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Economic and environmental performance analysis of Polish energy companies

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ABSTRACT

The tightening of the European Union climate and energy policy, directed to raising the resilience and effectiveness of the European Union Emissions Trading System, may influence on companies' economic performance. Polish energy companies, which mainly use coal in the energy production process, are particularly worried about the potential negative consequences associated with the implementation of new CO_2 emission reduction targets and their participation in the European Union Emissions Trading System. This paper analysis the link between economic performance and environmental performance of Polish energy companies, covered by the European Union Emissions Trading System in the years 2013-2017. This analysis may focus the attention of the European Union's and Polish institutions responsible for developing the climate and energy policies on positive and negative consequences concerning the low-carbon transformation of Polish energy sector. Two indicators of environmental performance: carbon intensity and the ratio of carbon dioxide emissions over the allowances, as well as chosen financial ratios: return on assets, return on investment, return on sales, asset turnover ratio are calculated for these companies. A Spearman's rank correlation coefficient is used in order to analyze the relationship between these environmental and financial variables. Presented empirical results highlights that the situation of Polish enterprises worsened in the 3rd trading period, as the number of allocated allowances in case of all energy companies was insufficient to cover their own CO_2 emission. A negative direction of the correlation dependency can be observed in the years 2013-2017 only between asset turnover ratio and return on assets, and the CO_2 emission intensity.

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INTRODUCTION

Launching in 2005 the European Union Emissions Trading System was aimed at reduction of greenhouse gasses emission by most burdensome to the natural environment enterprises in a cost-effective and economically efficient manner (Directive, 2003). The theoretical assumption referring to the functioning of the regulated carbon dioxide emission markets was that their price formation mechanisms would enable for optimal allocation of emission permits among potential polluters (Segnon *et al.*, 2017). About 11 thousand of installations were included into the EU ETS system, located in 31 countries of the European Economic Area and slightly more than 500 aircraft operators that carry out flight between airports in these countries, which as a result ensures the control over about 45% of greenhouse gases emission in the EU (European Commission, 2017). In Poland the system covers about 750 installations from the energy and industrial sectors, for which the total volume of CO_2 emission in 2016 amounted to 198051726 Mg, which constitutes about 10.28% of greenhouse gases limit for all stationary installations included into the EU ETS (KOBiZE, 2017). Each enterprise proportionally to the scale of its operations and determined for the given year EU's emission level receives free of charge or purchases on the market European Union Allowances (EUAs), which then it redeems in the amount corresponding its actual emission for the given trading year (European Commission, 2011). The analysis of the CO_2 permits' free allocation rules for the EU ETS phase 3 and their impact on firms' activity referring to key energy-intensive sectors across Europe has been conducted by some researchers (Branger *et al.*, 2015; Flues and van Dender, 2017; Lecourt *et al.*, 2013). Until the end of 2020 enterprises can also in the limited scope compensate own CO_2 emission with the use of international emission units: Certified Emissions Reduction (CER) assigned to Clean Development Mechanism (CDM) or Emission Reduction Units (ERU) generated as a result of carrying out projects covered by the Joint Implementation (JI) (Commission Regulation, 2013; Ellerman *et al.*, 2016). Making use of market mechanisms while designing the EU ETS contributed to increased responsibility of enterprises for polluting the air, as decisions on the manner that allowances for CO_2 emission are acquired and utilized are made at the level of enterprises. These enterprises that managed to reduce the actual emission with regard to the planned one in the given trading period may increase production or sell the surplus of allowances on the secondary market and acquired in this way resources can be spent on low-carbon modernization of their installations. However, in case of shortages of allowances, enterprises may reduce production, purchase the allowances they lack on the secondary market or make investments to increase the efficiency of machines or start using fuel that is less carbon-intensive (Dyduch, 2013). The price of CO_2 emission allowances and their allocation system determine a number of decisions in enterprises that concern optimizing the size and structure of their production or long-term investments in low-carbon, clean technologies (Calel and Dechezleprêtre, 2016; Freitas *et al.*, 2015; Martin *et al.*, 2016; Wang and Guo, 2018). However, on the other hand, tightening up the climate and energy policy of the EU associated, among others with an increase of the low threshold of greenhouse gases emission for the installations covered by the EU ETS system from 21% in 2020 to 43% in 2030 with reference to the year 2005, raises concerns related to its negative influence on the rate of economic growth and financial condition of enterprises in particular member states. Therefore, Polish energy companies apply the principle of economic calculation in decision-making operations, especially in the scope of increase the share of low-carbon technologies in electricity or heat production processes, as well as realisation of investment projects concerning construction of new high-efficiency coal-fired plants (Grabowska *et al.*, 2015; Skrodzka, 2016). Effectiveness of pro-environmental activities undertaken by Polish enterprises has been a subject of interest of many researchers and practitioners (Mesjasz-Lech, 2016; Skoczkowski and Wronka, 2017). In the light of the aforementioned facts a question needs to be raised whether it is possible to reach compromise between the long-term goal of CO_2 emission reduction and implementing a short-term, fundamental goal for each enterprise which is profit maximisation (Slawinski *et al.*, 2017). The answer to this question will be related to the implementation of the goal of the paper, which is to investigate the relationships between the financial condition of enterprises and fulfilling by them the obligations to limit carbon dioxide emission. All analyses were conducted for the selected energy groups in Poland, which were listed on the Warsaw Stock Exchange and were covered by the EU ETS in the years 2013-2017. Vinayagamoorthi *et al.*, (2015), stressed that this information would help policy makers to frame appropriate policy to persuade companies to implement eco-friendly technology and improve their energy intensity. Al-Najjar and Anfimiadou, (2012), on the basic of chosen financial ratios, market value indicators and dummy eco-efficiency indicator, proved that eco-efficient firms have higher market values compared to those without environmental strategies. In turn, Damert *et al.* (2017), found that neither carbon performance improvements were positively associated with financial performance improvements, nor short-term emission reduction initiatives improve long-term carbon performance. Segura *et al.,* (2018), showed that although energy and manufacturing sectors significantly reduced CO_2 emissions levels under the restrictive EU climate policy, it was needed to encourage green investments in these sectors in order to adjust them better to the EUAs' allocation policy. Joltreau and Sommerfeld (2017), concluded that it was not observed any significant negative effects of the EU ETS on firms' competitiveness due to the over-allocation of CO_2 permits and the ability of energy firms to pass costs onto consumers. Poland has developed and implemented programs involving the concept of sustainable development to improve the quality of air, which are aimed at reduction of emission of pollution generated by economic entities (Szopik-Depczyńska *et al.*, 2018; Włodarczyk and Mesjasz-Lech, 2016). However, the low-emission modernization of energy companies in Poland, which is connected with the necessity of significant reduction of hard coal as the basic fuel in electricity and heat production processes, and approaching the EU emission standards are still the subject of intense legislative work (Wierzbowski *et al.*, 2018). Therefore, the information about link between environmental performance and financial profitability of Polish energy groups can support the policy makers' decisions. The results of empirical studies indicating at the existence of a negative correlation between the financial condition of energy companies and CO_2 emission being a by-product of the electricity generation may confirm the effectiveness of the climate policy and firms' carbon strategy (Jong *et al.*, 2014; Zhang *et al.*, 2018; Zhao *et al.*, 2015). This article extends the existing research devoted to evaluation of a linkage between carbon dioxide emission reduction and firms' economic performance through an estimation of a wide set of environmental and financial indicators for Polish power plants in the 3rd commitment period. The majority of power plants use coal for electricity generation, which in the lights of the EU's efforts to achieve the 2030 greenhouse gas emission reduction targets, point at the necessity to analyze changes in the EUAs allocation, CO_2 emission levels and firms' profitability. The remainder of this paper is organized as follows. Section 2 provides a short description of chosen financial ratios and environmental performance indicators. It presents the statistical methodology employed in the analysis and includes a short description of the data. Section 3 reports the empirical results and presents interpretations of the obtained results concerning the identification of the relationship between the economic and environmental performance of Polish energy companies due to their further development. The last section sets out some conclusions. This study has been carried out at the Management Faculty of Czestochowa University of Technology, Poland, where data about environmental and economic performance of Polish energy companies was collected and statistical analysis was conducted in 2018.

MATERIALS AND METHODS

Environmental performance and economic performance indicators

In order to evaluate the energy business response on climate change and restrictive constraints imposed by the EU ETS in the 3rd commitment period, the relationships between production value, CO_2 emission level and companies' profitability are investigated. Pro-environmental activities of an energy group may be described by means of Eq. 1 (Segura *et al.*, 2018).

$$EA_{j,t} = \frac{\sum_{i=1}^{n_j} E_{i,j,t}}{\sum_{i=1}^{n_j} n(EUA)_{i,j,t}} \tag{1}$$

Where, $EA_{j,t}$ – the index that depicts the value of verified emission to the number of allocated allowances for a *j*-th enterprise in *t* year, $E_{i,j,t}$ – the value of verified CO_2 emission for an *i*-th installation owned by a *j*-th enterprise in *t* year, $n(EUA)_{i,j,t}$ –

the number of allocated free of charge EUAs for *i*-th installation owned by a *j*-th enterprise in *t* year, n_j – the number of installations owned by a j-th enterprise. The values $EA_{j,t} \leq 1$ confirm the surplus of allowances in a given energy group against its actual demand for covering own emission. The values of the index above 1 shall be treated as a signal warning about exceeding the permitted level of carbon dioxide emission in the given year, corresponding to the amount of allowances that have been allocated for free to all installations owned by the energy group. Another carbon intensity index refers simultaneously to financial results of an energy group and the scale of its impact on the environment, which has been shown in Eq. 2 (Damert *et al.*, 2017).

$$CoI_{j,t} = \frac{\sum_{i=1}^{n_j} E_{i,j,t}}{TS_{j,t}} \tag{2}$$

where: $CoI_{j,t}$ – the carbon intensity index for a *j*-th enterprise in *t* year (tons of CO_2 per PLN million), $TS_{j,t}$ – revenues on sales for a *j*-th enterprise in *t* year. The higher the value of this index, the more burdensome for the environment is the technology of electricity or heat production used by a given energy group. The value of the incurred expenditures of investment and development nature that are supposed to serve project development or introducing a system in the scope of maintaining the previous capabilities of an enterprise to generate income, is reported by energy companies as the Capital Expenditure level (CAPEX). It has been expected that the level of CAPEX in the years to come will be characterised by a growing trend using Eq. 3.

$$I^{j}_{CAPEX,t/t-1} = \frac{CAPEX_{j,t}}{CAPEX_{j,t-1}} \tag{3}$$

Where, I^{j}_{CAPEX} – a chain base index enabling the comparison of changes in investment expenditures for a j-th energy company between sequential years.

To assess the financial condition of energy groups the Author has used the following set of indexes;

- The return on sales (ROS) estimated as a ratio of net profit achieved by an energy group to the value of achieved revenues on sales using Eq. 4.

$$ROS_{j,t} = \frac{NP_{j,t}}{TS_{j,t}} \tag{4}$$

Where $NP_{j,t}$ – net profit for a *j*-th enterprise in *t* year;

- The total return on assets (ROA) described by Eq. 5, which allows to check the extent to which the total assets owned by an energy group are capable of generating profit, which will allow to evaluate the efficiency of managing own resources:

$$ROA_{j,t} = \frac{NP_{j,t}}{TA_{j,t}} \tag{5}$$

Where, $TA_{j,t}$ – total assets for a *j*-th enterprise in *t* year;

- The return on investment (ROI), which depicts the ratio of the operating profit/loss to investment expenditures, which allows to draw conclusions about the amount of profit/loss per each engaged in the investment project Polish zloty. ROI is depicted by means of Eq. 6:

$$ROI_{j,t} = \frac{OP_{j,t}}{CAPEX_{j,t}} \tag{6}$$

Were, $OP_{j,t}$ – operating profit/loss for a *j*-th enterprise in *t* year;

- The asset turnover ratio (ATR), which demonstrates how efficiently an energy group can manage its assets, is described by Eq. 7:

$$ATR_{j,t} = \frac{TR_{j,t}}{(TA_{j,t_b} + TA_{j,t_e})/2} \tag{7}$$

Where, $TA_{j,tb}$ – beginning total assets for a *j*-th enterprise in *t* year, $TA_{j,te}$ – ending total assets for a *j*-th enterprise in *t* year. All the aforementioned financial ratios are stimulants, while asset rotation ratio is used as an approximant of production size in an energy enterprise, which directly influences the volume of greenhouse gases emission. Additionally, one more control variable has been introduced, namely the size of an energy group measured by a logarithm of its total assets (Segura *et al.*, 2018). In order to evaluate the link between environmental performance and economic performance of Polish energy companies in the years 2013-2017, the Spearman's rank correlation coefficient is estimated on the basis of environmental indicators (Eqs. 1 and 2) and financial ratios (Eqs. 3, 4, 5, 6 and 7). Spearman's rank correlations coefficient is calculated in accordance with Eq. 8 (Szajt, 2014).

$$r_S = 1 - \frac{6 \cdot \sum d_i^2}{n \cdot (n^2 - 1)} \tag{8}$$

Where, d_i – refers to the difference of ranks between paired items, namely chosen environmental indicator (X variable) and financial ratio (Y variable); n – quantity of the statistical sample. Spearman's rank correlations coefficient is the value standardized in the interval [-1, 1] and its sign indicates at the direction of the relationship between environmental and economic performance of analyzed companies (Sharma, 2005).

Data description

Due to the data availability the subject of the research constituted the following energy companies listed on the Warsaw Stock Exchange in the years 2013-2017: Elektrociepłownia Będzin S.A., Enea S.A., Energa S.A., Zespół Elektrociepłowni Wrocławskich Kogeneracja S.A., PGE Polska Grupa Energetyczna S.A., Tauron Polska Energia S.A., Zespół Elektrowni Pątnów-Adamów-Konin S.A. (ZEPAK). Of all the mentioned companies the one with the largest share in electricity production market in Poland was in 2017 the PGE capital group (43.5%), which through a takeover of EDF group's production assets also achieved a significant influence on development of the heating sector in Poland. The Enea capital group occupied the second position in Poland with respect to electricity production (15.9%), thanks to the takeover of the Połaniec power plant together with other assets that belonged to Engie Energia Polska. The third, with respect to the size, producer of electricity in Poland in 2017 was the Tauron capital group (13.9%). The aforementioned energy groups together with the Energa group have largest shares in the sector index WIG-Energia (respectively 55%, 12.3%, 12.4% and 10.6%) (Warsaw Stock Exchange, 2018). Electricity produced in installations that belong to capital groups ZEPAK and Energa constituted respectively 6.4% and 3.2% of total electricity production in Poland in 2017. The data about the annual verified CO_2 emission and number of allocated emission allowances for Polish installations that generate heat or electricity in the years 2013-2017 was obtained from the European Union Transaction Log database. In turn, financial and accounting data for analyzed Polish energy groups in sequential fiscal years were obtained from the Notoria database.

RESULTS AND DISCUSSION

In order to verify the existence of the linkage between energy group's ability for profits' generation and its activity in the scope of carbon dioxide emission reduction, all environmental and economic indicators described in the previous section were estimated. First, data for all installations owned by the same energy company, considering the production assets taken over by the company from other energy groups, was subject to aggregation so as to calculate the EA ratio in accordance with Eq. 1.

While, analyzing the results presented in Table 1, it can be observed that in the 1st phase of the EU ETS functioning (2005-2007) all Polish energy groups obtained more CO_2 emission allowances than their actual demand, which reflected the global tendency in allocating allowances at that period. In the next trading period (2008-2012) Elektrociepłownia Będzin, Kogeneracja, Tauron and ZEPAK were still characterised by EA ratios lower than 1, which indicates an occurrence of surplus of allowance in these energy companies. However, this ratio's values for Energa and PGE indicate that the limit of greenhouse gases emission that was determined by the EUAs allocation rules was slightly exceeded. The situation of Polish enterprises worsened in the 3rd trading period, as the number of allocated allowances in case of all energy companies was insufficient to cover their own CO_2 emission, which is indicated by the values of the EA ratio ranging from 1.745 (Kogeneracja) and 12.372 (ZEPAK). For the purpose of the identification of the relationship between the financial condition of energy companies and their pro-environmental activity in the years 2013-2017, Eqs. 2, 3, 4, 5, 6 and 7 have been estimated based on data included in consolidated financial statements of capital groups. Values of financial and environmental ratios for particular energy companies have been

Table 1: Aggregated values of EA ratio for Polish energy groups in particular phases of the EU ETS

Commitment period	Będzin	Enea	Energa	Kogeneracja	PGE	Tauron	ZEPAK
2005-2007	0.908	0.981	0.989	0.862	0.956	0.967	0.975
2008-2012	0.986	1.048	1.076	0.902	1.090	0.986	0.887
2013-2020	2.683	3.221	2.098	1.745	2.420	3.068	12.372

presented in Tables 2-6.

In 2013 the most burdensome companies for the environment with respect to CO_2 emission volume per one unit of achieved revenues on sales were Elektrociepłownia Będzin (CoI = 3.929 Mg/th. PLN) and ZEPAK (CoI = 4.750 Mg/th. PLN). At the same time Elektrociepłownia Będzin was the only company that in 2013 recorded a financial loss, which was reflected in the negative value of ROA, ROI and ROS ratios. This was driven by the change of a strategic investor in the company, resignation from the launched unprofitable investment into construction of a biomass boiler, unfavourable situation on the market of electricity and its derived products. ZEPAK in turn was in this period characterised by highest values of ROS and ROI ratios, which can confirm that 8.4% of

Table 2: Financial and environmental ratios for Polish energy groups in 2013

Company	ATR	ROS	ROA	ROI	I_{CAPEX}	Size	EA	CoI
Będzin	0.785	-0.043	-0.033	-1.748	-	12.032	1.816	3.929
Enea	0.590	0.079	0.044	0.471	1.080	16.608	1.753	1.143
Energa	0.714	0.065	0.043	0.748	0.888	16.654	1.796	0.282
Kogeneracja	0.514	0.082	0.041	0.822	1.035	14.473	1.225	1.573
PGE	0.511	0.132	0.065	1.059	0.927	17.931	1.876	2.033
Tauron	0.601	0.070	0.042	0.495	1.200	17.292	1.417	0.974
ZEPAK	0.434	0.084	0.036	1.215	0.908	15.683	2.968	4.750
Average	0.593	0.067	0.034	0.438	0.962	15.810	1.836	2.098
S.D.	0.122	0.053	0.031	1.001	0.161	2.005	0.554	1.640
Median	0.590	0.079	0.042	0.748	0.981	16.608	1.796	1.573
Q.D.	0.102	0.009	0.004	0.294	0.086	1.410	0.229	1.477

Note: S.D. means standard deviation, Q.D. means quartile deviation

Table 3: Financial and environmental ratios for Polish energy groups in 2014

Company	ATR	ROS	ROA	ROI	I_{CAPEX}	Size	EA	CoI
Będzin	0.797	0.127	0.100	1.382	3.846	12.061	2.011	3.490
Enea	0.572	0.092	0.050	0.467	1.320	16.712	2.047	1.141
Energa	0.602	0.095	0.056	1.007	0.899	16.712	2.014	0.310
Kogeneracja	0.449	0.056	0.024	0.195	1.962	14.544	1.178	1.478
PGE	0.442	0.130	0.055	0.805	1.384	18.008	1.954	2.085
Tauron	0.555	0.064	0.034	0.536	0.875	17.358	1.233	0.758
ZEPAK	0.402	0.029	0.011	0.256	1.952	15.742	87.419	4.692
Average	0.546	0.085	0.047	0.664	1.748	15.877	13.979	1.993
S.D.	0.134	0.037	0.029	0.427	1.024	2.020	32.386	1.575
Median	0.555	0.092	0.050	0.536	1.384	16.712	2.011	1.478
Q.D.	0.080	0.036	0.016	0.376	0.531	1.407	0.407	1.366

Table 4: Financial and environmental ratios for Polish energy groups in 2015

Company	ATR	ROS	ROA	ROI	I_{CAPEX}	Size	EA	CoI
Będzin	0.375	0.088	0.020	1.123	1.864	13.467	2.714	3.159
Enea	0.479	-0.041	-0.017	-0.057	1.118	16.951	2.458	1.190
Energa	0.591	0.078	0.046	0.806	1.107	16.731	1.671	0.218
Kogeneracja	0.458	0.128	0.056	0.589	0.971	14.629	1.618	1.385
PGE	0.448	-0.106	-0.050	-0.419	1.353	17.931	2.238	2.042
Tauron	0.548	-0.099	-0.056	-0.483	1.152	17.283	24.136	0.892
ZEPAK	0.498	-0.638	-0.378	-4.388	0.710	15.420	100.973	4.158
Average	0.485	-0.084	-0.054	-0.404	1.182	16.059	19.401	1.863
S.D.	0.070	0.261	0.149	1.861	0.359	1.603	36.894	1.373
Median	0.479	-0.041	-0.017	-0.057	1.118	16.731	2.458	1.385
Q.D.	0.050	0.097	0.051	0.644	0.191	1.327	11.233	1.133

Table 5: Financial and environmental ratios for Polish energy groups in 2016

Company	ATR	ROS	ROA	ROI	I_{CAPEX}	Size	EA	CoI
Będzin	0.266	0.102	0.027	1.955	0.739	13.496	3.646	2.930
Enea	0.474	0.075	0.035	0.417	0.945	17.016	3.405	1.099
Energa	0.548	0.014	0.008	0.310	0.987	16.746	2.446	0.260
Kogeneracja	0.458	0.146	0.067	1.171	0.567	14.625	2.330	1.504
PGE	0.436	0.091	0.038	0.444	0.924	18.027	2.815	1.991
Tauron	0.539	0.021	0.011	0.230	0.885	17.326	27.364	0.844
ZEPAK	0.553	0.093	0.052	1.938	0.468	15.384	113.137	4.236
Average	0.468	0.078	0.034	0.924	0.788	16.089	22.163	1.838
S.D.	0.100	0.046	0.021	0.764	0.203	1.630	41.139	1.360
Median	0.474	0.091	0.035	0.444	0.885	16.746	3.405	1.504
Q.D.	0.048	0.022	0.013	0.342	0.141	1.083	11.067	0.471

Table 6: Financial and environmental ratios for Polish energy groups in 2017

Company	ATR	ROS	ROA	ROI	I_{CAPEX}	Size	EA	CoI
Będzin	0.285	0.070	0.020	5.699	0.330	13.474	4.804	2.798
Enea	0.432	0.102	0.041	0.724	0.767	17.159	42.215	1.727
Energa	0.530	0.075	0.037	0.957	0.806	16.863	3.189	0.251
Kogeneracja	0.432	0.134	0.057	2.134	0.475	14.660	5.034	1.555
PGE	0.331	0.115	0.037	0.599	0.763	18.094	4.152	2.972
Tauron	0.503	0.079	0.039	0.512	1.012	17.393	38.045	0.949
ZEPAK	0.528	0.075	0.041	3.060	0.495	15.310	130.419	4.448
Average	0.434	0.093	0.039	1.955	0.664	16.136	32.551	2.100
S.D.	0.096	0.025	0.011	1.902	0.237	1.680	46.363	1.410
Median	0.432	0.079	0.039	0.957	0.763	16.863	5.034	1.727
Q.D.	0.098	0.020	0.002	1.231	0.165	1.367	19.032	1.011

the net profit on sales remains in the enterprise. Moreover, return on investments incurred by this enterprise on low-carbon modernisation is higher than the average ROI for the studied group of enterprises in 2013, which amounted to 0.438. Best environmental ratios could be observed in the Energa capital group (CoI = 0.282 Mg/th. PLN) and Tauron (CoI = 0.974 Mg/th. PLN). Both companies were characterised by an increase in investments on low-carbon modernisation in 2013 compared to 2012, high values of the asset turnover ratio (respectively 0.714 and 0.601) and oscillating around average levels of return on sales ratios (0.067 – average), return on assets (0.034 - average) and return on investment (0.438 – average). The largest company - PGE (17.931 – size) generated in 2013 6.5% of profit on the total assets and also retained 13.2% profits on sales in the company, which places it on the first position among the studied companies. Simultaneously, CO_2 emission intensity that accompanies its activity was high (CoI = 2.033 Mg/th. PLN). While analysing the development of environmental ratios for particular companies in 2017 one can notice that the highest intensity of CO_2 emission per one unit of revenues characterised the following companies: ZEPAK (4.448), PGE (2.972), Elektrociepłownia Będzin (2.798), and the lowest one Energa (0.251) and Tauron (0.949). All the companies were characterised by an unfavourable relation of verified CO_2 emission to the allocated for the company emission allowances as the EA ratios exceeded the value of 1. Very high values of this ratio for three companies: ZEPAK, Enea and Tauron may be partially explained with lack of updating the account in the EU registry, which can be associated with the time necessary to verify financial expenditures incurred on implementation of tasks submitted to the National Investment Plan. Tauron is the only energy company that in 2017 increased CAPEX compared to the previous period (by 1.2%), which indicates that companies are very cautious while making new decisions on investments in

Table 7: Spearman's ranks correlation coefficient for economic and environmental ratios in 2013-2017

Ratio	EA					CoI				
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
ATR	-0.321	0.000	0.107	0.321	0.107	-0.464	-0.429	-0.643	-0.250	-0.429
ROS	0.286	-0.107	-0.643	-0.071	0.143	0.393	-0.107	-0.286	0.750	0.036
ROA	-0.071	0.000	-0.857	-0.107	0.243	-0.500	-0.214	-0.357	0.643	-0.036
ROI	0.393	0.071	-0.571	0.143	0.071	0.321	-0.143	-0.214	0.893	0.357
I_{CAPEX}	-0.657	-0.036	0.071	-0.393	-0.036	-0.143	0.786	0.000	-0.750	-0.571
Size	0.071	-0.107	0.036	0.036	-0.071	-0.464	-0.464	-0.393	-0.393	-0.429

low-carbon modernisation or construction of new production units. Such type of reaction may be explained by uncertainty derived from tightening up the EU climate and energy policy and its influence on postponing investment decisions by companies included to the EU ETS (Paulson and von Malmborg, 2004). High values of return on investment ratios have been recorded for smaller energy companies: Elektrociepłownia Będzin (5.699), ZEPAK (3.060) and Kogeneracja (2.134). These companies were not so much involved in the R&D activity and search for new models of financing investments into new production technologies. Therefore, the scale of their investments is much smaller than in case of large energy groups.

Based on the estimated Spearman rank correlation coefficients (Table 7) it is not possible to draw conclusions on an occurrence of a correlation dependence between environmental and economic ratios in the studied group of Polish energy companies. The relationship between the EA ratio and companies' profitability is weak in the case of Polish energy groups in the years 2013-2017, in addition to the year 2015. In 2015 the decrease in the value of the EA ratio corresponded to the increase in values of ROS, ROA and ROI. A negative direction of the correlation dependency can be observed in the years 2013-2017 only between asset turnover ratio and return on assets, and the CO_2 emission intensity. This means that an increase in the value of ROA or ATR involves also a decrease in carbon dioxide emission intensity. This is a positive result that demonstrates that better financial results of enterprises are associated with reduced degradation of the natural environment through reduced emission of greenhouse gases in the processes related to company's activity. The exception is year 2016, in which the increase in values of ROS, ROA and ROI leads to environmental degradation by increasing the level of carbon intensity.

CONCLUSION

This paper analyses the link between economic performance and environmental performance of Polish energy companies, which were listed on the Warsaw Stock Exchange and were covered by the EU ETS in the years 2013-2017. Two indicators of environmental performance: carbon intensity and the ratio of carbon dioxide emissions over the allowances, as well as chosen financial ratios: return on assets, return on investment, return on sales, asset turnover ratio have been calculated for these companies, based on information gathered in the European Union Transaction Log database and Notoria database. A Spearman's rank correlation coefficient has been used in order to evaluate the relationship between these environmental and financial indicators, which were estimated for each energy company in the period 2013-2017. The obtained results do not allow to confirm unambiguously the existence of the relationships between the financial condition of energy companies and fulfilling by them the obligations to limit carbon dioxide emission. It is worth stressing that two of financial variables, namely asset turnover ratio and return on assets did experience a proper relationship with carbon intensity variable, what means that the better financial condition of the energy company, the lower its carbon dioxide emission intensity. These are just preliminary research results, which will be further verified based on a larger database. Moreover, the research has shown that the situation of Polish enterprises worsened in the present phase of the EU ETS functioning, as the amount of allocated allowances in case of all energy companies was insufficient to cover their own CO_2 emission, which is indicated by the values of the EA ratio bigger than one. These results and the information that the top threshold of decarburization has been established for electricity producers in the EU at the level of 550 g/kWh strongly suggest that Polish energy enterprises ought to invest in low-carbon production technologies and strive at increasing the share of RES in the structure of fuels and other primary energy carriers used to generate electricity. For this reason, Polish energy companies can seek to acquire free emission allowances in the third trading period, according to Directive (2003), on condition that they incur own financial expenditures on investments related to modernization and retrofitting of the infrastructure, application of clean technologies, diversifying the energy structure or diversifying sources of supplies, which have been included into the National Investment Plan. The research has also demonstrated decreasing tendency in CAPEX value over the period 2013-2017 for most of the analyzed energy companies. Such regularity may suggest that Polish energy companies while making decisions on investments into low-carbon modernization of the existing installations or constructing new ones, more and more often consider economic factors, namely achieved financial results, electricity cost for final customers and chances of obtaining additional EU funds for carrying out the investments.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy were completely observed by the authors.

ABBREVIATIONS

%	Percentage
ATR	asset turnover ratio
CAPEX	capital expenditure
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
CO_2	carbon dioxide
CoI	carbon intensity index
d_i	difference of ranks between environmental indicator and financial ratio
E	value of verified CO_2 emission
EA	emissions per allowances
ERU	Emission Reduction Units
EU	European Union
EU ETS	European Union Emissions Trading System
EUA	European Union Allowances
g/kWh	gram per kilowatt-hour
I_{CAPEX}	chain base index for investment expenditures
JI	Joint Implementation
KOBiZE	National Centre for Emission Management
Mg	Mega grams
Mg/th. PLN	Mega grams per thousand Polish zloty
n	statistical sample size
n(EUA)	number of allocated free of charge permits
NP	net profit
OP	operating profit
PGE	Polska Grupa Energetyczna S.A.
PLN	Polish zloty
Q.D.	quartile deviation
RES	Renewable Energy Sources
ROA	return on assets
ROI	return on investment
ROS	return on sales
r_S	Spearman's rank correlations coefficient
S.A.	joint-stock company
S.D.	standard deviation
size	logarithm of total assets
TA	total assets
TS	revenues on sales
ZE PAK	Zespół Elektrowni Pątnów-Adamów-Konin S.A.

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