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Climate Risk: Reshaping the Energy Sector

Abstract

Objective: Climate risk is one of the major challenges for the energy sector globally. The energy transition and the struggle against climate change are putting increasing pressure on energy entities as well as create a need for action to mitigate climate risks. The purpose of this article is to characterise climate risk in the energy sector, with a focus on the electric power sector, as well as to review their impact on the functioning of energy entities.

Research Design & Methods: This article reviews the literature and uses publicly available data on the operation of the electricity system and the price of CO_2 emission allowances in the EU ETS so as to characterise the impact of climate risk on the energy sector with a particular focus on the Polish electricity sector.

Findings: Climate risk is one of the most important risks determining the functioning of entities in the energy sector and affecting the energy transition. It manifests itself in the form of the emergence of a set of new risks: carbon risk, weather risk, financial risk, regulatory risk, and social risk, all of which directly affect energy operators and reshape the energy sector.

Implications/Recommendations: The above creates the need to adapt and adjust to current market trends as well as the need to mitigate climate risks in order to keep a market position. It is, therefore, necessary to implement climate risk management measures to adapt the company's operations to changing market realities and an increasing exposure to climate risk. The results of the study can be used by policymakers and decision-makers responsible for energy policy and companies' strategy related to energy transition and compliance with the ESG standards.

Contribution/Value added: The research contributes to the field of climate risk in the energy sector. The value added of the paper is the interdisciplinary approach to a broad concept of climate risk, consisting both of transition and physical risks, with a detailed analysis about its influence on the energy sector.

Article classification: theoretical paper

Keywords: climate risk, energy transition, transition risk, energy sector

JEL classification: Q40, Q540, G32

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Introduction

Climate change is one of the greatest challenges facing the economy today. The range of impacts of climate change is remarkably wide and imprints its mark on many areas of life. Tackling climate change requires decisive action to reduce its negative impacts.

Risk in the energy sector is an exceptionally broad concept, referring to the many risks affecting the operation of the industry. This article addresses the climate risk present in the energy sector. This risk is currently one of the biggest challenges facing the sector (Kouloukoui et al., 2019, pp. 1-2). An inadequate mitigation of climate risk can lead energy-based entities to loss of competitive advantage, reduced financial performance, and, ultimately, bankruptcy. Therefore, a key element in the activities of entities in the energy sector is the proper analysis of climate risk exposure and the implementation of climate risk management for its mitigation. The ongoing energy transition will pose challenges to the entire sector, and those who do not participate will see their market position deteriorate over time. This will mainly be due to exposure to climate risk (Kouloukoui et al., 2019; Sobik, 2022).

This article characterises risks in the energy sector, with a particular focus on the Polish electricity sector. The climate risk specifics are then described. Climate risk is presented in the form of connections to the following risks affecting the electricity sector (Sobik, 2022, pp. 148–149):

- carbon risk;
- weather risk;
- financial risk;
- regulatory risk;
- social risk.

The aim of this article is to characterise climate risk in the energy sector, focusing particularly on the electricity sector, as well as to highlight the relationship of climate risk to the above-mentioned risks and to review their impact on the functioning of energy entities in the era of energy transition.

Material and methods

The methods used in this research include literature review and data analysis. This article uses a literature review of risks in the energy sector and climate risk, as well as other types of risks related with the climate risk: carbon risk, weather risk, financial risk, regulatory risk, and social risk. Publicly available data on the operation of the electric power system and the price of CO_2 emission allowances in the EU ETS was also used. The paper refers to economic and technical literature analysing the issue of climate risk in the broadest sense. The used research methods include a qualitative analysis and a comparative analysis of scientific articles and reports relating to the issues addressed in this publication.

Risk in the energy sector

There is no single definition of risk in the literature due to the heterogeneity of this concept (Adamska, 2009, p. 11; Rogowski, 2018, p. 178). Most definitions associate risk with an unfavourable deviation from predicted values (Rogowski, 2018, p. 179). The literature also distinguishes two approaches to risk – it is understood both as the danger of a negative event occurring and incurring a loss (the defensive approach) and as the chance of achieving better results than expected (the offensive approach) (Rogowski, 2018, pp. 178–179). However, it should also be made clear that risk is not the same as uncertainty, which is a non-measurable concept and the theory of probability calculus does not apply to it.

When it comes to classifying risks, one can distinguish between symmetrical and asymmetrical, short- and long-term, permanent and one-off, as well as specific and systematic risks (Rogowski, 2018, pp. 182–185). The functioning of entities in the energy sector means that they have to deal with many types of risk. The specific nature of energy market activities – and in particular the ongoing energy-climate transition – means that energy companies have to face not only the risk of conducting day-to-day operations, but also the risk of systemic changes aimed at adapting the functioning of energy companies to the new reality resulting from the energy-climate transition. The degree to which they adapt to the market and are active in changing e.g. the energy mix or the economics of electricity production will determine their competitiveness and market position in the future.

In the era of energy transition, taking place basically at all levels of the functioning of energy entities, there is often a situation related to the perception of risk as an opportunity – i.e. a risk that the entity cannot afford not to take. It occurs at breakthrough moments, i.e. those that have a dramatic impact on the economic situation and potential of the company (Karmańska, 2008, p. 30). Failure to take this risk may lead, in the short or long term, to a loss of competitiveness by the enterprise or even to its bankruptcy (Rogowski, 2018, p. 183). The energy sector faces precisely this kind of risk; the failure of energy companies to seize the opportunity may lead to their unprofitability, uncompetitiveness, and, consequently, to their bankruptcy. The adaptation of energy companies to the current market situation is dictated not only by climate issues, but also by the need to adapt to market conditions in order to remain competitive and maintain market share.

Sources of risk in the activities of the company can be generally presented in the form of internal and external sources, which may be divided into those related to the close environment of the business entity (micro-environment) and those related to the further environment (macro-environment), which is beyond the company's control (Figure 1) (Karmańska, 2008, pp. 12–13).

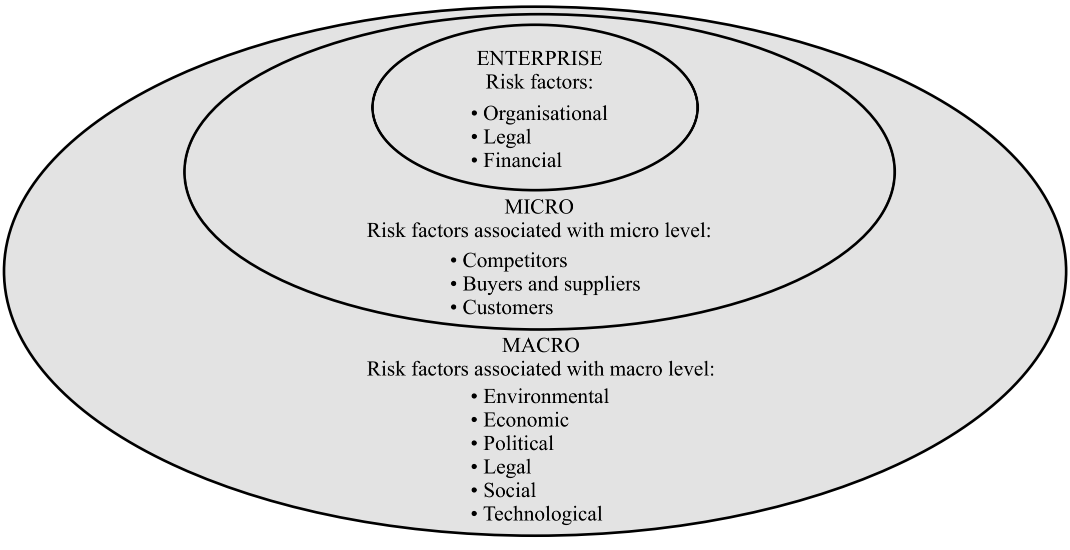

Figure 1. Sources of risk in company performance

Source: Own study based on Karmańska, 2008, pp. 12–13.

Internal risk factors, i.e. those occurring within the company, are related, for example, to organisational issues (work efficiency), legal issues (risks of illegal actions), or financial issues (company's financing structure, profitability, and liquidity).

External risk factors related to the micro-environment, i.e. the close environment of the enterprise, may include aspects related to the activity of competitors on the market, customers and suppliers, as well as customers. These aspects have a significant impact on the financial situation of the enterprise – high competition may lead to the erosion of market shares, while the lack of collection of receivables from customers or delays in payment to suppliers may adversely affect the liquidity of the enterprise and may threaten with bankruptcy.

External factors originating from the further environment of the company (the so-called macro-environment) do not depend on the company and have no influence on them. Hence, it is important to analyse these risk factors in order to be able to optimally mitigate them. These types of risk factors can include the following aspects:

- environmental – climate change, natural disasters, climate and environmental protection;
- economic – economic situation, inflation, interest rates, situation on the capital and currency markets, prices of energy resources;
- political – the implementation of economic, energy and climate policy, favouring specific industries, the implementation of policy at the European level;
- legal – the introduction of new legislation, restrictions, or deregulation;
- social – society's views on energy technologies and the environment, greater awareness of environmental issues;
- technological – the emergence of new technologies, opportunities (higher efficiency, lower cost), threats (capital-intensive investments, decreased competitiveness in relation to other market entities).

These factors are often intertwined to create synergies. An example is the increasing interaction of economic aspects with environmental aspects and political aspects with legal aspects through the use of effective tools to combat climate change.

Climate risk in the energy sector – characteristics

According to the report by the Intergovernmental Panel on Climate Change (IPCC), the impact of human activities on the warming of the atmosphere, land, and oceans is indisputable (IPCC, 2021, p. 4). The impact of global climate fluctuations on the formation of new risk areas is worldwide (Magnan et al., 2021, p. 880). The energy and climate policy pursued by the European Union is part of a global trend of combating and adapting to climate change. Hence the range of actions taken to slow the rate of increase in global average air temperature.

The multiplicity of climate elements affecting the functioning of people and economic entities – alongside the still ongoing scientific research on estimating the magnitude of human influence on the dynamics of climate-forming processes – means that a precise estimate of the risk associated with the impact of climate change is not feasible at this stage. The consequences of climate change vary throughout the world due to geographical factors.

Climate is a general term, it covers the overall meteorological phenomena that occur in a given area in the long term, on the basis of numerous years of observation. The special importance of climate is manifested by the fact that the effects of its changes have significant consequences not only in the ecological element, but also in social, political, and economic dimensions (Trocka, 2021, pp. 178–179). In the context of climate change, the inherent risk associated with the law of large numbers materialises (Burchard-Dziubińska, 2020, p. 161).

Climate risk is a very broad and complex concept, making it difficult both to define precisely and to quantify. Nevertheless, in general terms, climate risk could be defined as a set of risks induced by climate change (Charpentier, 2008, p. 91; Sobik, 2022, p. 148). The IPCC understood it as a climate-related effect of the interaction of hazards, vulnerability, and exposure (Jurgilevich et al., 2017, p. 3). Climate-related risks, which are a subcategory of sustainability risks, could be broken down into transition risks and physical risks, according to some authors (e.g. Hoffart et al., 2022, p. 2). Additionally, climate risk impacts the financial system through climate-related transition risks. Thus, climate risks are transmitted to the financial system and must be mitigated (Hoffart et al., 2022, p. 5). In the following part of the article, a set of new risks caused by the materialisation of climate risk (both transition and physical) will be analysed, as they particularly affect the electricity sector.

Climate risk and carbon risk

A major climate risk factor is the burning of fossil fuels and the resulting carbon dioxide (CO_2) emissions. The use of coal in power generation or other fossil fuels results in pollutants being emitted into the atmosphere, which have a negative impact on the climate. Basing the electricity generation sector on hard coal and lignite (which is still common in Central and Eastern European countries) causes a significant increase in climate risks. As part of its energy and climate policy, the European Union introduced the CO_2 Emission Trading Scheme (EU ETS) in 2005, which is a keystone of the European climate policy designed to help reduce CO_2 emissions and contribute to the implementation of the Kyoto Protocol (Convery, 2009, p. 407). The latest EU ETS reform, introduced in 2018, has meant that the emissions cap is no longer determined by a political decision, but also depends on the surplus of emission allowances and other aggregate variables. Consequently, EU policymakers have lost direct control over long-term cumulative CO_2 emissions (Beck & Kruse-Andersen, 2020, p. 806). Furthermore, between 2020 and 2021, an increased interest in the EU ETS market was observed among investment and hedge funds. Between November 2020 and April 2021, the number of net open positions in the EU ETS futures market increased by 240%. These years also saw a significant inflow of funds into Exchange-Traded Funds (ETFs) (Lizak, 2021, pp. 15–16). The above factors related to the involvement of entities with no obligation to account for emissions in the EU ETS became price impulses influencing the sharp increase in allowance prices in 2020–2021. Starting from November 2020, allowance prices began to grow rapidly – counting up to December 2021, the price increase amounted to as much as 270% (Lizak, 2021, p. 10). The reasons for such a rapid increase, apart from the much greater involvement of investment and hedge funds, include the rebound in demand after lockdown periods in Europe, as well as extremely high prices of energy raw materials in Europe. The increase in natural gas and hard coal prices recorded between November 2020 and December 2021 amounted to approximately 568% and 119%, respectively (Lizak, 2021, p. 11). Such a sharp increase was triggered by greater global demand resulting from the recovery of the world economy after the COVID-19 pandemic. A significant factor in the case of natural gas was the very low level of filling gas storage facilities in Europe. In the case of hard coal, this was due to restrictions in coal supply as well as record demand for this raw material, resulting, among other things, from the energy crisis in China. As a result of such a sharp increase in natural gas prices, energy entities boosted the production of energy from other energy sources, including hard coal, putting upward pressure on the price of CO_2 emission allowances. The increases were also fuelled by a decline in wind generation in Europe (due to a decrease in windiness), which made it necessary for conventional energy sources to produce. Therefore, the climate factor has had a direct impact on energy commodity prices.

The price level of the EU ETS CO_2 emission allowances is a key element of climate risk for energy companies. Figure 2 on the next page shows the EU ETS Carbon Permits prices from 2020 to August 2023.

CO_2 allowance prices tripled over the period of 2020–2022. In November 2020, prices broke out of their consolidation in the area of 25–30 EUR/tCO_2 and in December 2021, the ceiling of 90 EUR/tCO_2 was reached. Such a sharp increase significantly affected energy companies that use fossil fuels to a large extent. It even exceeded the European Commission's estimate that the 85 EUR/tCO_2 level would not be reached until 2030 (European Commission, 2021, p. 580), as well as the assumptions of Poland's Energy Policy until 2040, which set CO_2 emission allowance prices in 2040 at 40 EUR/t CO_2 (Ministry of Climate and the Environment, 2021, p. 7). The Russian aggression against Ukraine and the related turbulence in energy markets are responsible for the sharp drop in CO_2 allowance prices in February and March 2022. CO_2 allowance prices are currently a large cost component of energy companies using fossil fuels to generate electricity. The energy and geopolitical crisis in Europe as well as the panic in the natural gas market in August 2022 led to record electricity and gas prices on the one hand, but on the other hand, they resulted in a strong fall in the price of CO_2 emission allowances in the EU ETS. However, the correction was only short-term – further down the line, the EU ETS Carbon Permits prices broke through the psychological barrier of 100 EUR/tCO_2 in 2023, consolidating around 90 EUR/tCO_2. Moreover, in connection with the work on the introduction of the „Fit for 55" package, aimed at intensifying the EU climate policy and extending the ETS system to new sectors, an upward trend in the prices of CO_2 emission allowances is likely to continue in the coming years. Rapid increases in the CO_2 market will influence the acceleration of decarbonisation processes due to the decreasing economic efficiency of emission sources. However, the above trend poses a serious threat to companies which base their manufacturing activities on hard coal and lignite.

The climate risk of having coal assets in the generation mix has led to these power plants being called ‚toxic assets'. Owning coal units is viewed poorly by lenders, the market, and – in the face of record high CO_2 allowance prices – it generates ever higher costs. This results in an ever higher Levelised Cost of Electricity (LCOE) and makes it permanently uncompetitive with renewable energy sources (RES)[1].

Basing power generation activities of energy entities on low- and zero-emission energy technologies makes it possible to minimise risks related to price fluctuations on the EU ETS market. Moving away from fossil fuels also mitigates the risks associated with volatile energy commodity prices. Entities that rely on fossil fuels are largely aware that climate policies against CO_2 emissions will have a significant impact on their costs and market position (Kolk et al., 2008, p. 724). Therefore, energy companies are changing their strategy towards the development

[1] However, the dependence of energy systems on conventional energy sources (coal, gas, nuclear power) should be emphasised here in order to balance the functioning of the system in the absence of generation from RES. Therefore, the abandonment of fossil fuels should be carried out in an orderly manner and with energy security in mind. However, this issue will not be discussed further in this article.

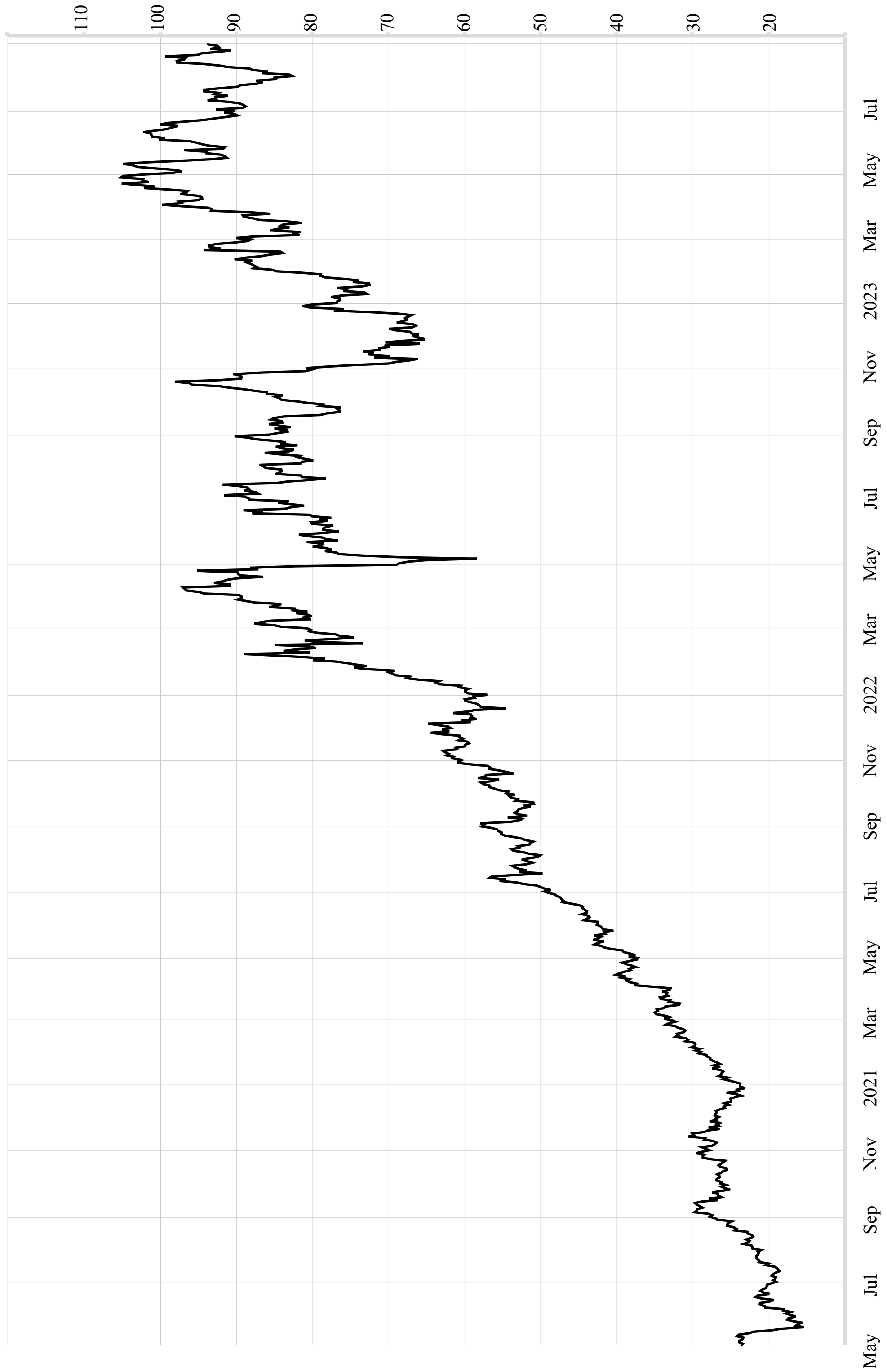

Figure 2. EU ETS Carbon Permits from 2020 to August 2023.

Source: Tradingeconomics database, available at: https://tradingeconomics.com/commodity/carbon [accessed: 31.08.2023].

of green energy technologies and are increasingly guided by sustainable energy development in their operations. An example of this is the decision of the Czech energy group ČEZ to sell its coal assets in Poland (hard coal-fired power plants and CHPs) in order to monetise them and reduce its carbon footprint due to a change in strategy and a shift towards green energy.

The weather risk of climatic anomalies and natural disasters

Weather risk is related to the exposure of an enterprise's activities to meteorological factors. Meteorological phenomena associated with weather risk can be divided into non-catastrophic and catastrophic (Blachowski, 2011, pp. 639–640). Non-catastrophic phenomena are broadly defined climatic anomalies[2]. On the other hand, catastrophic phenomena, as their name suggests, are associated with the occurrence of natural disasters such as floods, droughts, or hurricanes. Distinguishing between these two types of phenomena is important due to the different ways of hedging against them – in the case of catastrophic phenomena, these are insurance, and in the case of non-catastrophic, these are weather derivatives (Blachowski, 2011, pp. 640–641).

One element of climate risk may be the weather risk associated with anomalies that are unusual for particular climate zones. Examples include a drop in wind that is unusual for a given climate zone or season, heat waves, or the occurrence of droughts and very low water levels. They have a direct impact on the functioning of the energy sector, usually affecting the ability to generate electricity. They also affect the behaviour of energy consumers and the entire electric power system. Examples include the increased popularity of air conditioners in Europe during the summer, which translates into a noticeable upward trend in electricity demand. The most effective solution to mitigate such risks is to adequately diversify the structure of electricity generation so that a single meteorological event cannot have a major impact on the generation of a large part of an entity's electricity.

Climate risk is also the risk associated with the occurrence of natural disasters, whose impact on the economy is clearly negative (Fang et al., 2019, pp. 1455–1456). They cause huge financial losses and clearly have a negative impact on energy sector entities. Due to the character of natural disasters, it is not possible to prevent them effectively; the only possibility is to carry out actions aimed at protecting the climate and translating largely into a decrease in the occurrence of climate-induced natural disasters.

The risk of climatic anomalies and natural disasters is reflected in the company's capital market valuation and value. High exposure to this risk or the occurrence of damage to energy infrastructure negatively affects the market perception of the company and may cause the erosion of its value (e.g. in the form of EVA – Economic Value Added). Consequently, it may contribute to a deterioration of the financial situation and an increase in the cost of capital. Thus, the risk of climatic anomalies and natural disasters translates into the materialisation of financial risk.

Climate risk and financial risk

The core of climate risk results in its inextricable integration with financial risk (Giglio et al., 2021, p. 16). The impact of climate risk on the financial aspects of an energy company's

[2] Climatic anomalies constitute a deviation from the norm for a given climatic zone, determined on the basis of long-term meteorological measurements.

operation is steadily increasing. The concepts of sustainability and action to protect the climate have been reflected in finance.

Sustainable financing is understood as financial support for sustainable development at three levels: social, economic, and environmental (Ryszawska, 2016, p. 188). Thus, in general, it is related to financing activities aimed at implementing the idea of sustainable development in practice across many areas of socioeconomic life.

In the literature, there also exists the concept of „climate finance", understood as financing the mitigation of or adaptation to ongoing climate change (Hong et al., 2020, p. 1011). According to this definition, the development of energy and climate policies to address climate change will result in even greater climate pressure on financial and economic aspects. An example of such a relationship can be seen in the impact of dynamic increases in the price of CO_2 emission allowances on the cost structure of energy companies, as presented above.

Another term indicating the intertwining of climate and financial aspects is „green finance", which, however, is not precisely defined – it generally refers to financing investments in green energy, supporting green initiatives, encouraging transformation towards a green economy, and reducing negative environmental pressure (Ryszawska, 2016, p. 188). One example of the implementation of green finance in practice includes green bonds used to finance investments in renewable energy sources.

Climate risk is also associated with the risk of a decline in the credit rating of energy companies and an increase in the cost of raising debt and capital market valuations. Companies exposed to fluctuations in the price of CO_2 emissions allowances – as well as those basing their energy mix on coal – receive a worse credit rating and their costs of raising debt are higher when compared to green companies. Thus, there is a significant relationship between climate risk and credit risk exposure (Seltzer et al., 2021, p. 2). A worse credit rating and a rising cost of capital both act as a negative feedback loop, inhibiting investment in emitting energy technologies. The risks associated with emitting CO_2 and basing electricity generation on coal are also reflected in a company's capital market capitalisation and affect its value. Companies heavily exposed to this risk have lower capitalisation and value.

The investments of energy companies are also exposed to risks related to the forecast of future cash flows, which directly affects the result of the investment efficiency calculation and, consequently, may affect the cost of capital. The possibility of large fluctuations in future cash flows is related to the risk of events such as large price increases in the EU ETS market, demand or supply shocks, deviation of the LCOE from the assumed value, or the need to adapt installations to new environmental requirements (Chen & Silva Gao, 2012, pp. 2–3). The above climate aspects are, therefore, reflected in the financial terms of the investment.

From an economic point of view, investments in emission-intensive energy technologies (especially those using hard coal and lignite) are characterised by high risks related to the economic viability of the investment and are strongly exposed to climate risks. The future financial flows generated by a coal-fired power plant may be even more at risk due to the loss of competitiveness of these energy sources in light of the rising the LCOE of coal-fired power (mainly due to rising the EU ETS prices), as well as the falling the LCOE of RES (Timilsina & Shah, 2020, p. 1). Given the high level of climate risk and, consequently, the significant exposure to financial risk, the world's largest investment banks are withdrawing from financing investments in coal power (Kolk et al., 2008, p. 724). Similarly, investments in gas-fired power plants, due to their carbon intensity, are no longer supported by the European Bank for Reconstruction and Development

(EBRD) or the European Investment Bank (EIB). Moving away from supporting natural gas as a transitional resource to support the energy transition towards green energy can be a challenge especially for CEE countries that are only at the initial stage of the energy transition.

The last investment in a hard coal-fired power plant in the European Union was to be the new Ostrołęka power plant in Poland. From the very beginning, the investment faced difficulties in putting the financial arrangements together. None of the commercial banks wanted to get involved in the project due to the fact that the investment was in contradiction with the current decarbonisation policy and also due to the high degree of climate risk. The efficiency calculation of the investment in the Ostrołęka coal-fired power plant indicated from the outset that it would not meet the basic criteria for economic viability (Krupiński et al., 2019, p. 77). Both the net present value (NPV) and net present value ratio (NPVR) of this investment were negative. The investment encountered serious problems in finding sources of financing and completing the financial assembly. Both commercial banks and international and national financial institutions refused to finance it, which would have forced the Special Purpose Vehicle (SPV) to seek capital at a higher cost. This, in turn, would have implied a further deterioration of the financial projection and could have further worsened the NPV result. Despite the negative result of the investment efficiency account, and without completing the financial assembly, the decision was taken at the end of 2018 to start the construction of the power plant. However, after just over a year, construction was suspended in February 2020. By ignoring the climate risk, which directly exposed the project to financial risk, the result of such an investment was only sunk costs. Design work is currently underway for the construction of a gas-fired power plant in Ostrołęka. The above example shows the consequences of ignoring climate risk in decisions taken by energy companies.

Climate risk and regulatory risk

Regulatory risk, implied by pursuing the energy and climate policy, is a particularly important risk that affects every energy actor. Research by Stroebel and Wurgler found that regulatory risk associated with the implementation of the energy transition is the most significant element of climate risk (2021, p. 489). It can manifest itself in the form of materialising risk for many business models operated in the energy sector, resulting from increased regulation aimed at reducing CO_2 emissions. Regulatory risk materialising in the form of creating legislative solutions to address climate change is the biggest risk for energy companies, both short-term and long-term (Papadis & Tsatsaronis, 2020, p. 9; Stroebel & Wurgler, 2021). The essence of the components of climate risk means that legislative activities related to climate protection (regulatory risk) imply exposure to financial risk – these two risk areas are closely linked due to the interdependence of the law enacted with financial elements. This synergy effect makes for effective action on climate protection. An example of an effective combination of regulatory and financial measures is the implementation of the CO_2 emissions trading scheme – the EU ETS. Moreover, the allocation of the number of allowances will only be linked to administrative decisions, which will be an effective incentive to increase the pace of decarbonisation and influence the decisions made by energy entities.

Regulatory risk manifests itself, *inter alia*, through plans to develop the EU ETS to enable the achievement of more ambitious emission targets contained in the EU's „Fit for 55" package or through the implementation of new regulations that significantly affect the operation of the energy industry, such as the 2016 law completely blocking the development of on-shore wind farms in Poland. From the perspective of energy companies, difficult-to-predict regulations that seriously affect the profitability of already implemented investments or completely prevent the implementation of new projects are an unfavourable situation. Hence, the lack of effective counteraction to regulatory risk may pose a threat to the profitability of ongoing investment projects and may lead to decisions on new investments being abandoned.

Regulatory risk, associated with the materialising climate risk, results in the exclusion of the development of emission and non-organic energy sources, implying financial risk for energy companies which have a large number of such units in their portfolio of generating assets. Regulations affecting the profitability of these units (such as the EU ETS mechanism) – as well as increasingly stringent environmental standards (including BAT[3] conclusions) – prevent the implementation of new investment projects in EU countries using emission-intensive energy technologies and exacerbate the uncompetitiveness of outdated emission technologies. Environmental regulations are, therefore, an effective tool of climate policy, acting especially on the financial sphere of energy companies and visibly influencing their decisions.

Climate risk and social risk

Climate risk affects the emergence of social risk. The aspect of climate risk can be perceived by society in the form of a social problem – a situation defined by one social group can be perceived negatively and by another social group neutrally or even positively (Wrochna, 2018, pp. 205–206). Such an issue may be the question of ecology, environmental protection, and climate. Public awareness related to ecological and environmental topics is constantly growing, especially in developed countries. In the countries of the European Union, more and more emphasis is placed on promoting pro-ecological and pro-climate attitudes. This does not remain without influence on consumer behaviour. Basing one’s activity on fossil fuels, high emission levels of industrial plants, or having a negative impact on the environment is perceived by society in a negative way and adversely affects the image of the entire company. This trend is a particular challenge for energy companies. Changing public attitudes and the legal and financial environment resulting from the materialisation of climate risks is putting increasing pressure on energy companies – resulting in accelerated decarbonisation and the development of renewable energy sources. This is clearly visible in the strategies of energy companies, which emphasise the drive towards decarbonisation, environmental performance, and care for the environment. Such an approach is also important from the point of view of company shareholders, as the market negatively values entities that do not care about the environment, as well as those generating electricity from fossil fuels. Changing social behaviour, which is a materialisation of climate and social risks, also influences the growing popularity of Power Purchase Agreements (PPAs) for purchasing energy generated from renewable sources. Consumer awareness is growing to the extent that more and more attention is being paid to the origin of electricity, naturally favouring those generating electricity from RES.

The lack of the consideration of social risks by energy companies may also affect the implementation of investments, especially in infrastructure extracting fossil fuels or generating electricity from fossil fuels. Ignoring social factors may lead to social conflicts, delay the investment, or decrease its profitability, and in extreme cases may lead to its blocking (Rogowski, 2018, p. 191). Examples of social conflicts affecting the activities of energy companies include the exploitation

[3] BAT – Best Available Technics / Best Available Technologies.

of lignite deposits and plans to build new open-pit mines, the exploitation and construction of new nuclear power plants, or the construction of new coal-fired power plants.

Discussion – managing climate risk

As was presented in the paper, climate risk can seriously affect the operations of energy entities, requiring them to adopt a proactive attitude and implement measures to mitigate these risks (Kouloukoui et al., 2019, p. 2). Therefore, there has been a need to implement corporate Management of Climate Risk (MCR) as an integral part of conducting business in the energy sector. MCR is defined as a set of actions taken by a business entity to address the potential negative impacts of climate change affecting business operations (Weinhofer & Busch, 2012, p. 127). However, following the definition proposed by Weinhofer and Busch, in the case of the energy sector, there is a need to extend it, as not only the physical effects resulting from climate change affect the operation of the sector, but especially the economic effects resulting from climate policies aimed at climate protection are exerting influence. The process of implementing the MCR consists of three stages (Kouloukoui et al., 2019, p. 2):

- identifying climate risks affecting the energy company's activities;
- assessing exposure to the risk based on determining the degree of probability and potential consequences of its materialisation;
- taking action to mitigate the identified risk – an indication of the identified risk together with the actions developed to avoid, mitigate, or transfer that risk.

Only by taking a proactive attitude and responding to climate risk can energy entities protect themselves from the negative impact of such risks on their activities in the sector. Ignoring climate risk will pose an increasing threat to energy companies, as exemplified by the collapse of the Ostrołęka investment, among other things.

Concluding remarks

The article highlighted the crucial role of climate risk in the energy sector. The broad impact of climate risk resulting in the emergence of a number of new risks in the form of carbon risk, weather risk, financial risk, regulatory risk, and social risk makes it necessary to take proactive measures to adapt the functioning of energy entities to the new market reality. Failure to adapt can lead to a loss of competitive advantage, a deterioration of the financial situation and, as a consequence, even bankruptcy.

Climate risk will increasingly affect the operation of the energy sector also due to the increasing implementation of non-financial reporting, ESG[4] standards, and green finance instruments. This is another reason for energy entities to revise their strategy and take measures to adapt to the current market situation and mitigate climate risks.

Research presented in the article was focused mostly on the electric power sector. The analysis of climate risk can be extended to sectors such as mining or oil and gas drilling. However, in these cases, the impact of climate risk will lead to a decline in the importance of these industries over the next few decades. The electricity sector is currently facing a progressive energy transition, so the impact of climate risk is now a key issue that is reflected in the shape of the energy transition associated with the development of low- and zero-carbon energy technologies.

[4] ESG – Environmental, Social, and Corporate Governance.

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