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EVALUATION OF THE USE OF COGENERATION BONUS AS A SUPPORT MECHANISM FOR THE TRANSFORMATION OF THE HEATING SYSTEM IN POLAND IN 2019-2020

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ABSTRACT: The development of cogeneration is an element of the transformation of the heating sector in Poland. Consequently, the state applies various subsidy mechanisms. One of them is the cogeneration bonus, designed to stimulate investment in high-efficiency cogeneration. It subsidies the generated electricity to entities that won the cogeneration bonus auction and then made investments in new cogeneration engines. This paper aims to evaluate the use of the cogeneration bonus. The thesis assumes that the cogeneration bonus, despite its supportive nature, is not used by investors. This is evidenced by the low level of contracting of subsidies available in individual auctions. To achieve the study's objective, the ratio of contracted subsidies in the cogeneration bonus auctions to the volume available for contracting in individual auctions was analysed. The author has studied the auction results for cogeneration bonuses, sector reports, CO_2 emission price, types of fuel, and aggregated financial data of heat plants in Poland. The research has an implication character, confirming the lack of adequacy of cogeneration bonuses to the financial situation of potential investors.

KEYWORDS: CHP, cogeneration bonus, RSE, support mechanisms

Introduction

Pollution of the environment and deteriorating air quality have caused regulators to look more and more closely at environmental issues, including ways of generating electricity, especially from renewable sources. One of the solutions in this area is cogeneration, i.e. production of heat and electricity in one technological process. The transition from conventional heat generation to cogeneration poses a significant challenge to the economy due to the substantial investment needed to modernize heating plants; hence Polish legislation applies several incentives and support mechanisms to develop this energy sector. One of them is cogeneration bonus auctions organized by the Energy Regulatory Office.

The essence of the research is to assess the level of utilisation of funds from the cogeneration bonus auctions in 2019-2020 and, as a further search for the causes of the existing situation, macroeconomic analysis of the heating sector in Poland. In this publication, the author has focused on the main factors affecting the condition of the heating market in Poland, i.e.:

- types of fuels used in heat plants in Poland,
- changes in the prices of CO_2 emission rights over the 2017-2020 period,
- changes in prices of coal used in the heating sector in 2017-2020.

Numerous reports of the heating sector and data aggregated by the Energy Regulatory Office in Poland give researchers the opportunity and tools to evaluate the effectiveness of support mechanisms. This article will determine the level of use of the support mechanism, which is the cogeneration bonus.

Basic research categories – An overview of the literature

For ease of understanding by the reader of the text, selected definitions have been adopted that will apply to the terms used later in the paper. Table 1 summarises the basic terms used further in the article and their adopted definitions.

The problem of cogeneration bonuses in Poland is a novel issue, as the first auction of the cogeneration bonus auction was organised by the Energy Regulatory Office only in 2019. Hence, there are not many studies on this detailed issue. The auction organiser for the cogeneration bonus is the Energy Regulatory Office. The auction is open to heat plants, which intend to produce not only heat but also electricity in the so-called cogeneration, i.e. in one technological process (Kiciński & Lampart, 2005). Entities that win the auctions must modernise and start production under high-efficiency cogeneration within five years. As a result of winning the auction, the company (heat

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plant) receives a surcharge on the kWh produced, declared in the auction price, once the heating plant starts producing electricity. The auction is won by entities that meet the formal requirements and declare the lowest auction price until the volume of funds allocated to the cogeneration bonus for a given auction is exhausted (URE, 2021).

Table 1. Definitions of basic categories

Category	Definition
Cogeneration	Generation of heat and electricity in a single process
High-efficiency cogeneration	According to the Energy Law, this is the fuel savings achieved, in a cogeneration system relative to a separate system with reference values, greater than 10%
Cogeneration bonus	Subsidies for electricity generated in auctions held by the Energy Regulatory Office dedicated to medium-sized cogeneration units with electric power between 1 and 50 MW

Source: Kiciński & Lampard 2009; Energy Regulatory Office, 2019; Energy Law, Art. 1. Pt. 38.

Also, the issue of the situation of the heating sector and, in particular, the analysis of support mechanisms in the context of the transformation of the heating sector in Poland is not the subject of many studies in both domestic and foreign literature. The topic of cogeneration itself and its positive impact on the process of heat and electricity generation is addressed by, among others, Jan Kiciński, Piotr Lampart (Kiciński & Lampart, 2009), Janusz Flasza (Flasza, Popenda, & Jąderko, 2013) or Marek Urbanik (Urbanik & Tchórzewska-Cieślak, 2014).

Despite the occurrence of scientific studies and articles in the literature, there is a research gap concerning support mechanisms, their sense-making and effectiveness of action. Within the framework of this article, the author attempts to partially fill this gap by assessing the use of the cogeneration bonus in Poland.

The production of heat and electricity is part of a closed-loop economy. A closed-loop economy is an increasingly prevalent issue in environmental economics. More and more publications appear in this area, and numerous authors, including Walter R. Stahel (Stahel, 2016), Piero Morseletto (Morseletto, 2020), and Joseph Sarkis (Geng, Sakris, & Bleischwitz, 2019), conduct research on the sensibility and the way to implement a closed-loop economy. Within the Polish authors, it is worth noting the studies of Jerzy Śleszyński (Śleszyński, 2018) or Elżbieta and Agnieszka Lorek (Lorek & Lorek, 2018). The main assumption of a closed-loop economy is its self-sufficiency and closed circulation of materials, recycling of waste and reuse in the same processes (Pichlak, 2018, p. 335-339). Non-carbon generation of heat and electricity is necessary within the various processes. Figure 1 shows the pro-

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cesses in a closed-loop economy, along with a listing of energy and heat-intensive processes.

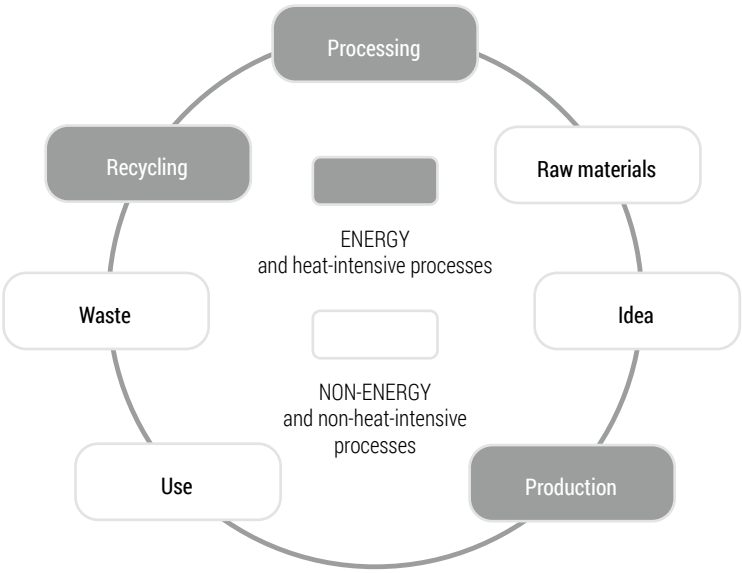

Figure 1. Energy and heat generation in a closed-loop economy

Source: author's work based on Andersen, 2007, 133-140.

Some operations such as recycling, manufacturing or processing often involve the consumption of both electricity and heat. An important aspect is a self-sufficiency and emission-free production of heat and power itself. The production of energy and heat from renewable sources and the efficiency of the production process itself are key factors in developing a closed-loop economy.

Hence, as part of the ongoing energy transition, great importance is attached to renewable energy sources and the generation process itself, including cogeneration. It is worth noting that both the European Union and Poland impose plans for energy transformation. Legal acts regulating climate targets as well as support models for cogeneration include:

- Act of 14 December 2018 on the promotion of electricity from high-efficiency cogeneration (Journal of Laws of 2019, item 42),
- National Energy and Climate Plan 2021-2030,
- Energy Policy of Poland until 2040 (PEP2040),
- Energy Law (Journal of Laws of 2021, item 716).

The main goals for Poland in the context of the energy transformation until 2030 are (KPEiK):

- 7% reduction in greenhouse gas emissions compared to 2005 baseline,

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- 21-23% share of RES in gross final energy consumption,
- reducing the share of coal in electricity production to 56-60%.

The mentioned legal acts also set targets for Poland in the field of heating and cogeneration, i.e. increase of the share of renewable energy sources in heating by 1.1% per year and increase of new cogeneration capacity by 5 GW by 2030.

Legal acts and programs implemented by state institutions result in several support mechanisms aimed at stimulating changes in the heating industry in Poland. These mechanisms can be divided into those focused on supporting capital expenditures and those aimed at stimulation through subsidies to the energy generated in the cogeneration process.

Figure 2 shows Poland's existing and planned support mechanisms for cogeneration until 2030.

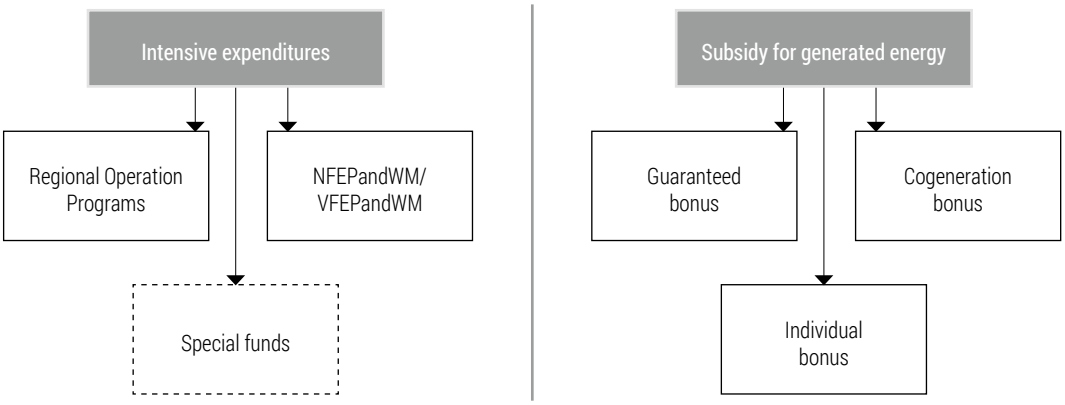

Figure 2. Support mechanisms for cogeneration

Source: author's work based on Urząd Regulacji Energetyki, 2021a.

Regional Operational Programs and resources from the National Fund for Environmental Protection and Water Management are among the most important mechanisms designed to support investment expenditures. These are support programs financed mainly from EU funds. Additionally, national resources' special funds for cogeneration development are planned until 2030. In contrast to the mechanisms focusing on capital expenditures, there are mechanisms based on subsidies for energy generated in high-efficiency cogeneration. These programs stem from the Act on Promoting High-Efficiency Cogeneration (2019, item 42) and are run by the Energy Regulatory Office.

This article focuses on the cogeneration bonus because the distribution of funds under this mechanism (unlike the others) operates on an auction basis, using market mechanisms (i.e. equating supply and demand).

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Research objectives and methods

As the literature review shows, there are many measures and support mechanisms in place for both renewable energy sources and high-efficiency cogeneration itself. It is worth investigating whether these mechanisms are effective and whether they are being used appropriately and as intended. The utilization rate of the cogeneration bonus is measured in this study as the ratio of the contracted funds in a given auction to the volume of funds allocated to that auction (contractable volume).

It was defined by the formula:

$$DCB = \frac{A}{P}, \tag{1}$$

where:
DCB – the degree of use of the cogeneration bonus in a given auction,
A – actual contracted volume (PLN),
P – volume possible to contract (maximum amount of subsidies specified in the auction announcement in PLN).

The author's thesis is that the cogeneration bonus is not adequately used. Within the framework of the study, the author's task is to assess the utilisation level and the reasons for the success or failure of the cogeneration bonus auction. As it is commonly known, each research method should be correlated with the set research objective (Apanowicz, 2000, p. 86) and fulfil the research provisions in a coordinated way. According to the classification of research methods of J. Apanowicz (Apanowicz, 2002, p. 61-77), the method of the research of secondary sources was chosen. Numerous sources were analysed, ranging from market reports, results of the auction for the cogeneration bonus, to coal price indices and aggregate financial results of the heating sector in Poland.

The research process was divided into the following stages:

- Analysis of the results of the Energy Regulatory Office's cogeneration bonus auction in 2019-2020.
- Summary of fuel types used in the heating sector in Poland.
- Analysis of prices of coal used in heating (PSCMI2 index).
- Analysis of CO_2 emission allowance prices (CFI2Z1 index).
- Aggregation of results of heating companies on the Polish market.
- Conclusions from the research.

The research process was designed to fill a research gap, which is the evaluation of the level of utilisation of the cogeneration bonus.

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Course and results of the study

The first part of the research concerns the cogeneration bonus and the degree of its utilisation in 2019-2020. The transformation of heating in Poland is complex and is influenced by many factors. It is determined by normative regulations economic and sectoral situation on the national and EU level. In the further part of this study, the analysis of factors that influence changes in the heating sector is presented. Firstly, the structure of fuels used in the heating sector in Poland was analysed. On this basis, exogenous factors were selected, and two factors were chosen that have a significant influence on the cost and profitability of these enterprises:

a) heating coal prices over recent years,
b) CO_2 emission prices affecting environmental charges.

The study concludes with aggregate financial data for heat plants in Poland.

Cogeneration bonus as a support mechanism for the Polish heating sector

The cogeneration bonus is one of the support mechanisms to promote investment in cogeneration. It stems from the Act on Promoting (2019). Energy Regulatory Office is in charge of conducting auctions for cogeneration bonuses. The cogeneration bonus consists of subsidies for the generated electricity by the companies selected under the auction system.

The main assumptions for the cogeneration bonus auction:

- units with generation capacity between 1 and 50 MW can participate,
- the auctions concern only new or significantly modernised units,
- the surcharge for each kWh applies to the energy produced within 15 years from the first day after the date of the auction, generation, introduction to the grid and sale of electricity,
- the investment implementation period is 60 months,
- the subsidy applies only to each kWh of electricity generated as part of high-efficiency cogeneration,
- no less than 70% of usable heat from the cogeneration unit must be introduced into the public heating network.

The provision concerning usable heat to be fed into the public network limits the support mechanism to enterprises controlled by local governments or companies controlled by the State Treasury. This makes it very difficult to use alternative forms of financing, such as Public-Private Partnership (PPP) or heat plants reaching for private investors or investment funds.

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Results of the 2019-2020 cogeneration bonus auction

The research analysed the effectiveness of the cogeneration bonus auction. Figure 3 shows the support funds available for contracting and their actual use. The study covers the period from the first auction held in 2019 to the end of 2020.

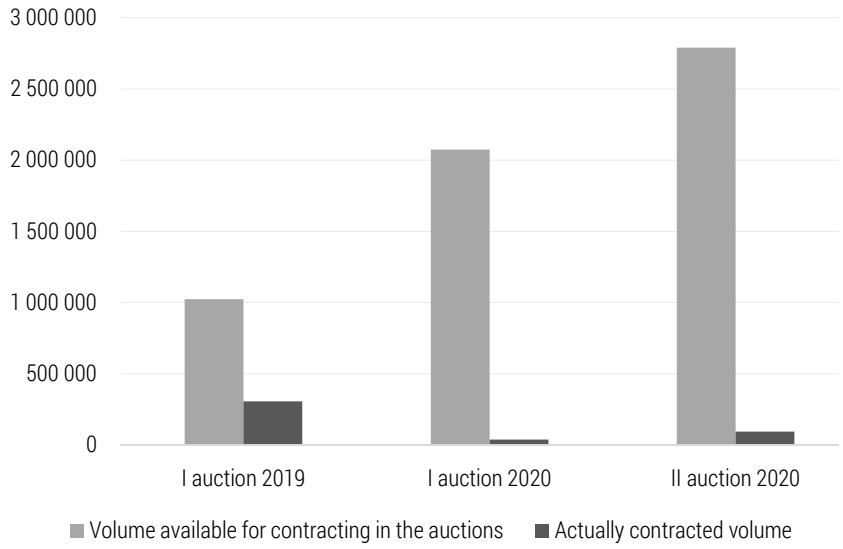

Figure 3. Cogeneration bonus auctions in 2019-2020 in thousand PLN

Source: author's work based on the Energy Regulatory Office data, (15-12-2021).

As shown in the chart, the first three auctions for the cogeneration bonus did not use even a fraction of the possible volume. The efficiency of the first auction measured by the percentage share of available funds was 30.09%, while the efficiency of the two subsequent auctions was 1.89% for the first auction in 2020 and 3.4% for the second auction in 2020. The second auction in 2020 contracted only PLN 94.77 mill. out of the PLN 2 788.93 mill. that could be contracted.

Types of fuel used in heating plants in Poland

The type of technology and raw material for heat generation is one of the key issues in the context of the profitability of heat generation. The most common raw materials used in the heating industry in Poland include hard coal, natural gas and biomass. Based on data from the Energy Regulatory Office, the percentage share of raw materials used in the total heat production in Poland is presented below (Figure 4).

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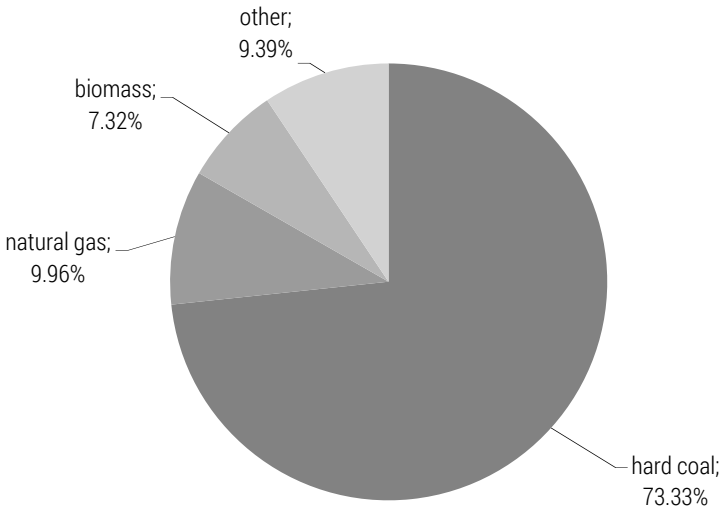

Figure 4. Types of raw materials used for heat generation in Poland in 2019
Source: author's work based on Urząd Regulacji Energetyki, 2021.

Most of the heat in Poland is generated by burning hard coal. In the total volume of raw materials consumed, almost three quarters are coal, 10% is natural gas, and 7% is biomass. Considering that most of the heat is generated from hard coal, it is worth analysing changes in its prices in recent years.

The impact of hard coal price changes from 2017 to 2020

Prices of coal, the primary raw material for heat generation, are reflected in the PSCMI2 index, calculated in PLN/ton. The index is traded on the Polish Power Exchange. Its calculation methodology was developed by the Institute of Mineral Raw Materials and Energy Management of the Polish Academy of Sciences in Krakow. The index represents prices of coal dust used in heating, having the following quality parameters:

- energy value between 23 and 27 MJ/kg,
- sulphur content is less than 0.8%.

Presented prices (Figure 5) are ex-mine (net price excluding excise tax, determined at the point of loading, not including insurance costs).

The price of coal in 2017 was at 240 PLN per one ton. In 2020, heat generators already had to pay more than 315 PLN per one ton. This gives a price increase of more than 30% within three years. The raw material price is the highest cost in every heating company. Price increases in recent years have had a negative impact on the heating market in Poland and have reduced the profitability of most companies in this sector in Poland.

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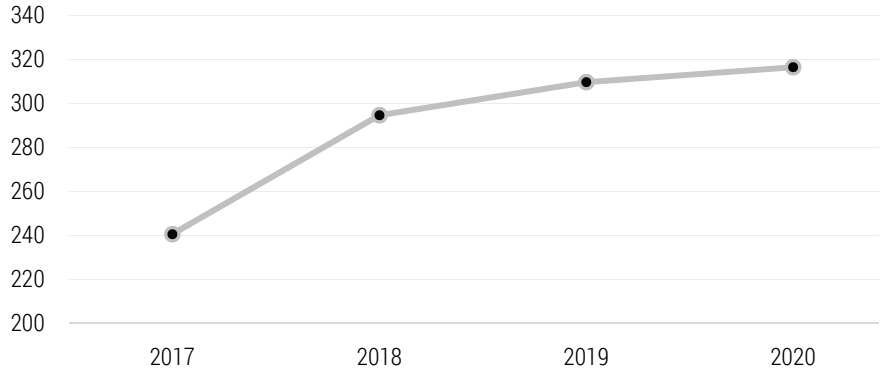

Figure 5. PSCMI2 Index 2017-2020 (PLN/Mg)

Source: author's work based on data from the TGE.

Prices of CO_2 emission allowances

Another factor that burdens heat generation costs is the prices of CO_2 emission allowances (related to the use of hard coal as a fuel). Depending on the level of CO_2 emissions of a given heating plant, it has to reckon with the costs of purchasing emission allowances. The prices of CO_2 emission allowances are reflected in the CFI2Z1 index, which is maintained on the London Stock Exchange. This index presents the costs of forwarding contracts to purchase CO_2 emission permits.

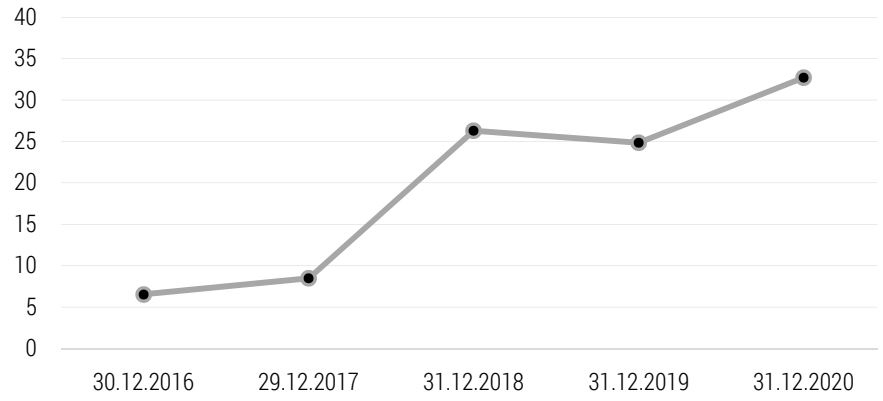

Figure 6. CFI2Z1 Index (EUR) 2016-2020

Source: author's work based on Investing.com, 2021, (15-12-2021).

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The prices of CO_2 emission allowances have increased significantly. While at the end of 2016, the price was at EUR 6.54, by the end of 2020, the price was almost five times higher at EUR 32.72 (Figure 6). This directly affected the performance of heating companies in Poland (shown in Table 2), which use fuels that cause significant emissions (including, to a large extent, Polish heating plants based on coal fuel).

The situation of the heating sector in Poland from 2017 to 2019

The study aggregates the data of the heating sector in Poland and shows the most important total data of the heating industry in Poland from 2017 to 2019. The impact of rising prices of fossil fuels (including hard coal) and CO_2 emission allowances caused a significant deterioration of the heating market in Poland.

Aggregate financial results of heating plants in Poland are presented in Table 2.

Table 2. The financial situation of Polish heating plants in 2017-2019

Selected total results of heating companies in Poland			
Specification	2017	2018	2019
	[in thousand PLN]		
Revenues from heating business	18 942 094,9	18 368 410,7	18 590 936,8
Costs of heating business	17 671 154,7	18 023 295,9	19 134 003,9
including the cost of process fuel	4 083 316,8	4 589 625,6	4 807 128,8
percentage share of fuel costs	23,11	25,46	25,12
incl. environmental charges	188 542,4	235 762,7	324 307,2
Gross profit on heating business	1 270 940,2	345 114,8	-543 067,1
Return on sales	6,71%	1,88%	-2,92%

Source: author's work based on Urząd Regulacji Energetyki, 2021.

In the three years under review, the financial situation of the heating market in Poland deteriorated significantly. While in 2017, heating companies in Poland generated more than PLN 1 billion profit from the heating business, in 2019, they already showed a loss of more than PLN 500 mill. Fuel costs (mainly hard coal) increased by more than PLN 700 mill. in this period, and emission prices almost doubled. The deterioration of the cost positions of the heating companies adversely affected their financial condition, as well as their ability to incur financial liabilities and limited their potential to carry out modernisation and investments in new technologies.

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Conclusions

The development of the market for heating services and support mechanisms designed for renewable energy sources and the assessment of their effectiveness is undoubtedly an important research gap in environmental economics, as well as public finance itself. The author focused on the cogeneration bonus within the study's framework, as it is a new mechanism, existing only since 2019 (the date of the first auction for the cogeneration bonus). The presented study illustrates how important a factor is the excellent selection of support mechanisms to the economic situation of the sector and its current financial condition.

The main findings of the study are:

- as a support mechanism in its current form, the cogeneration bonus is not effective and does not fill the intended and available volumes;
- the main reasons for the insignificant interest in the cogeneration bonus by companies in Poland are:
- the deteriorating financial situation of heat plants causes a lack of funds and credit capacity to carry out the investment (need to incur outlays before the payment of support resulting from winning the auction for the cogeneration bonus),
- limitation of the support mechanism to companies with access to public heat transmission networks (restriction to public heating plants);

Poland needs to introduce new, more tailored support mechanisms for the coal-fueled heating sector to achieve the objectives arising from the National Energy and Climate Plan for 2021-2030 (2021) and the Energy Policy of Poland until 2040 (2021).

This article does not cover the entire spectrum of evaluating support mechanisms for renewables or even cogeneration itself. There are several possible directions for further research in this area. As part of further work, the author intends to focus on the issue of changing the assumptions of the support mechanism, which is the cogeneration bonus, and the analysis of possible measures to support the use of the cogeneration bonus, including:

- facilitation of PPP in the framework of investments in cogeneration,
- creation of additional financial products for Polish municipalities not constituting state aid (in the context of the required own contributions).

The data presented in the paper and their interpretation show that the correct initial assumptions of the support mechanisms do not produce the expected effects in stimulating the development of the heat market and its profitability due to the unused volume of support and external costs, including the increase in fuel prices and the increase in the costs of CO_2 emission allowances.

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