https://doi.org/10.32056/KOMAG2022.1.4

Dilemmas of the energy transformation in Poland 2021/2022

Received: 03.02.2022

Accepted: 04.03.2022

Published online: 31.03.2022

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Abstract:

The subject of the article is an analysis of the energy transformation in Poland against the background of the changes taking place in the environment. Authors study key issues related to the energy transformation to analyze the dynamics of the Polish energy transformation as well as the possible directions. In the end they discuss the three possible scenarios for Poland which could transform the country's energy system from coal to zero emission. The discussion is up-to-date according to the European and world directions of industrial transition into green energy and Poland has got huge challenges ahead while the time to take steps is passing.

Keywords: just transition, energy system, renewables, energy transformation

Publisher: **KOMAG Institute of Mining Technology, Poland**

1. Introduction

The turn of the year 21/22 showed the challenges faced by the domestic energy sector in Poland. The high share of coal in electricity generation resulted in an increase in electricity bills. It was overlapped by turbulences on the gas market, which the domestic gas operator could not handle, which resulted in a surge in gas prices on the domestic market. The subject of the article is an analysis of the energy transformation in Poland against the background of the changes taking place in the environment, which are gaining momentum. We will conduct a literature review of key issues related to the energy transformation to analyze the dynamics of the Polish energy transformation. We will analyze program concepts aimed at overcoming the delays of the domestic energy sector. The aim of the article is to show the complexity of the energy transformation process on the example of Poland. The working hypothesis about the strong resistance of incumbent energy operators who have taken over the main decision-making centers of the state by creating a false coal energy security doctrine with the weaknesses of the organizational structures supporting the energy transformation will be verified. We will apply a process approach to the analysis of the accompanying social and economic phenomena. The literature review will be supported by own observations from the position of the ZKlaster association operating in the field of energy transformation.

2. Materials and Methods

2.1. Key issues of the energy transformation

The literature review allowed for the construction of bundles of issues that are used to describe the current situation in the field of energy transformation in the technological, social, economic and political environment and to identify the premises for the formulation of energy transformation scenarios.

Just Transition

The Paris Agreement signed in December 2015 under the United Nations Convention on Climate Change (UNFCCC) is an extremely important and ground-breaking agreement that applies to almost all emissions in the world. As agreed, the EU target (in the context of the necessary reductions by developed countries as a group) is to reduce greenhouse gas emissions by 80-95% by 2050 compared to 1990. This requires a deep, rapid transformation of the energy system and an assessment of the role of policy instruments such as pricing in transition carbon. The challenge of decarbonization is also posed in the context of a limited carbon budget and the concept of "non-combustible coal", which has implications not only for Europe, but also for the whole world [1].

In Poland, the solidarity aspect of the energy transformation process is exposed. However in political activities, this translates into delaying the process of energy transformation in the interests of incumbent energy operators and demanding increased funds from the EU to protect large professional groups related to the energy sector and counteracting energy exclusion of wide social classes. The transition from high-carbon to low-carbon energy systems raises serious concerns in regions whose economies are heavily dependent on coal-fired power. Concepts of a comprehensive just transition framework, based on a multi-level perspective of socio-technical change, appear in the literature. They have the character of system innovations, proposing mapping of a just transformation in three dimensions: 1) spatial scale (regional, national, international); 2) time horizon (currently experienced and anticipated injustices); 3) connection with the dynamics of change (injustices related to the optimization of the currently dominant system, destabilization of the incumbent system, acceleration of alternative solutions in niches). This framework is used to analyze the ongoing energy transition in Estonia, for example, including the interactions between the incumbent oil shale regime and wind, solar, nuclear and bioenergy as new niche challenges. Based on the analysis of the content of media information, Estonian scientists have compiled a list of 214 separate cases of deviations from the just transformation in 21 different categories. It was discovered that strong actors push energy solutions and influence current political elections in violation of the principles of just transition. From the perspective of the general public, ethical dilemmas arise related to the costs of destabilizing the regime of old operators and accelerating the construction of new energy [2].

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Building a false awareness of the energy transformation in Poland is related with fear of losing jobs by large professional groups. Meanwhile, many countries around the world are prioritizing cheap renewable energy sources for recovery from a global pandemic and long-term economic growth. Climate change mitigation goals set choices for a rapid move away from coal and other fossil fuels. Sustainable technologies bring wider socio-economic benefits, as shown by the example of countries that previously restructured their energy sectors and increased the share of RES. The energy transition has generated an interest in employment changes linked to concerns about job losses in conventional energy sectors. A better understanding of the direct employment impact of the energy transition is crucial for policy making by politicians. Research by scientists focusing on the effects of accelerated use of renewable energy, assuming that the world will obtain 100% of its energy from renewable sources by 2050, shows that direct jobs related to energy, heating, transport will increase significantly from around 57 million in 2020 to nearly 134 million by 2050. The conclusions of extensive research support the thesis that value chains for renewable energy and sustainable technologies are more labor-intensive than fossil extractive fuels. This means that the global energy transition will have a positive impact on future stability and economic growth worldwide [3].

Energy transformation scenarios

The adoption of the European Green Deal strategy was received without enthusiasm by government centers in Poland, as achieving the target of 100% reduction in greenhouse gas emissions by 2050 was very abstract. Only the adoption of the climate target to reduce greenhouse gases by 55% for 2030 caused a shock. The Fit for 55 package proposals launched aggressive government propaganda against the rapid decarbonisation of the energy system in Poland. Renewable energy interest groups and climate activists have been pushed on the defensive under the pressure of the doctrine of independence and energy security based on coal. Large interest groups of the old energy operators have gained an advantage in the political narrative in Poland.

At the same time, a determination has emerged on the part of the European Commission, driven by a combination of factors and synergies between technological development, political activities and public attitudes, to strengthen cooperation within the EU to achieve climate goals. EU support programs have been launched to increase social commitment and stimulate technological innovations that may become the basis for an effective energy transformation in Europe. Concepts of transformation pathways have emerged, shaped by the intersection of policy, technology and society development. Analyzes indicate that achieving rapid decarbonisation inevitably involves the implementation of new technologies, accompanied by the ruthless enforcement of decarbonisation policies in the short term to accelerate the energy transition. A review of Europe's energy transition scenarios leads to findings leading to the identification of consolidated and robust recommendations to policymakers and politicians for the effective achievement of the EU's Green Deal [4].

Many countries in Europe have opted for a gradual transition to 100% green energy generation. However, uncertainty has arisen over the economic and social consequences of such a transformation based on wind and solar technologies. Concerns have arisen about rising electricity prices due to a mismatch between supply and demand. In Switzerland, studies were carried out using the theory of dynamical systems to analyze the process of gradual transition from nuclear power generation to solar and hydro power generation. Various transformation scenarios were developed to test the cost-effectiveness of a water pump energy storage system to address the problem of the time difference between supply and demand. Research shows that leaving the system on the free market may entail energy shortages in the transition period and a doubling of the electricity price. To mitigate this effect, a capacity auction mechanism has been proposed, which will facilitate the transition to renewable energy. In addition, subsidizing photovoltaics indirectly encourages storage, thus eliminating shortages and mitigating the increase in electricity prices during the transition period (Fig. 1) [5].

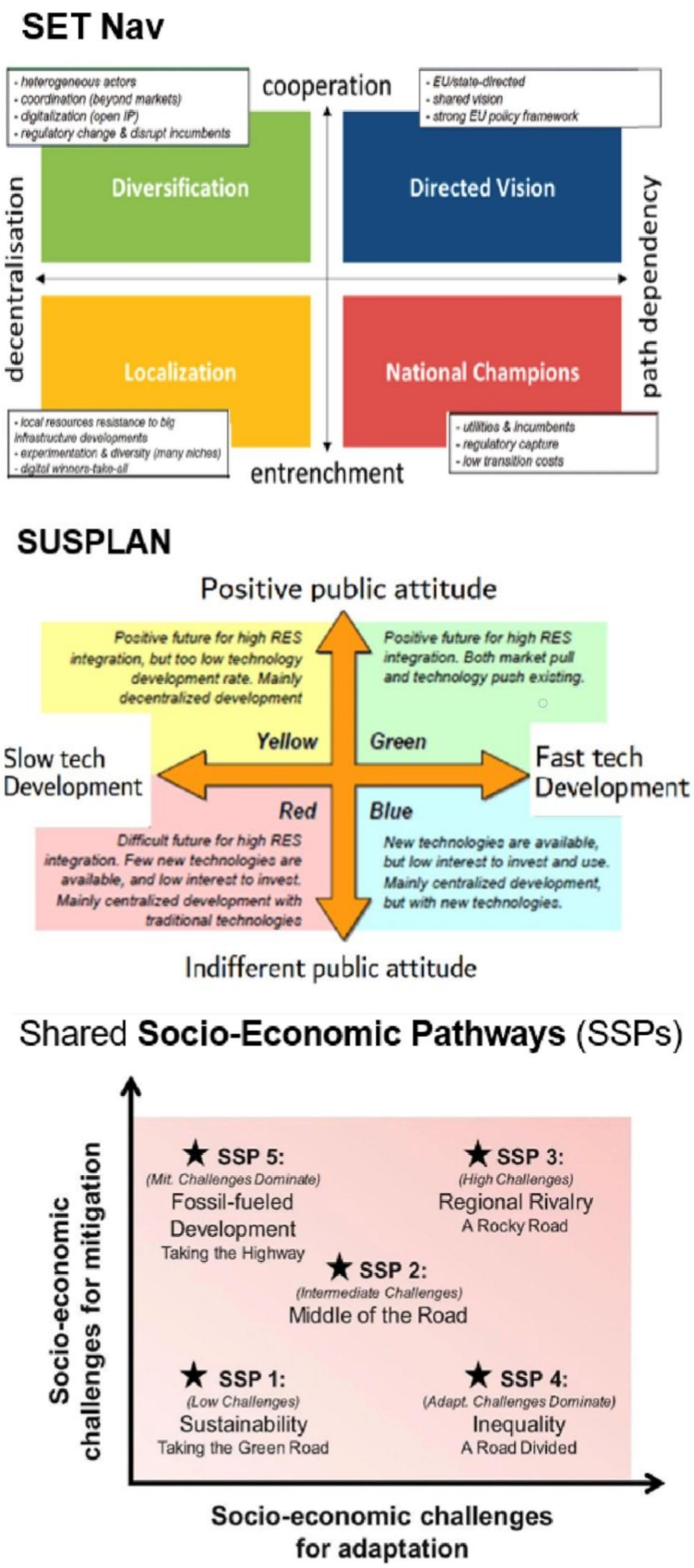

Fig. 1. Examples of widely-used 2 × 2 scenario typology to combine two main dimensions of uncertainty into four storylines spanning a wide possibility space [5]

In recent decades, global trends have seen a sustained and rapid growth in RES and an unprecedented pace of learning by organizations in generating electricity from solar and wind photovoltaics. Thanks to new technologies, which are now available at lower costs than those used by fossil fuel operators, the continued high growth rate of RES is certain. Verification of the hypothesis about achieving the dominance of photovoltaics and wind in global primary energy supplies by 2050 by applying "top-down" extrapolation of global trends gives positive results. Simulations of solar and wind energy deployment using a logistic substitution model containing a number of potentially fundamental limitations to further growth lead to the conclusion that there are no insurmountable constraints in terms of physical and raw material requirements, production capacity, energy balance, system integration and macroeconomic conditions. In addition, there is synergy with the direct capture and storage of carbon dioxide in the air that would achieve global zero CO_2 emissions by the middle of the century. However, achieving such an outcome would require a large-scale reconfiguration of the architecture of global and regional energy systems (Fig. 2). Cheap renewable primary electricity is likely to be an important factor driving the energy transformation. However, obstacles will remain, the overcoming of which will require foresight and strategic, coordinated actions due to the depth and dynamics of the transformation [6].

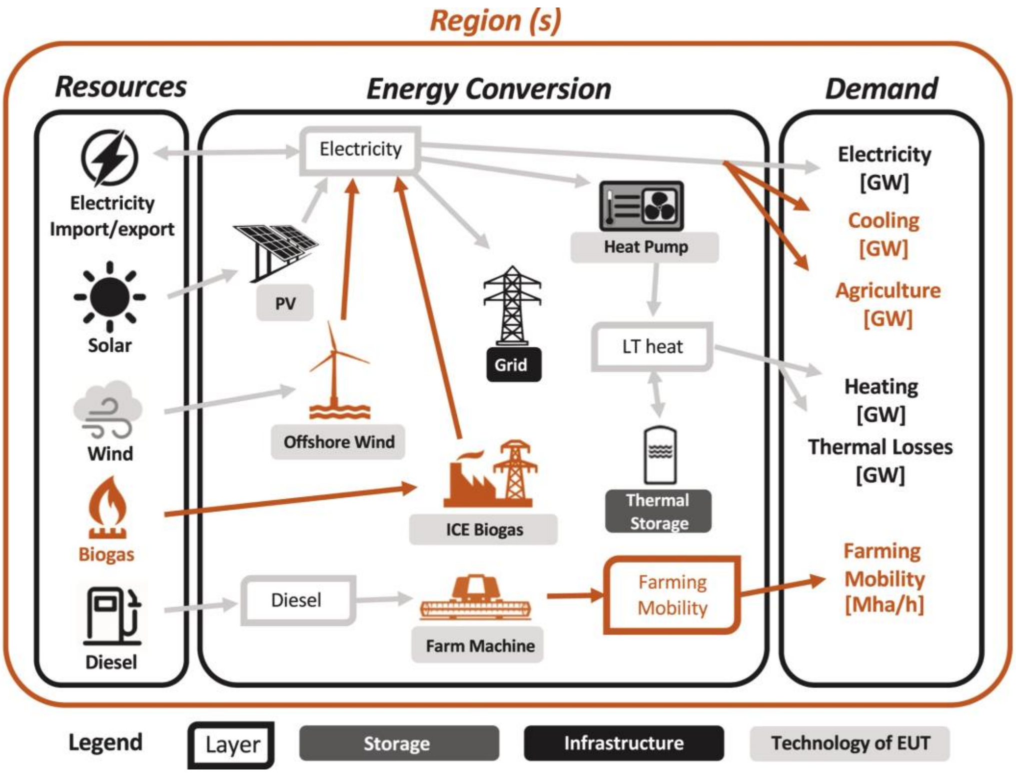

Fig. 2. Conceptual representation of a regionally-characterised national energy system: resources are converted by technologies to supply end-use demand in the different sectors (electricity, mobility, heating). Layers – such as electricity and LT heat – are defined as all the vectors in the system that need to be balanced in each period. The novel features of the regionalised EnergyScope version are highlighted in orange. Abbreviations: natural gas (NG), Internal Combustion Engine (ICE), photovoltaic (PV), low temperature (LT), end-use type (EUT) [6]

Deep decarbonization, meaning a transition to net-zero emissions energy systems, is made possible by modeling renewable energy technologies, storage and sector coupling. For example, you can use an extended and regionalized version of the EnergyScope software to be able to analyze the increasing complexity of energy systems and facilitate the selection process among the various possible transformation scenarios. The first Italian decarbonisation strategy feasibility model developed with regard to the uncertainty in the implementation of carbon capture and storage and renewable technologies shows that emissions can be [6] thanks to radical electrification of the energy system combined with a broad the use of renewable energy sources and efficient energy conversion technologies. An analysis of the synergies, advantages and disadvantages of the proposed approach with regard to alternative modeling approaches, used in recent deep decarbonisation research, shows that modeling the energy transition, using high computing efficiency programming tools and a snapshot approach, can justify transition scenarios by optimizing the energy transition path renewable [7].

The transformation to climate neutral energy systems is becoming a global challenge. In Poland, attempts are being made to improve planning capacity by combining generation expansion and short-term planning models into a single modeling system. An example is the combination of two models: TIMES-PL and MEDUSA, to design the road to carbon neutrality in the Polish power system. Three energy scenarios have been developed which show that by 2050 it is possible to reduce carbon dioxide emissions by 95% from the public electricity and heating sector. Detailed simulations of the power system operation have shown that load balancing is possible after installing 15-20 GW of electric power by 2050 in disposable energy technologies, next to energy storage and CHP plants [8].

Hydrogen is gaining in importance in the current global energy transition. There is growing enthusiasm and widespread enthusiasm for the hydrogen economy, as shown by economic and policy strategies currently under development that support carbon neutrality by 2030 and a swift clean energy transition. According to experts, green hydrogen has the potential to create a favorable cycle for future energy networks based on renewable energy sources. Hydrogen can provide much-needed flexibility to energy systems by acting as a buffer for non-dispatch renewable generation. The excess energy stored in hydrogen can be used to produce electricity (fuel cells or power systems), heat (combustion) or both (cogeneration), drastically reducing greenhouse gas emissions.

In the hydrogen scenario, it is important to plan the transformation of various sectors of the economy (transport, industry and energy) in order to achieve scale and synergy. The conducted analyzes indicate that hydrogen can effectively contribute to the achievement of the goal of carbon neutrality and, in the area of mobility, it can compete with lithium-ion batteries. The analyzes also show short-term solutions to reduce the carbon footprint of energy production. An example is the blending of fossil fuels with hydrogen where a combined cycle gas turbine power plant can achieve a significant reduction (0.28) using a 70% and 30% blend [9].

Problem sectors: gas, construction and transport

In Poland, the doctrine of gas diversification was adopted in the consensus of all political forces in the geopolitical context of rapid independence from gas supplies from Russia. It was concluded that the economic risks are weighed down in relation to the risk of cutting off supplies from the main direction. However, the objective function constructed in this way was severely tested when spot gas prices broke records at the turn of 21/22, which the Polish operator began to translate into the accounts of retail customers. This did not result in a revision of government centers in their approach to optimizing gas supplies and building a long-term strategy to decommission fossil fuels, but rather burdensome propaganda and conflicts in centers of political disposition. This leads to questions about the mechanisms leading to the hardening of the adopted doctrine of gas diversification.

The ongoing research into the interests of natural gas in the context of climate action in the European Union provides interesting insights. Initially, it was difficult to determine whether climate policy would reduce or increase the role of natural gas in the energy system. It is widely accepted that gas is a transition fuel during decarbonisation, meaning that it can briefly replace the more emissive fossil fuels such as coal. This narrative perpetuated the forms of power of incumbent natural gas operators, including control of resources, infrastructure and involvement in the policy-making process. Gas operators assumed that they were able to apply adaptive strategies for the transition to a low-emission energy system. However, the EU tightened its climate targets, which forced incumbent gas operators to modify the political discourse in the changing context of the fuel market. Research shows how incumbent operators use their material, organizational and discursive power to expand the status quo and adapt to pressures to introduce far-reaching changes to transformation scenarios. The process, known as "trasformismo" (Gramsci), is the natural gas industry's response to climate action that determines the political discourse shaping the trajectory of the gas energy transition [10].

The construction sector is a huge challenge, as it plays a key role in the energy transition and the reduction of carbon dioxide emissions. Capturing the dynamic CO_2 emission characteristics of building materials is a great problem during the entire life cycle of a building. In the Netherlands, research was carried out on the basis of a dynamic building stock model that combines dynamic material flow analysis with energy modeling of buildings. The environmental impact of material and energy requirements has been assessed taking into account the future electricity mix in the path towards climate neutral and energy supply of residential buildings in the Netherlands by 2050. The research results are very optimistic and show that the demand for space heating is declining by around 2 / 3 by 2050 and 80% of the electricity from the public grid for appliances and lighting could potentially be replaced if rooftop PV systems are installed on 50% of refurbished buildings and all new buildings. Greenhouse gas (GHG) emissions from operating energy will be reduced by 60-90%, depending on the adopted energy mix [11].

In the light of the Paris Agreement, road transport from issue is a segment of human activity that is extremely difficult to transform. Achieving ambitious emission reduction targets in the European transport sector requires a rapid transition to carbon-free technologies. Relative cost competitiveness analyzes of commercial vehicles constructed with different alternative propulsion technologies through the Total Cost of Ownership (TCO) assessment are needed to assist policymakers in accelerating the carbon-free transition to road transport. The research carried out in this area allowed for the identification of key parameters which, after appropriate targeting, enabled the use of more sustainable niche technologies. The assessment was based on a newly developed database of cost parameters that were triangulated during expert interviews. Scientific research shows that the cost competitiveness of low-emission or zero-emission niche technologies in some application segments in European countries is already visible today. In particular, battery electric vehicles were found to be very promising in the light and medium truck segment, but also in the heavy long-distance segments in countries that have introduced targeted support measures. Three TCO parameters drive this competitiveness of low-emission mobility: tolls, fuel costs and CAPEX subsidies. Following the analyzes, recommendations were made to make policy makers more focused on the OPEX parameter than on the CAPEX parameter, and use a combination of different state support instruments to ensure greater coverage, increased policy efficiency and flexibility [12].

Impact of the COVID-19 pandemic on the energy transition

The COVID-19 pandemic has raised important questions about energy. The pandemic shock initially led to emissions reductions in line with the rate of decline required to achieve the goals of the Paris Agreement. These unforeseen drastic emission reductions proved temporary as they did not involve major structural changes. However, the subsequent consequences of COVID-19 and the political response had an impact on the global economy. In the EU, recovery plans have provided an opportunity to deepen the path towards a low-carbon economy, while seeking to improve employment, health and equity and enhancing the role of modeling tools. Long-term adaptation to the low-carbon path and the development of a pandemic resilient transition to renewables has put in place policy mechanisms to help energy-intensive sectors such as transport, tourism and the automotive industry reduce CO_2 emissions. Despite the risk of an increase in emissions following a pandemic, current energy-socio-economic-environmental modeling tools allow for broadening the scope and tackling these complex issues of the energy transition. The research community is now able to assess distinct and unusual scenarios such as sector and country lockouts, drastic changes in consumption patterns, significant investments in renewables and breakthrough technologies, and conduct an uncertainty analysis. All of these instruments are capable of assessing the cost-effectiveness of decarbonisation options and the potential consequences for employment and income distribution [13].

The COVID-19 pandemic has highlighted the challenges awaiting the energy transition, but also the opportunities for its development. The main obstacles to the pandemic's impact on renewable energy transformation are the lack of investment and weak market demand. First, renewable energy projects suffer from high start-up costs and technical investment as a result of significant reductions in government subsidies. Second, the lower price of fossil fuels further increases the difficulty of selling fossil fuels. Third, the reduction of industrial activity leads to a decrease in the demand for renewable energy equipment, slowing down the growth of renewable energy production capacity. Fourth, the

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global renewable energy supply chain has been disrupted by mandatory trade restrictions, making it difficult to implement new projects. Finally, during a pandemic, energy poverty is more pressing than ever, making the transition to renewable energy more difficult. The COVID-19 pandemic has also created a unique opportunity to switch to renewable energy. First, the risk of investing in fossil fuels has increased dramatically as global demand for fossil fuels has plummeted. Second, governments have unprecedented implementation capacity to implement energy reform policies and legislation during an economic recovery. Third, the unique benefits of renewable energy enabling remote operation and digital intelligence provide an excellent opportunity to replace fossil fuels with renewable energy during a pandemic [14].

The coronavirus pandemic has further led to an increased use of online tools across society, both in business, education and in everyday life. This shift to an online society has prompted researchers to reflect on the extent of public control and surveillance and the forms of enforcing compliance with official ways of thinking, attitudes and behaviors through online activities. On the other hand, the process of spreading smart energy systems around the world has started with the increased use of smart meters in energy systems. Research on intelligent energy systems and current trends in energy policy allowed for the formulation of recommendations regarding the development of energy democracy and democratic legitimacy in the context of the possible impact of intelligent technologies on Community energy systems [15].

In Poland there is a meaningful increase of RES in the system despite the pandemic situation. The increase is also visible among microinstallations in households of which there were about 350,000 in Poland at the end of 2020. It brings the phenomenon called ”duck curve”, consisting in low energy consumption from the power grid (correlated with the simultaneous delivery of the produced PV energy to the grid) during the day and relatively high energy consumption in the evening which is the next challenge for transformation [16].

2.2. Program initiatives

Popczyk's concept

Jan Popczyk proposed a coherent concept for the transformation of the entire energy sector based on fossil fuels towards electroprosumerism (an economy without fossil fuels, also without nuclear energy) before 2050. The concept is universal, but clearly focused specifically on Poland. According to Professor Popczyk, the energy transformation in the breakthrough (innovative) mode should be based on scientific foundations, defined by the paradigmatic three: (1) the eclectic electro-consumerist paradigm and two hard paradigms, i.e. (2) exergy and (3) virtualization. The concept also has three broad dimensions: economic, social and environmental (nature and climate). The concept consists of 51 program postulates that can be creatively confronted with the EU energy transformation plans and in the global context (American in the Euro-Atlantic zone and Chinese in the socialist market economy) [17].

10 steps of the Energy Forum

Forum Energii is an independent Think Tank, the purpose of which is to support the transformation of the Polish energy sector. As a result of many years of work, 10 steps to overcome the crisis have been presented, each of the proposed points has its justification in in-depth analyzes. According to the authors, a plan based on the presented steps can be prepared in two years. Forum Energii invites further groups of experts, politicians and non-governmental organizations to discuss and wants to build a broad consensus around the energy sector [18].

Instrat Foundation

The independent foundation dealing with energy issues believes that the share of renewable energy in Poland in the electricity sector may be increased to 61% in 2030, in heating and cooling from up to 32.5%, and in transport from 14% up to 15%. This requires regulatory changes, especially those specifying support for PV, the abolition of the 10H rule on wind energy and timely actions related to the construction of offshore wind turbines [19].

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Jagiellonian Institute

The institute, which is an independent analytical center, a center for the exchange of views and strategy building, recommends a thorough restructuring of the energy sector, pointing to imperfections causing overstated costs of the current energy sector, e.g. excessive employment, low efficiency and inadequate qualifications, maintaining redundant or multiplied organizational units, improper purchasing policy, pathology - e.g. in fuel supply, scrap management, management of coal combustion by-products, maintenance of the network or just simple theft, inadequate internal communication and politics social dialogue, the tendency to defend "possessions" by various interest groups [20].

Five ZKlaster's strategic initiatives

During the ZKlaster analytical workshop on 17/01/2022, five initiatives were formulated that should receive funding from the KPO. These are:

1) Support for the development of energy communities (microgrids).
2) Development of independent energy distributors equipped with energy storage.
3) Strategic management of hydrogen projects with experimental clauses.
4) Financing systemic energy storage services.
5) Development of green heating with the circular CO_2 cycle.

3. Discussion of the directions of transformation

When analyzing the possible directions of transformation, several scenarios appear for Poland. When we talk about the energy transformation, three positions are clear. The first of them talks about the immediate need to develop nuclear-based energy, and about renewable energy sources as supplementary sources. This direction seems difficult for several reasons. Western European countries have started the process of abandoning this type of energy, and their negative approach to creating new nuclear power plants may effectively block this process in Poland. In addition, the construction of such power plants is very time-consuming and expensive, and observing the construction of recently launched nuclear units in European countries, each time it takes longer than planned, multiplying the costs at the same time. This may result in a reduction of investments in renewable energy sources with the simultaneous risk that the power plant will not be put into operation on time, and therefore it will expose Poland to loss of energy security and collapse of the stability of supplies. The last important aspect of nuclear power plants is the storage of radioactive waste, which poses a real threat to people and the environment.

The second position, strongly advocated by politicians, tries to base the transformation on small, prosumer energy sources. This doctrine wants to prove that the energy security of the society and green energy transformation can be based on renewable sources installed at each house or on the roofs of multi-family blocks, thermal modernization of buildings and small energy storage facilities. This solution does not take into account the fluctuating energy demand of residential buildings, a poorly developed power network that is not able to operate effectively in two directions (receiving and delivering energy) and the constant, large needs of industry and services for electricity. This is also the worst option for cost reasons. Here we can compare the costs of an industrial photovoltaic installation with a capacity of 1 MW and a total of prosumer installations with a capacity of 1 MW. According to data from Zklaster, 1 MW of an industrial installation currently costs PLN 2.4 million (about 0.6 million EUR), compared to a photovoltaic prosumer installation where 10 kW is a cost of PLN 40,000 (about 9,000 EUR) upwards, which means a minimum of PLN 4 million per 1 MW (about 900,000 EUR) [21]. This means that with significant shortages of RES energy, investing in smaller sources, apart from educational and political activities, is unjustified and may lead to further increases in electricity prices for the general public, mainly for industry and services, which will directly translate into their prices. To sum up, if we continue to invest domestic money in prosumer energy instead of large sources, we will not cause a significant increase in the amount of green energy in the national energy mix, for which end consumers will pay in the prices of products and services anyway.

The third direction is to create a hybrid solution based solely on renewable energy sources and energy storage systems, assuming that energy will be sent from the recipient as short as possible. This requires the creation of regions for distributed production of renewable energy that will strive for maximum self-balancing. In this case, the emphasis is on the largest possible renewable energy sources combined with all possible energy storage systems. We are talking here about technologies that use water, wind and sun, as well as hydrogen to generate and make the best use of electricity and heat in the emerging microgrids. Such a system would meet the requirements of EU directives and seem to have the lowest risk. Moreover, it is possible to find potential domestic and foreign investors to finance investments.

An important aspect for the discussion is the transformation of society, including the current employees related to the coal economy. In this case, maintaining unprofitable jobs, instead of preparing them for a smooth transition to modern technology sectors, may cause a significant crisis on the labor market. If you take into account modern sectors and Industry 4.0, they require highly qualified human resources, providing well-paid jobs in return.

4. Conclusions

The global direction resulting from the care for the natural environment and the prevention of natural disasters occurring due to the significant emission of CO_2 into the atmosphere by humanity has already been given. We are talking not only about Europe, but also China, the Arab Emirates and the USA. More countries are joining efforts to reduce CO_2 emissions, the largest producer of which is industry, including coal-fired power plants. Despite the considerable resistance of the incumbent operators, who are afraid of changes, which is completely natural, there is currently no possibility for Poland to deviate from the goals set by the European community in the collection of documents under the collective name of Fit for 55. The only unknown is the moment when very rapid changes begin, because due to many years of shortcomings in preparing for transformation, Poland no longer has time to slowly enter the situation of change.

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Publisher: **KOMAG Institute of Mining Technology, Poland**