, resulting from both the economic crisis and monetary deprivation. Similarities between CEE (central and eastern European) states in the case of their energy situation are apparent to different degrees. The difference between Poland and Hungary, for example, is much less significant than that between Poland and the Czech Republic when one takes into account, inter alia, the relationship between the energy poverty index and the at-risk-of-poverty rate” (Libor & Bouzarovski, 2018: p. 66).

Many citizens in Poland possibly face energy poverty as a result of the greenhouse gas emission reduction plans demanded and initiated by the EU, though the scholarship on energy poverty in Poland is still under exploration. Continuing closures of conventional coal mines and underdevelopment of renewable energies result in significant rising of electricity prices. Karpinska and Śmiech (2021, p. 2-3) investigate three tenets of social costs of energy poverty in Poland. First, hidden energy poverty: scarcity in energy expenditures based on household and family characteristics, is common among Polish household and families, and studies done in other European regions (e.g. Betto et al., 2020) indicate that members of poor households are trying multiple ways to lower the energy costs. For example, self-restrained behaviors such as extending hours of staying in bed during the days, and of using cheap and dirty energy sources to cope with the cold are demonstrated among low-income households. Not many inquiries have been conducted to examine hidden energy poverty situations in Poland, but many scholars such as Karpinska and Śmiech (2021) alert such possible situations of energy poverty. Second, the depth of energy poverty: this mainly deals with the relation between income gap and energy poverty or the difference between maximum affordable energy costs and the actual expenditure on energy (Meyer et al., 2018; cited by Karpinska & Śmiech, 2021, p. 2). Third, is relevance to energy transition: there are many questions and doubts about concurrent energy policies in Poland. Energy transition may lead to energy poverty and deepen the problems of energy poverty for certain geographic regions, and the problems of energy poverty are un-affordability in energy costs, higher risks for health issues (e.g. “asthma, tuberculosis, winter mortality, and obstructive pulmonary diseases” (Karpinska & Śmiech, 2021, p. 3)) related to use of unclean energy sources, and poorer living conditions within their households (e.g. “indoor dampness and mold, cold, smoke from solid fuels and biomass” (Karpinska & Śmiech, 2021, p. 3)).

The Polish general public's attitudes toward climate change and energy policy seem ambivalent and mixed. In a study done by Yazar, Hermwille & Haarstad (2022, p: 281-293), the survey methodology and analysis are applied to contest the contrasting paradigms of right-wing populist politics and climate change policy in Poland. In this study, questions like "to what extent are you in favor or against the following policies in Poland to reduce climate change: (1) increasing taxes on fossil fuels such as oil, gas, and coal? and (2) using public money to subsidize renewable energy such as wind and solar power?" are asked. The study generates rather surprising results. First, in terms of party ideology connections to climate change mitigation policies, those voting for parties other than the extreme right-wing have a strong association with support for climate change mitigation policies. Those voting for parties including Poland Together, Law and Justice Party, and center parties Civic Platform and Polish Peasant Party, are strongly linked to support for climate policies. Interestingly, voting for the left-wing parties is only significantly correlated with climate policy support when climate policies propose using public money to subsidize RES energies (except for the carbon emission intensive and coal mining Silesia region). Voting for the right-wing is correlated with support for a tax on fossil fuels and using public funds to subsidize RES energies, and the center parties using public funds to subsidize RES energies. Second, the analysis indicates a less significant relationship between anti-elitist and anti-establishment rhetoric and support for climate change mitigation policies (except for the carbon-intensive Silesia region). Third, social-demographic factors are reported to be somewhat associated with support for climate policies, including gender (more males supports using public funds to subsidize RES energies), age (41-55 year group strongly support to using public money to support RES energy development), higher education (higher education is a good determining factor for supporting increasing taxes on fossil fuels at the national level, but no has significant association on the local level), and lastly employment (the strongest predictor for support of climate policies in the emission intensive Silesia region). Unemployed individuals of Silesia region support increasing taxes on fossil fuels, but employment reports show no significance for support of climate policies at the national level.

LowCarbon Transition: a Possible Pathway?

In 2022, Poland's scores on the Eco-innovation scoreboard are not high and the nation's score on the Eco-innovation index is 67.4 while the average score of the EU-27 (after the Brexit) is 100 (Al-Ajlani et al., 2022). Poland's vulnerability and weakness in eco-innovation stem from poor management in resources and energies as the country is still heavily dependent on coal-based energy production. According to a study by Nyga-Kraszewski (2016, p. 107), energy innovation accounts for most of the eco-innovation in Poland, and energy innovation consists of renewable energies (biomass, bio-fuels, biogas, and solar), energy conservation technologies, and energy efficiency technologies. These innovations come from 53 private companies, 2 state-owned companies, and 34 Research and Development (R&D) sections, and 10 municipalities (Nyga-Łukaszewska 2016: p. 107). Poland's R&D energy budget is 8% of the total R&D expenditure in the overall economy, and ranks above the OECD average of 6%, and above the EU 28 (before the Brexit average of 7% in 2014, while the total R&D budget (0.9% GDP) in Poland's economy is comparatively lower than the EU average (2% GDP) (Nyga-Łukaszewska, 2016: p. 107).

Table 1: Expenditures of energy-associated R&D in Poland from 2013 to 2023 in USD (million)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total budget	151.093	136.779	113.592	65.252	66.743	65.775	75.959	107.151	135.684	219.585	167.729
Other frontier research	1.467	1.821	2.428	2.791	6.672	7.266	8.121	14.532	11.495	13.868	8.689
Hydrogen fuels	8.189	2.644	0.938	1.059	0.879	0.77	1.818	2.363	6.217	9.383	6.909
Fossil fuels	63.53	39.715	34.891	15.363	15.729	12.46	9.752	12.857	10.093	21.336	8.19
Unallocated	0	0	0	0	0.321	0.614	0.692	6.876	40.367	78.723	60.559
Other Power & storage technologies	18.82	21.972	21.594	9.671	7.981	6.444	12.098	20.101	16.902	18.467	20.896
Nuclear	9.089	21.327	19.434	8.389	5.956	5.333	7.618	11.072	7.707	16.975	15.776
Energy efficiency	33.184	27.978	11.064	10.802	10.356	13.514	17.901	23.94	23.793	28.827	20.987
RES	16.814	21.322	23.244	17.177	18.848	19.375	17.959	15.411	19.11	32.006	25.723

(source: IEA Energy Technology R&D Statistics,)

<https://www.iea.org/data-and-statistics/dataproduct/energy-technology-rd-and-d-budget-database-2>

But energy production from renewable sources in Poland sustains a strong interest for the nation's concerns of economic benefits and sustainability building. Energy production by renewable resources has experienced developmental growth in recent years, especially for biogas, biomass, biofuels, and wind technologies. In Poland, there are 303 biogas plants (240 MW), including 93 agriculture biogas plants (100 MW), generating 5% electricity (Website of Energy Regulatory Office in Poland, 2017; Woźniak & Twardowski, 2018: p. 99). In 2015, around 48% of renewable energies were from wind technologies and 22% from biomass energies, and the country produces 171,284 tons of biofuels, mainly bio-gasoline and biodiesel (Woźniak & Twardowski, 2018: p. 99).

Iskandarova et al. (2021: p. 5-6) indicates that there exist two phases regarding the renewable energies progression of Poland after the country's accession to the EU in the year of 2004. The first phase, from 2004 to 2015, involves the part of environmentalist thought and activism becoming gradual interests of the governmental administration and political debates. The main governmental unit, the national fund for environment protection and water management (NFEPWM), is responsible for distributing and managing public grants and funding from the EU, and setting agendas, coordinating resources, and monitoring project progress regarding the nation's renewable energy building and energy efficiency advancement (Iskandarova et al., 2021: p. 5). In 2010, the NFEPWM implemented a scheme of green investment which, by 2019, had managed PLN 530 million in loans, and PLN 586 million in subsidies, and had led to energy efficiency increases in 1700 public buildings, the construction of 17 biogas power plants, and the connection of 7 wind power plants to the grid (Iskandarova et al., 2021: p. 6). The Polish government also instituted a program of green certificates, obligating energy providers to show that a certain amount of the electricity they were selling had been obtained from renewable energy sources, and there was a substitution fee for failure to meet the requirements (Iskandarova et al., 2021: p. 6).

The second phase concerns the ratification of the RES Act in February 2015, which enabled an emerging auctions mechanism (replacing the Green Certificate scheme), net-metering, and an increase in electricity prices. This series of actions was an attempt to appease strong and growing public interest and lobbying for the creation of conditions more conducive to energy prosumerism (Iskandarova et al., 2021: p. 6). However, there are studies pointing to the problematic management, administration, and coordination of public governance in renewable energy transition. According to study by Dolega (2016), technical barriers for development of renewable energies in Poland constitute problems related to restrictive auctions measures, complicated processes of granting permissions for technology deployments, bureaucratic and lengthy administration procedures, vague legislative frameworks, lengthy time of processing financial subsidies, and scarcity in grid networks. Also, Pietrzak et al. (2021) find that lobbying procedures hamper the renewable energies industry diffusion due to heavy lobbying influence by the coal-based industry.

Bio-energies (including biomass and biogas) are initiated and incensed by a state's development of bioeconomy. The idea of bioeconomy was introduced by leading OECD member states in their publication "The Bioeconomy to 2030" and defines bioeconomy as an innovation and reformation of production processes dictated by scientific and technological innovation and development that creates bio-products, and promoting bioeconomy is to process this life science knowledge into sustainability of eco-efficiency and eco-competitiveness (Woźniak & Twardowski, 2018: p. 97). This agenda aims at food security, the binding of sustainability with uses of natural resources, reducing reliance on unclean energy resources, and mitigating climate changes. Many countries, for their lack of institutional capacities and policy regulations, do not have sufficient access to the scientific and technological innovations necessary for the development of bioeconomy in their states. Poland's part in bioeconomy development is uncertain. The state government has ambitious planning and objectives for these changes and has succeeded in developing certain technologies

(e.g. biomass) in progressing bioeconomy, however the state still lags behind advanced industrial countries regarding scientific and technological innovations among many fields related to bioeconomy. In 2019, the Polish government created close alliances and cooperation among different ministries, including the Ministry of the Environment, the Ministry for the Economy, and the Ministry for Information Technology. It proposes developing bioeconomy aiming at promotions in the following areas: biomass developments, ecological awareness in economic activities, a supporting framework at both national level and local level, local values chains and resource base, removing barriers to bioeconomy, and a renewed taxing system (Mikielewicz, Dabrowski, Bochniak & Gołabek, 2020: p. 12). Poland has chosen food, agriculture, green industry, and bioenergy as the state's smart specialization in terms of bioeconomy, and the state's predominant successes are agriculture development and development of biomass technology.

Poland is a receiving country of foreign investments and technology innovation with regards to renewable energies, and foreign direct investments from advanced industrial countries have laid the foundation for renewable energies development, predominantly in the areas of solar and wind energy, and foreign direct investments are triggering further RES development. It is doubtful that Poland could succeed in facilitating the renewable energies development by having a steady dependence on foreign direct investments while still maintaining the state's status quo of social and economic advancements. There are few scholarships devoted to offering arguments of pros and cons of foreign direct investment on the green energies industry in Poland. Nonetheless, there are studies done by international scholars which tackle the contesting trilemma and these studies make inquiries into the contesting relations between foreign direct investments, economy, and renewable energies. A study by Sarkodie and Strezov (2019) shows that foreign direct investments into developing countries (e.g. China, India, Iran, Indonesia, and South Africa) would increase greenhouse gas emissions of the capital-receiving states. But it is also expounded that foreign direct investments will assist and facilitate the renewable energy industrial development of the developing countries and regions (Doytch & Narayan, 2016; Fan and Hao, 2020). A study by Murshed et al. (2021) investigates the panel data from 1972 to 2015 involving foreign direct investment and ecological footprints in Bangladesh and points out that while the country's economic development led by foreign direct investments has created a series of devastating pollution problems, foreign direct investment also plays a positive role in promoting local renewable energies advancement. A study by Fan and Hao (2020) reveals empirical evidence that in the short run, foreign direct investments cannot significantly boost renewable energy consumption change, but in the long term a moderately slower pace in economic growth and targeted foreign direct investment projects would augment positive effects on increasing renewable energies in China. But how can Poland coordinate the equilibrium and contest interrelations among foreign direct investments, economic growth, and renewable energy development? Can the state be capable of breakthroughs in its RES development? These questions await further in-depth exploration and scholarly debate.

Discussion

Poland's renewable energies progression is impeded by its interactions with the domestic politics of coal, and baffling relations to the EU climate and energy schemes. The state's transition to renewables also needs to tackle financial burdens to the Polish citizenry. A comprehensive low-

carbon transition necessitates bioeconomy development, ecological and energy-related innovations, and investments from foreign corporations. According to Brauers and Oei (2020: p. 7), some barriers to transforming the coal mining and production in Poland are: 1) “regional economic dependence and high employment share in the coal sector”; 2) limited financial and legislative supports for developing renewable energies and relevant policies; 3) household burdens due to rising electricity prices; 4) energy security dependent on unreliability of energy imports; 5) concurrent heavy reliance on coal-based economy; 6) vested interests and political supports in coal industry; 7) strong labor unions of the coal mining sector; and 7) potential challenges of downsizing coal mining and production (energy poverty).

This section finds agreement with other studies as to Poland’s rather critical and baffling position regarding the EU’s climate neutrality policies, and the EU’s enforcing influence on setting this country’s agenda for economy and social development. The Polish government in its policy narratives depicts the nation as a passive EU member as regards activating and realizing these energy and climate neutrality plans (Biedenkopf, 2021: p. 395). The nation calls for more responsibility and sense of solidarity from the EU to offer more financial assistance in decarbonization of the conventional coal-based energies production and consumption system (Biedenkopf, 2021: p. 395). Furthermore, Biedenkopf’s study on Poland’s policy narrative on energy transition reveals that the EU climate and energy policies are also portrayed as threats to Poland’s economic competitiveness, as “I would like to emphasise the fact that the government is right to disagree with this type of restriction, because our natural resource, which is coal, will suffer a great deal under this solution. I think that our entire economy would slow down quite sharply if we were to adapt to these requirements” (Biedenkopf, 2021: p. 397). But the survey (Yazar, Hermwille & Haarstad, 2022: p: 281-293) in the aforementioned section indicates a mixed and nuanced perspective of supporting renewable energy transition among the Polish voters, and this sketches a different picture of political phenomena debating Poland’s connection and contestation with the EU climate agenda. The section suggests that there are discrepancies regarding supporting renewable energy transition between the acting political party and the actual voters, as Pietrzak et al. (2021) suggests the lobbying’s interests and intentions play significant roles in policy narratives and policy making as they pertain to renewable energy diffusion in Poland.

Regarding concerns for the positive or negative impacts of foreign direct investments on Poland’s economy, it is also questionable and uncertain if the nation’s development of renewable energies could benefit from the globalizing financial mechanism of renewable energy technologies. A study by Huenteler, Niebuhr & Schmidt (2016: p. 6-21) analyzes cases of Thailand’s electricity sector for relative advantages of local and global technological learning, and the study concludes that “enabling local learning, such as a skilled workforce, a stable regulatory framework, and the establishment of sustainable business models, have a more significant impact on (the) cost of renewable energy in developing countries than global technology learning curves”. Academic literature for this area is still comparatively scarce, and the question of whether or not enhancing local technology learning in Poland’s context would advance the country’s renewable energy transitions is waiting for further empirical efforts and research evidence.

Conclusion

In connection with the formulated hypotheses, I can summarize the study in four points. First, the old and “dirty” coal business in Poland has obstructed the nation’s energy transition to renewables. Second, Poland’s part in the EU energy agenda is complex, as the nation devotes efforts to promote energy transition but is somewhat non-compliant to the EU demands. Third, Polish society is willing to embrace renewable energies given their desire for energy securities and protecting local communities’ interests. Fourth, Poland experiences difficulties in terms of its low-carbon transition, and questions arise over the country’s technology innovation, policy-making, and financial investments. This article hopes to offer some humble insights into Poland’s energy policy-making and administration: 1) the national government should aggregate measures to expedite restructuring the coal industry, and to ameliorate people’s confidence in renewable energies; 2) it would be beneficial for both the economy and energy transformation for the state to augment low-carbon economic development, and this would be a feasible means to counteract the state’s resistance in adopting EU energy policy; 3) the state should contribute intensive investments into renewable energy technology diffusion and innovation, hence implementation of renewable energies could also produce profits; and 4) the state is in need of further negotiation and bargaining with the EU commission for more renewable technology transfusion, financial incentives, and regulatory supports.

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