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DECARBONISATION AND FINANCIAL PERFORMANCE OF ENERGY COMPANIES

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Abstract

Our daily lives are unimaginable without energy. Producing it, however, may be harmful to the environment depending on the energy source. The Paris Agreement brought a key question to the fore: with or without coal? The Powering Past Coal Alliance (PPCA) members, including the European Union, have committed to the phasing out of coal by 2030. Several Member States of the European Union have recently closed almost 130 coal-fired power plants. The closure of these plants, in addition to impacting greenhouse gas (GHG) emissions, also exerts influence on the financial position of power plant owners. This study seeks to answer the question of how the profitability of the company groups that operate (and have closed) coal-fired power plants in the European Union has evolved. Is there a relationship between decarbonisation and profitability trends, and are there any patterns in the environmental and financial performance of individual company groups? The main added value of our research is highlighting that different groups of companies have responded differently to the EU's decarbonisation targets, and these reactions have also been reflected in their financial performance. The study included 21 company groups that cover more than 70% of CO₂ emissions from coal-fired power plants in the EU. The profitability indicators were calculated based on the publicly available consolidated annual reports of the companies for 2016 and 2020. Following a reliability test of the indicators, a cluster analysis was carried out. The different reactions allowed us to classify the energy groups into different clusters. The analysed companies were classified into four homogeneous groups: Frontrunner, Up-and-coming, Sacrifice makers, and Stagnating companies. Although a significant relationship could not be found between the change in GHG emissions and the change in profitability position, a multidirectional relationship was identified between the environmental and financial performance of companies.

Keywords: decarbonisation, GHG emission, corporate financial performance, profitability, energy companies

JEL Classification: J24, K31

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Introduction

The history of the European Union (EU) is closely linked to coal. Over the past years and decades, the EU took many efforts to become a climate-neutral, sustainable, and competitive economy. The EU has become a world leader in the fight against climate change (Lindberg et al., 2019; Janota et al., 2022). In 2015, in line with the UN General Assembly's Sustainable Development Goal (SDG7), the EU set out the framework conditions of the Energy Union ensuring its energy supply's security, economic sustainability, and competitiveness; these conditions were finalised in 2019 (COM (2015) 80 final; IRENA, 2017). The Paris Agreement, signed in 2015 by 194 countries, is the first international alliance to take effective action against global warming. The convention states that the countries commit to "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels" (UN, 2015, p.5).

The contribution of developing and developed countries to the success of the goals is different, but they are supported by national plans reviewed every five years (UN, 2015; EU 2016 / 1841; Climate Analytics, 2017). Thanks to the common action, the EU was able to record around 23% reduction in greenhouse gas (GHG) emissions along with a 61% economic growth by 2018 (European Commission COM (2019) 640 final). Despite the favourable results, the efforts to implement the Paris Agreement still proved to be insufficient (European Commission COM (2019) 640 final). In 2019, the European Commission adopted a new package of proposals that would deliver the desired reductions in GHG emissions through faster and more ambitious actions. A central element of the European Union's Green Deal is a strong support for renewable energies through a complex socio-economic transition, which will bring with it a continuous decline in fossil fuels (European Commission COM (2019) 640 final; European Commission COM (2020) 21 final; Bloomberg Philanthropies, 2020; Janota et al., 2022). The Clean Energy for All Europeans Strategy and the Green Deal urge to reach a 32% share of renewables in electricity generation by 2030 and an 80% share by 2050 (Tanțău et al., 2019; Janota et al., 2022).

Although most of the policies in place support the increasingly widespread use of electricity, its production mix cannot be separated from greenhouse gas emissions, as they account for a quarter of total emissions (European Commission COM (2019) 285 final). One of the most significant achievements of the Paris Agreement was the creation of the Powering Past Coal Alliance (PPCA) in 2017. Its members, including the European Union, are committed to phasing out coal by 2030. However, to meet the climate goals, it will be crucial for the rest of the world to commit to decarbonisation by 2050 (PPCA, 2019). In Europe, countries that joined the PPCA have announced their coal phasing-out plans. Between 2017 and 2020, almost 130 power plants in 15 Member States of the EU were affected by the decision to phase out coal. Despite that, nearly 67% of the EU's coal-fired power plant capacity, around 50 GW of installed fossil capacity (in Poland, Czech Republic, Romania, and Bulgaria), still has to be replaced (Bloomberg Philanthropies, 2020).

The venue for the 26th Conference of the Parties (COP26) held in Glasgow in 2021 could also be considered symbolic, as the UK was the first to announce the phasing out of coal from energy production. The result of the conference was that another 23 signatories from around the world pledged to phase out coal, including Poland, which had abstained until then (UNFCCC, 2021a). Nevertheless, 25 countries committed themselves to ending international support for the fossil fuel sector by 2022 and instead focus on financing a just transition (UNFCCC, 2021b). A key outcome of COP26 was the signing of the Global Coal to Clean

Power Transition Statement by 46 countries, including the European Union, five subnationals, and 26 organisations (including Drax, EDF, EDP, Engie, Iberdrola, and SSE, which were also examined in the study). The Declaration states that coal-fired power plants are the main cause of climate change, and the parties advocated for clean energy production, government subsidies, and terminating the licensing of new coal-fired power plants (UNFCCC, 2021c).

There are major tasks in reducing GHG emissions in all areas to meet the energy and climate policy targets. Expectations are particularly high in the sectors that contribute the most to climate pollution. In this way, the energy sector is under increasing pressure from both society and regulators to reduce its emissions.

Given that coal-fired power plants are major emitters of carbon dioxide, there is a growing call for the closure of coal-fired power plants to meet corporate targets. At the same time, the events of recent months, particularly the energy crisis that threatens Europe as a whole due to the war between Russia and Ukraine, have led to renewed talk of reopening coal-fired power plants that had previously been closed, making the issue even more topical.

As such, we seek to answer the question of how the EU's decarbonisation efforts affect the financial performance of companies, in particular their profitability. To answer this, we try to identify specific patterns in the environmental and financial performance of individual company groups. The EU's climate protection measures and the steps taken to promote them effectively are typically analysed in the literature from the perspectives of demand side response, the rise of renewable energy, and energy efficiency (Chatterjee et al., 2022; Hainsch et al., 2022; Karakosta and Petropoulou, 2022). Although energy companies, traditionally based on fossil fuels, are responsible for 31 % of CO₂ or GHG emissions in the EU and for 42 % in the world based on 2019 data (IEA, 2020a-e, 2021), their role in the energy transition is seldom discussed. Therefore, linking the profitability of companies and the extent of their contribution to climate objectives is a novel approach. The main added value of our research is that it highlights the different ways in which different groups of companies have responded to the EU's decarbonisation targets, which are reflected in their financial performance. The results of the analyses did not show a significant relationship between the developments in GHG emissions and changes in the companies' profitability position, but hierarchical cluster analysis allowed us to classify the companies studied into four homogeneous groups: leaders, improvers, sacrificers, and stagnators.

Our article begins with a brief literature review, in which we aim to provide a summary of the results of empirical research aimed at exploring the relationship between the firms' environmental and financial performance. Next, we present the methodology of our research, covering the sampling process, data collection, and statistical methodology. After that, we present the results of the analyses we carried out and compare them with the researchers' previous expectations. The main findings of our research are summarised in the Conclusion.

1. Literature review

In line with the objectives of our study, the literature review is divided into the following 3 subsections. In subsection 1.1, we summarise the criteria for measuring financial performance, and in subsection 1.2, we summarise the criteria for measuring environmental performance, based on relevant literature. Subsection 1.3 contains the most relevant sources for our research, analysing the relationship between financial and environmental performance of companies.

1.1 Measuring the financial performance of companies

When looking at the financial performance of companies, profitability indicators play an important role. Profitability indicators show the ability of companies to generate profits. ROA and ROE are the most frequently used profitability ratios used in the literature to measure company performance (Pătări et al., 2014; Paun, 2017; Vuță et al., 2019; Schabek, 2020; Wang et al., 2021; Kludacz-Alessandri and Cygańska, 2021; Aastvedt et al., 2021). ROA is the profit per unit of asset value (Return on Assets). The ROE indicator shows the return on equity of a company, i.e. the percentage of the profit on equity. In the calculation of ROE, earnings before tax (EBT) is in the numerator, “as it eliminates the influence of a country's taxation system on the companies’ performance” (Schabek, 2020, p.1409). It is true for both indicators (and reflected in their criticism) that they can be challenging for comparing companies if their capital structure differs (Illés, 2016). The ROS indicator is also a commonly used profitability ratio, and measures earnings (EBT) per unit of sales. Its suitability for corporate comparisons is also limited. ROI can be regarded as the real rate of return on capital, which contains the smallest distortions, since it is calculated as total return on capital relative to total capital (Illés, 2016). However, no standard formula for its calculation can be found in the literature, and it is difficult to extract the relevant data from financial statements.

1.2. Measuring the environmental performance of companies

Energy companies are coming under increasing pressure from tightening environmental and climate protection regulations and societal expectations. A minimum level of compliance with requirements has become a condition for staying competitive, and competitive advantage can be achieved through the rapid deployment of innovative green technologies and environmentally and climate-conscious corporate behaviour that permeates the company's operating philosophy (Pătări et al., 2014; Kludacz-Alessandri and Cygańska, 2021; Aastvedt et al., 2021; Latapí et al., 2021; Jarboui, 2021). The “environmental performance” of companies is determined in different ways, among others, by corporate social responsibility (CSR), in particular, by the efforts made in the area of its environmental pillar (Kludacz-Alessandri and Cygańska, 2021), socially responsible investing (SRI) (Schabek 2020), green innovation (Aastvedt et al., 2021), CO₂ emission reduction, energy transition to renewable energy sources (Jarboui, 2021), sustainability, environmental and climate protection.

1.3. Empirical research on the relationship between corporate environmental and financial performance

It is legitimate to ask in what way the efforts invested in increasing environmental performance affect the corporate financial performance of energy producers. Companies will be motivated to make socially responsible investments if a win-win situation can be achieved, i.e. the investments will not only improve their environmental performance, but also their financial performance (Aastvedt et al., 2021).

Several literature sources explore the relationship between corporate environmental performance and corporate financial performance (CFP) (Table no. 1).

Table no. 1. Research examining variables effected on corporate financial performance

Authors	Indicators of financial performance	Independent variables	Sample
Ionascu et al. (2022)	ROA, Liquidity, indebtedness	Digital transformation (Digitalization index), sustainability (ESG score)	454 listed companies (all sectors) of the main stock exchanges located within the EU
Kludacz-Alessandri and Cygańska (2021)	Six different indicators: ROA, ROE, EBIT, Enterprise Value to EBITDA, EBITDA per Share, and Beta coefficient.	CSR adoption – CSR adoption is measured by a dummy variable, which takes the value of 1 if the company has implemented CSR and 0 if it has not.	219 companies in the energy industry from 32 countries
Schabek (2020)	Profitability measured with ROA, ROE, (using EBT in the numerator)	Legal forms and types of renewable energy sources, size of the company measured as a natural logarithm of total assets, the growth rate of the total revenues, capital investments, the debt to asset ratio, type and share of renewable energy	298 (282) private companies specialized in renewable energy in 16 emerging markets (from all companies of 2504), a sample of fossil fuel-based producers (316 companies)
Pătări et al. (2014)	ROA, market capitalization	CSR strengths and concerns	14 companies in the energy sector
Aastvedt et al., (2021)	ROA	Environmental pillar score of ESG reported by Refinitiv, and third sub-category of this score, which is innovation score. Control variables: company size, crude oil price, leverage ratio	27 US and 17 European oil and gas companies.
Paun (2017)	ROE, ROA, Total debt/Total assets, Current ratio	Type of energy sources	91 energy producers in Romania
Jarboui (2021)	Desirable output: Operational efficiency (operational revenue) Undesirable output: Environmental efficiency (CO ₂ emission)	Inefficiency determinants: renewable energies. Inputs: number of employees, total assets	45 US oil and gas companies

Most studies only confirm the direction and strength of the relationship between the two factors (Table no. 1), but there have also been attempts to explore the causal relationship (e.g., Granger causality between CSR and CFP in Pătări et al., 2014), to see whether environmental performance affects financial performance or whether the financial performance of the company determines its actions taken in environmental responsibility. Based on the examples cited by Schabek (2020) – SRI-CFP, Pătări et al. (2014), Kludacz-Alessandri and Cygańska (2021) – CSR-CFP, Aastvedt et al. (2021) – green innovation-CFP, there are four different possibilities in terms of the nature and direction of the relationship:

- Environmental performance has a positive impact on a company's financial performance: positive actions in environmental (and social) responsibility tend to increase stakeholder satisfaction, the social acceptance of the company, and employee engagement, thus the company's image and reputation will improve. This leads to growing corporate

competitiveness and productivity, and lower operating costs, thereby entailing improved corporate financial performance. Sustainable companies gain a competitive advantage over non-green companies through green innovations.

- Environmental and climate protection activities and other CSR activities have a negative impact on the financial performance of the company. These measures actually increase the costs of the company, and the return on these costs is uncertain. Increased costs worsen the company's profitability prospects and/or market conditions. Due to the limited availability of resources, CSR activities reallocate resources from other, more productive activities. The marginal benefits of these measures are sometimes lower than the marginal costs.

- The company's financial performance determines its environmental performance, with a positive relationship between the two. The company's good financial performance allows for more intensive activity in the area of environmental protection and CSR, as financially stable, stronger companies can afford to invest in CSR activities more.

- A company's financial performance influences its environmental and CSR performance, but the relationship between the two is negative. This could be explained by the fact that when a company's financial performance is poor, managers try to hide their poor performance by investing in CSR.

The examined studies show that the need to reduce CO₂ emissions is becoming more and more pronounced in the strategy of energy companies; therefore, they are gradually shifting their energy mix from fossil fuels towards alternative energy sources and are looking for innovative solutions to make their products and processes more environmentally friendly. The aim is to increase these investments without jeopardising the achievement of their financial goals. Aastvedt et al. (2021) analysed US and European oil and gas companies and found a positive relationship between green innovation and corporate financial performance. The research stated that US and European companies have different willingness and attitudes towards environmental performance (US companies are less committed), which is due to the different regulatory environments. Jarboui (2021) found that the role of renewable energies in the energy sector is growing, and, therefore, energy companies are gradually moving towards the path of energy transition. However, the issue of climate protection is less prominent in US regulation, where the priorities are rather competitiveness and profitability of energy companies than their environmental performance. This was also confirmed by the fact that in 2017, the US left the Paris Agreement (Jarboui, 2021).

The intensity of company openness toward renewables was also influenced by the development of the profitability prospects of conventional energy production in the post-2015 period.

Schabek (2020) conducted a comparative analysis of the performance of renewable energy-based electric power producers, and of fossil fuel energy-based electric power producers, over the period 2013-2017, in emerging markets. He found, that "The EBT/E (earnings before taxes/equity) grew from 2% to 15% while for fossil fuel-based producers, the EBT/E decreased from 14% in 2013 to 9% in 2017. Such a change might have been caused by the increased efficiency of the equipment used in renewable production and the higher cost of the CO₂ emission rights borne by traditional producers. The main trends show an increase in profitability for sustainable producers and a decrease for fossil fuel-based ones" (Schabek, 2020, p.1415). Carbon Tracker (2018) analysed the profitability of 6,685 coal plants operating (95% coverage) or planned to operate (90% coverage) worldwide. In 2018, around

42% of the coal plants surveyed made a loss. According to the estimates of Carbon Tracker, the proportion of coal-fired power plants operating at a loss will increase even further by 2030 and 2040. Edis and Bowyer (2021) came to the same conclusion when analysing the profitability of coal-fired power plants in Australia. They stressed that the economic viability of coal-fired power plants is in question and cited increasing renewable energy production as one of the reasons (Horváth et al., 2022).

2. Methodology

For the purpose of our research, we formulated the following research questions:

- RQ1: How has the profitability of the company groups that operate (and have closed) coal-fired power plants in the European Union evolved?
- RQ2: Is there a relationship between the development of decarbonisation and the profitability of the companies?
- RQ3: Are there any patterns in the environmental and financial performance of individual company groups?

In describing the methodological part, the following fields are covered: first the sampling process, then the data collection method, and finally the statistical methodology.

2.1. Sampling process

In 2015, around 36% of total EU CO₂ emissions came from electricity and heat production, 75% of which came from coal-based power generation (IEA, 2020a.-e., 2021). CO₂ emissions from coal-fired power plants in the European Union in 2015 were nearly 769 million tonnes. Therefore, it is not by chance that demands have intensified to close coal-fired power plants to meet climate targets. The main consideration in compiling the corporate sample was the selection of the energy companies that are the most severely affected by the increasingly stringent environmental and climate protection efforts, so the company groups that own the coal-fired power plants were chosen during our research.

In 2021, the Europe Beyond Coal initiative conducted a survey on the situation of coal-fired power plants, and its database provides a time series of CO₂ emissions from power plants between 2005 and 2020 (Europe Beyond Coal, 2021). The European Coal Plant Database contains around 300 emissive coal-fired power plants for the EU-28. Given the landmark nature of the Paris Agreement, the time horizon for our analyses is the post-2015 period (2016-2020). In our sample, the 2015 emissions of coal-fired power plants operating in the EU were summed up broken down by the company group that owns them, and then the company groups were sorted in descending order. The cumulated relative CO₂ emission of the power plant owners was examined. The company groups were selected to be included in the sample were those that together covered 90% of all CO₂ emissions from coal-fired power plants, according to 2015 data. Thus, the sample includes 31 companies (Figure no. 1). One methodological limitation of the study is the assumption that the owners assigned to the power plants in the European Coal Plant Database of August 2021 are the same as the owners in 2015. The resources required to clarify the situation would exceed the benefits of the information obtained, so the research disregards the systematic exploration of changes in ownerships.

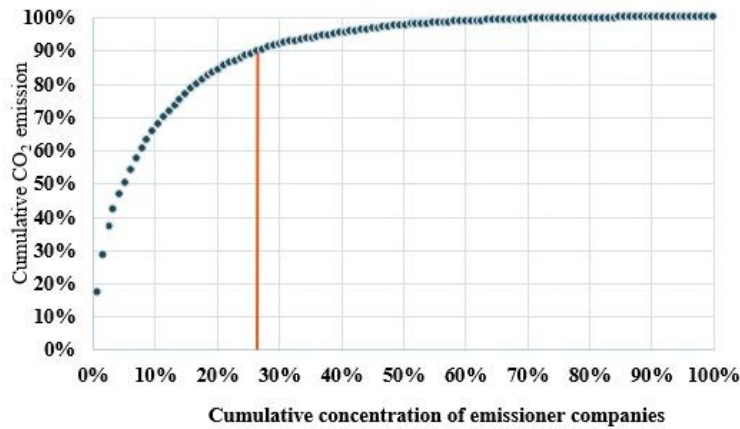


Figure no. 1. Cumulated relative CO₂ emission of the power plants by owners (n=113 owners) in 2015

Source: authors' editing based on *Europe Beyond Coal*, 2021

This paper aims to present the partial results of a comprehensive study that aims to identify patterns of change in carbon dioxide emissions and the profitability of the company groups involved in the phasing out of coal. Of the 31 companies surveyed, CO₂ emissions data were available for 21 companies, so this study focuses primarily on these company groups (Table no. 2). Nevertheless, a significant share of the total emission mentioned above can be attributed to these companies (71.25%). In 2016, the 21 companies investigated operated 152 coal-fired power plants (and around 390 of their generating units) in the EU, with an installed capacity of around 124,382 MW. If the dates of power plant closures shown in the European Coal Plant Database are correct, only 119 coal-fired power plants (with 298 units and 93,868 MW installed capacity) are in operation in 2020 under the ownership of the companies investigated. This represents a 25% reduction in coal-based capacity, a 22% reduction in the number of power plants, and a 24% reduction in the number of power plant units.

Table no. 2. Analysed Companies

No.	Company	No.	Company	No.	Company
1.	CEZ	8.	Engie	15.	RWE
2.	Drax Power plc	9.	EPH	16.	SSE
3.	EDF	10.	EnBW	17.	Tauron
4.	EDP	11.	ESB Group	18.	Uniper
5.	Endesa	12.	Iberdrola	19.	Vattenfall
6.	Enea	13.	Naturgy	20.	Veolia
7.	Enel	14.	PPC	21.	ZEPAK

2.2. Collection of corporate data

Corporate data was collected from the 2016 and 2020 consolidated annual reports of the sampled company groups. International accounting standards provide guidance on the main structure of the balance sheet and income statement. Current and non-current assets as well as current and non-current liabilities must be presented separately in the balance sheet.

International Accounting Standards 1 (IAS 1) does not prescribe a fixed balance sheet format, but does specify the minimum set of information to be presented. The income statement shows the entrepreneur's profit or loss. It describes the main factors that affect the generation and modification of profit or loss, the components of profit or loss, and its formation. As in the case of the balance sheet, the standard does not prescribe a fixed structure for the income statement. It only defines the possible forms and minimum content. Companies therefore have great flexibility in the structure of their balance sheets and profit and loss accounts and in the valuation of individual items, which also limits the comparability of financial data. A further limitation of comparability is that our analyses were based on consolidated accounts of company groups. These factors also mean a research limitation. Calculations were done in EUR million. Since the financial statements of the companies investigated are denominated in different currencies, the values were translated using the cross rates of the euro as at 31 December 2016 and 31 December 2020 (by the website of exchange rates 2016, 2020).

In our analysis, the companies were investigated along two dimensions. This paper sought to answer the question of how energy companies progressed on the path of decarbonisation and how their profitability evolved in parallel, in the period 2016-2020. Decarbonisation was measured by the change in GHG emissions of company groups from 2016 to 2020 (company group total or direct GHG emissions from fossil fuel combustion for power and heat generation expressed in CO₂ equivalent).

The evolution in profitability was expressed by the change in a calculated profitability composite indicator (PCI), expressed as a percentage. The use of a composite indicator differs from the practice seen in the literature. However, most of the indicators used to define PCI (Table no. 3) are found in the literature in the context of measuring the financial performance of companies.

Table no. 3. The indicators and their formulas included in the Profitability composite indicator (PCI)

Indicator	Numerator	Denominator
Return on Assets (ROA)	Profit before tax (EBT)	Total assets
Return on Equity (ROE)	Profit before tax (EBT)	Owner's Equity
Return on Sales (ROS)	Profit before tax (EBT)	Revenue from sales
Return on Investment (~ROI 1)	EBIT	Equity+Non-current liabilities
Return on Investment (~ROI 2)	EBIT	Total equity and liabilities
EBITDA (Earnings before interest, taxes, depreciation and amortization); EBIT (Earnings before interest and taxes); Operating profit; Profit before tax (EBT); Net profit for the year		

Interpretation of these indicators: the most frequently used profitability indicators (ROA, ROE, ROS) are applied in this study, as they were presented above in the literature review. Two measures close to ROI were quantified. EBIT is included in the numerator in both cases. Capital was defined in two ways: first, as the sum of liabilities and equity, and second, as the sum of equity and long-term (non-current) liabilities. In addition to profitability indicators, the main income statement categories are also included in the analysis. "EBITDA stands for earnings before interest, taxes, depreciation, and amortization, and it is used to evaluate a company's operating performance. EBIT is used to analyse the effectiveness of the company's core business without capital structure costs and tax expenses affecting profit." (Kludacz-Alessandri and Cygańska, 2021, p.7). Operating profit is the same as the EBIT

category in most companies. Earnings before tax (EBT) is the profit adjusted for the result of financial operations, while net profit for the year shows the company's profit after tax.

2.3. Statistical methodology

When calculating the profitability composite indicator (PCI), the following method was used: Before aggregating the indicators, a reliability test was performed, and based on the Cronbach's alpha (0.809) it was concluded that the indicators could be aggregated (Cronbach, 1951). As the measurement scale of each indicator is different (different units, different orders of magnitude), a 0-1 scale transformation was performed before the aggregation, where 0 is the smallest measured value for the indicator during the two years investigated and 1 is the largest. (This is a general approach known as max-min normalisation.) Following the scale transformation, an unweighted average calculation was used to construct the profitability composite indicator for both 2016 and 2020. Key aspects of the process and methodology of our research (e.g., aggregate indices and clusters based on financial indicators) are also reflected in the research of Novokmet and Rogošić (2017). Further similar procedures can be found in the construction of the so-called Summary Innovation Index (SII), calculated from the European Innovation Scoreboard (EIS) data (Hollanders, 2021).

3. Results and discussion

The aim of our research was to investigate whether there are identifiable patterns emerging in the development of the environmental and financial performance of individual company groups. The changes along the two dimensions (i.e., GHG emission, profitability) essentially reflect the shift of companies relative to themselves.

The 21 energy companies analysed take the following positions on the plane of dimensions developed according to the previous methodology (Figure no. 2).

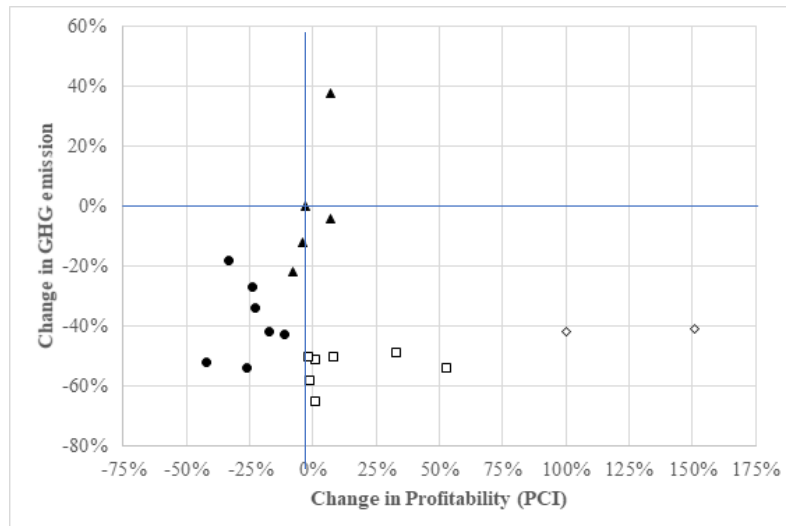


Figure no. 2. Position of energy companies investigated in the two-dimensional space of change in GHG emissions and profitability from 2016 to 2020

The companies were classified into four homogeneous groups based on their position in a two-dimensional space, using a hierarchical cluster analysis (Ward's method; squared Euclidean distance). The characteristics of the clusters are summarised in Table No. 4.

Table no. 4. Clusters of the companies

Name of the cluster	Companies (company groups)*	Average change in profitability composite indicator (PCI)	Average change in GHG emission
FRONTRUNNERS Cluster 1 (empty rhombus)	Uniper, EnBW	125.5%	-41.5%
UP-AND-COMING COMPANIES Cluster 2 (empty square)	EDP , Vattenfall, RWE, Enel, PPC, Endesa, Iberdrola	13.3%	-53.9%
SACRIFICE-MAKERS Cluster 3 (full circle)	Drax Power , ENEA, Tauron, ZEPAK, NATURGY, EDF , Engie	-25.1%	-38.6%
STAGNATING COMPANIES Cluster 4 (full triangle)	EPH, CEZ, SSE , Veolia, ESB Group	-0.2%	0.0

Notes: *The companies in bold signed the Global Coal to Clean Power Transition Statement in 2021

Frontrunners – Cluster 1: Two companies were placed in this group. These are companies that achieved significant reductions in GHG emissions (41.5% on average) as well as significant improvements in profitability (100% and 150% improvement in their position in the PCI dimension). It is important to highlight that both companies were loss-making in 2016 (negative EBIT and EBT), but they had become profitable by 2020. In terms of assets, the two companies are similar in size, but there is a significant difference in their net sales. Their return on assets is similar, and increased from a -7, -8% to 1.3-2.2% between 2016 and 2020. The ROA of both companies increased at a similar rate during the investigated period. In terms of their ROI (EBIT/(Equity+Non-current liabilities)), they showed year-on-year improvement, as they managed to cut their losses by 2020 and even turn their core business profitable. The Uniper group had reduced its coal capacity in the EU by 19% by 2020, while the EnBW group had reduced it by only 0.5%, which is almost unchanged.

Up-and-coming companies – Cluster 2: The seven companies in this cluster also achieved significant reductions in GHG emissions (-53.9%), and on average they were able to reduce their emissions even more than the companies in Cluster 1. However, their profitability improved modestly (by an average of around 13.3%) compared to the 'Frontrunners'. (On average, they improved their position in the PCI dimension by 0, and 50% respectively.) Both in the base year and in the current year, the companies analysed operated their core business profitably (positive EBIT). Although, at the EBT level, two of the group's companies were loss-making in 2016, but by 2020 their pre-tax profit had turned positive. The size of the companies in the group (see Total Assets in Table no. 5) varies widely. It ranges from EUR 17 132 million to EUR 155 596 million. Based on the available data, the difference is not reflected in the number of coal-fired power plants in Europe. One company phased out coal-

based capacity by about 42%, one by more than 89%, one company took no action on coal phase-out, and the remaining four companies reduced their coal capacity by an average of 20%. In terms of return on assets, five companies managed to increase their profitability compared to the base year, while two company groups saw a negligible decrease in the value of the indicator. For the group as a whole, the ROA ratio increased from 1.16% in 2016 to 3.09% in 2020 on average. The ROI indicator barely changed in terms of the cluster average (from 5.26% to 5.2%). For five companies, there was a minimal change in ROI (mixed positive and negative), and for two companies there was a larger change.

Sacrifice makers – Cluster 3: Cluster 3 includes seven company groups. For these companies, GHG emissions decreased moderately, by 38.6% on average, but at the same time, their profitability position (PCI) deteriorated significantly, by 25.1% on average. In 2016, all the company groups were profitable (both at EBIT and EBT category level), but by 2020 the profitability of all companies had declined significantly. At EBIT level 4 companies and at EBT level six companies became loss-making. Companies that become loss-making are typically small companies, both in terms of their assets and net sales. ROA decreased from 3.46% to -4.38% based on the cluster average. Here it can again be seen that large companies suffered a smaller decline in their return on assets. ROI decreased from 6.13% to -3.80% during the investigated period. This represents a decrease of around 10 percentage points on average. Only large companies managed to achieve a positive ROI in 2020. According to the data from the European Coal Plant Database (July 2021), two companies almost completely phased out their coal-fired power plant capacity, two companies reduced their coal-fired capacity by no or a small amount, and the remaining three companies reduced their coal-fired capacity by an average of 44%.

Stagnating companies – Cluster 4: Cluster 4 includes five company groups of similar size (with similar asset value). For these companies, the change in GHG emissions is not significant. (In this cluster, the only company whose emission did not decrease but increased by almost 40% during the investigated period, can be found). Furthermore, the change in profitability is not significant, with only a +/- 10% change in the CPI over the investigated period. Their operation is characterised by relative stability. At the EBIT and EBT levels, they were able to operate profitably in both investigated years with minor fluctuations (in mixed directions). At the group level, the average ROA was 3.61% and 3.63% in 2016 and 2020, respectively. The same negligible change (0-2 percentage points) is also seen for individual companies. The average ROI also shows a slight change (decrease) (from 6.33% to 5.52%), with fluctuations of 0-2 percentage points at the individual level. One company completely phased out its coal-fired power plants, two companies took no steps towards coal phase-out, and the remaining two companies reduced the installed capacity of their coal-fired power plants by an average of 18%.

Table no. 5. shows some key data for the investigated company.

As Dinu (2020) also points out, there have been changes in the field of environmental policy in recent years, but further research is needed to assess their economic and social impacts. Consistent with the work of Novokmet and Rogošić (2017) and Ionascu et al. (2022), our research suggests that corporate financial data are suitable for examining the relationship between financial performance and social and environmental impacts. Environmental challenges and impacts also drive firms to respond. The impact of these responses is reflected in the financial performance of companies.

Table no. 5. Some relevant data of the 21 investigated companies

Cluster	Company Group	Total Assets (millions of EUR)		Total revenue from sales (millions of EUR)		EBIT (millions of EUR)		EBT (millions of EUR)		ROA (%)		ROI (%)		Capacity-change* (%)
		2016	2020	2016	2020	2016	2020	2016	2020	2016	2020	2016	2020	coal
1	Uniper	48 871	40 222	67 285	50 968	-3 963	599	-4 258	541	-8.7	1.3	-14.1	2.7	-19.1
1	EnBW	38 535	45 965	19 368	19 694	-1 663	1 103	-2 722	1 003	-7.1	2.2	-6.5	3.2	-0.5
2	EDP	44 084	42 947	14 595	12 448	2 264	2 206	1 351	1 535	3.1	3.6	6.2	6.3	0.0
2	Vattenfall	42 741	46 036	14 538	15 786	140	1 518	-527	1 193	-1.2	2.6	0.4	4.1	-30.0
2	RWE	76 402	61 668	43 590	13 688	3 082	1 771	-5 807	1 196	-7.6	1.9	6.5	3.9	-15.7
2	Enel	155 596	163 453	70 592	64 985	8 921	8 368	5 780	5 463	3.7	3.3	7.8	6.9	-11.5
2	PPC	17 135	13 686	5 257	4 649	331	202	169	67	1.0	0.5	2.5	1.9	-21.9
2	Endesa	30 964	32 062	18 979	17 579	1 965	1 886	1 710	1 788	5.5	5.6	8.4	8.0	-41.7
2	Iberdrola	106 706	122 518	28 759	33 145	4 686	5 536	3 879	5 053	3.6	4.1	5.1	5.3	-89.2
3	Drax Power	4 305	4 693	3 461	4 751	239	-175	231	-263	5.4	-5.6	7.3	-5.4	-43.4
3	ENEA	5 567	6 562	2 554	3 995	254	-375	243	-572	4.4	-8.7	5.2	-7.4	0.0
3	Tauron	7 591	8 652	4 004	4 472	182	-380	115	-521	1.5	-6.0	2.8	-5.4	-4.0
3	ZEPAK	1 089	632	614	485	84	-64	70	-67	6.4	-10.5	10.5	-16.1	-53.3
3	NATURGY	47 114	39 545	23 184	15 345	3 006	466	2 083	-36	4.4	-0.1	7.5	1.5	-100.0
3	EDF	281 640	305 891	71 203	69 031	7 514	3 875	4 181	1 293	1.5	0.4	3.4	1.5	-34.9
3	Engie	158 499	153 182	66 639	55 751	6 172	4 578	1 072	-177	0.7	-0.1	6.1	4.6	-100.0
4	EPH	11 975	18 052	4 931	8 531	966	1 376	999	1 976	8.3	10.9	9.0	9.7	-15.1
4	CEZ	23 337	26 786	7 537	8 150	966	480	715	301	3.1	1.1	5.2	2.5	-21.1
4	SSE	26 032	23 539	39 559	4 535	922	1 279	696	743	2.7	3.2	5.3	7.2	-100.0
4	Veolia	37 949	45 364	24 390	26 010	1 477	1 275	930	721	2.5	1.6	6.7	5.1	0.0
4	ESB Group	12 907	13 842	3 212	3 731	597	369	194	186	1.5	1.3	5.4	3.0	0.0
AVERAGE		56 145	57 871	25 441	20 844	1 816	1 709	529	1 020	1.65	0.60	4.32	2.06	-33

Notes: * Capacity change (coal) calculated according to the European Coal Plant Database (July 2021) based on reported dates of power plant unit closures

Our result is consistent with the findings of the research presented in the literature review (Pätäri et al., 2014; Schabek, 2020; Kludacz-Alessandri and Cygańska, 2021; Aastvedt et al., 2021), stating that a multidirectional (positive and negative) relationship is identified between the environmental and financial performance of a company. Companies are more motivated to make environmentally responsible investments if a win-win situation can be achieved, i.e. the investments improving their environmental performance also improve or at least not jeopardise their financial performance (Aastvedt et al., 2021). Our analysis also showed that the clusters that reduced their GHG emissions the most were those that achieved the most significant increase in profitability (Cluster 1 and Cluster 2).

To overcome the uncertainty of renewable energy production, a so-called capacity mechanism has been introduced. In this case, certain energy companies are encouraged to purchase and operate fossil-fuelled power plants in order to maintain the supply security of the energy system. This duality of the energy transition, namely the need to move to a carbon neutral economy while maintaining fossil power plants for system security, does not effectively support the reduction of greenhouse gas emissions by owners like EPH (Papadis and Tsatsaronis 2020; Černoch et al., 2021).

The profitability of energy companies is mainly influenced by fuel prices, the burdens of climate protection efforts (e.g., the EU ETS carbon prices, taxes and levies), the costs and speed of expansion of renewable energy production, as well as the wholesale electricity prices (Nalbandian-Sugden, 2016; Edis and Bowyer, 2021). The majority of the companies (15 out of 21 companies investigated) were profitable in both 2016 and 2020, i.e., they achieved positive EBIT. Two companies were able to emerge as profitable from previous loss-making operations. Four companies became loss-making in 2020.

CO₂ emissions from companies decreased in all but three companies, two companies had no noticeable decrease, and only one company had an increase. There are several possible means

of decarbonisation. One is the phasing out of coal-fired power plants. As it can be seen from the data, that all but four of the companies investigated took steps with regard to coal phase-out, closing more coal-fired power plant units (and whole coal plants), reducing their installed coal capacity (by a total of about 25%). However, there is a wide variation in the steps taken by companies, which may be explained by the different legal frameworks governing the implementation of the coal phase-out strategy in different countries (Lund, 2017; Heinrichs and Markewitz, 2017; Rentier et al., 2019; Akerboom et al., 2020; Brauers and Oei, 2020; Brauers et al., 2020). Another way to decarbonise is to open the path to renewables and green innovations (e.g., green hydrogen). This is also in line with the research referred to in the literature review which found in different parts of the world that energy companies embarked on the path to decarbonisation. The energy mix of the firms has moved towards renewable energy sources, and they invest remarkable amounts in technology innovations (Aastvedt et al., 2021; Jarboui, 2021; Papadis and Tsatsaronis, 2020).

Conclusions

Energy companies have faced several obstacles since 2015. Residentials and community organizations (i.e. cooperatives) have become entitled to produce their own energy by the European Union's climate protection efforts and the provisions of new Electricity (Directive (EU) 2019/944) and Renewable Energy Directives (Directive (EU) 2018/2001). An essential feature of these groups is the pursuit of self-sufficiency, increasing independence from centralized energy production systems (including our analysed company groups) and fossil fuels, which is further strengthened and supported by significant financial resources along the goals and measures that are set out in the Green Deal. Residentials and community organisations that previously benefited from companies' environmental performance have become legally recognized competitors operating in a decentralized way.

The focus of our research is on energy companies operating coal-fired power plants in the EU, as these companies are most seriously affected by the need to comply with the tightening requirements. This article presents a subset of the results of our research which analysed the emissions and financial data of 21 company groups operating in the energy sector. In our analysis, companies are investigated in two dimensions. This article seeks to answer the question to what extent energy companies made efforts to decarbonise in the period 2016-2020, following the Paris Agreement, and how their profitability evolved in parallel with their efforts. Although a significant relationship cannot be found between the change in GHG emissions and the change in profitability position in our research, companies could be classified into four homogeneous groups according to their position in the two-dimensional space, using hierarchical cluster analysis (Ward's method; squared Euclidean distance). Cluster 1 is a group of "Frontrunner" companies that significantly reduced their GHG emissions while their profitability substantially improved (relative to themselves) over the investigated period. Cluster 2 includes the "Up-and-coming" companies. They saw the largest reductions in GHG emissions and improved profitability, but at a more modest rate compared to the Frontrunners. Cluster 3 includes the "Sacrifice makers". They achieved a moderately high rate of reductions in GHG emissions, but at the same time their profitability deteriorated significantly, and they even became loss-making. Finally, "Stagnating" companies were placed in Cluster 4, for which no significant change in GHG emission reductions, nor in profitability was noticed. Decisionmakers should not ignore the findings according to which there will be a significant number of decisions on investing in green

innovations and social responsibility if companies can increase such investments without jeopardising the realisation of their financial goals. Therefore, efforts should be made to achieve a win-win situation for the company's environmental and financial performance. The analysis time horizon ended in 2020.

These are some limitations of this research. One of them is that there have been several major policy changes that have affected the groups of companies studied since 2020 (HIV prevention measures). Our findings are also affected by the fact that during 2021 and 2022, further increases in energy prices and the war in Ukraine led to a rethinking of previous environmental policy directions (e.g., to invoke the idea of reopening coal-fired power plants). Finally, it should be noted that the financial statements (annual reports) of the companies under review are prepared in line with international accounting standards. This raises several issues. On the one hand, the standards allow a high degree of flexibility in the quantification of balance sheet and profit and loss account data. During the period under review, the ownership structure of some companies has changed and, with it, the accounting valuation methodology used. All these factors limit the full comparability of the financial data.

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