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DETERMINANTS OF ACTIVITY AND THE IMPACT OF EXISTING THREATS ON THE STATE OF THE POLISH HEATING INDUSTRY

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Purpose: The purpose of this article is to identify existing threats to the operations of local district heating companies, as well as to indicate their impact on the condition of the Polish heating industry.
Design/methodology/approach: The stated aim was achieved through the use of a method of desk data analysis (desk research). The study used information from the activity reports of 158 local district heating companies.
Findings: The research conducted made it possible to systematize the current threats and their impact on the operation of the heating in Poland in the era of energy transition. They also showed the ability of managers of local district heating companies to recognize existing risks.
Research limitations/implications: The obtained research results concern the identification of threats by local heating companies in the period before the occurrence of emergency events (pandemic and war in Ukraine). It is advisable to repeat the research after the stabilization of prices on fuel markets.
Originality/value: In a cognitive sense, the results of the study identify the hierarchy of threats to the operations of local district heating companies. They also prove the correctness of management's identification of risks by indicating their impact on the condition of the Polish heating sector.
Keywords: heating industry, conditions of activity, local district heating companies, threats.
Category of the paper: Research paper.

1. Introduction

District heating companies operate in a changing environment, which, especially in recent years, has posed difficult challenges and significant risks to their operations. This is related to the stringent climate and energy policies consistently implemented in the European Union. It implies legal and environmental frameworks, efficiency measures, technological solutions and development trends. The main elements of this policy in the area of district heating are efficient use of energy, development of renewable energy sources (RES) and cogeneration,

reduction of greenhouse gas emissions and implementation of energy-saving technologies in buildings (European Commission, 2016). In continuation of this policy, the EU has adopted:

- in 2019 - European Green Deal action strategy (European Commission, 2019),
- in 2021 - European Climate Law and the "Fit for 55" Package.

Achieving the set climate goals by 2050 requires transitioning the energy sector, including district heating, to low-carbon technologies, reducing fossil fuel consumption in favor of renewable energy sources, and transforming existing district heating systems into efficient systems. It should be noted that these issues are particularly relevant in EU countries where district heating is most developed due to lower external temperatures. Currently, more than 77 million EU citizens receive heat from district heating systems (Euroheat and Power, 2024). The highest percentage of citizens using district heating (above 40%) is found in Denmark, Estonia, Lithuania, Latvia, Poland, Slovakia, Sweden and Finland (Euroheat and Power, 2024). Therefore, the transition of the district heating sector is important in the energy policies of these countries, including in Poland (Ministry of Climate and Environment, 2021). The most advanced solutions as well as studies in this area are conducted in Denmark, Sweden and Finland. They indicate that the directions of development and possible decarbonisation paths of the heating sector require the implementation of modern fourth and fifth generation district heating systems (4GDH and 5GDH). These are low-temperature district heating networks (LTDH) integrated into sustainable energy systems using renewable energy sources and heat storage (Lund et al., 2014; Bloess et al., 2018; Buffa et al., 2019; Kavvadias et al., 2019; Allen et al., 2020; Millar et al., 2021). Advantages of LTDH systems include reduced heat losses in the network (efficiency), reduced greenhouse gas emissions, flexibility to use multiple renewable heat sources (including consumers), increased use of heat storage units, improved power-to-heat ratio in CHP systems, and economic benefits (Olsthoorn et al., 2016; Werner, S., 2017; Mathiesen et al., 2019; Sorknæs et al., 2021).

A significant problem in decarbonising district heating and increasing the share of RES in the heat generation process is the fragmentation of heat markets (OECD/IEA, 2018). Indeed, urban district heating systems are mostly operated by locally based companies that are limited on the demand side by heat demand (population, climatic conditions, etc.). Local district heating companies operating under energy policy solutions at the national level must adopt a risk-sensitive development strategy and a business model focused on necessary technological changes (Lygnerud, Werner, 2018; Lygnerud, 2019; Vilén et al., 2024). Applying this to the Polish district heating sector, which currently still uses more than 66% of coal fuels, the highest in the EU (Euroheat and Power, 2024), the question must be asked:

Do local district heating companies in Poland identify current threats to their operations?

Awareness of existing threats and the ability to exploit opportunities are essential not only at the stage of creating a long-term development strategy, but also in ongoing operational activities. This is a prerequisite for the effective implementation of the transition process of the Polish district heating industry while ensuring the security of heat supply.

2. Operating conditions and directions of change in the Polish heating industry

The complexity of factors currently influencing the development and direction of changes in the heating sector companies is shown in Figure 1 (Wrzalik, 2021).

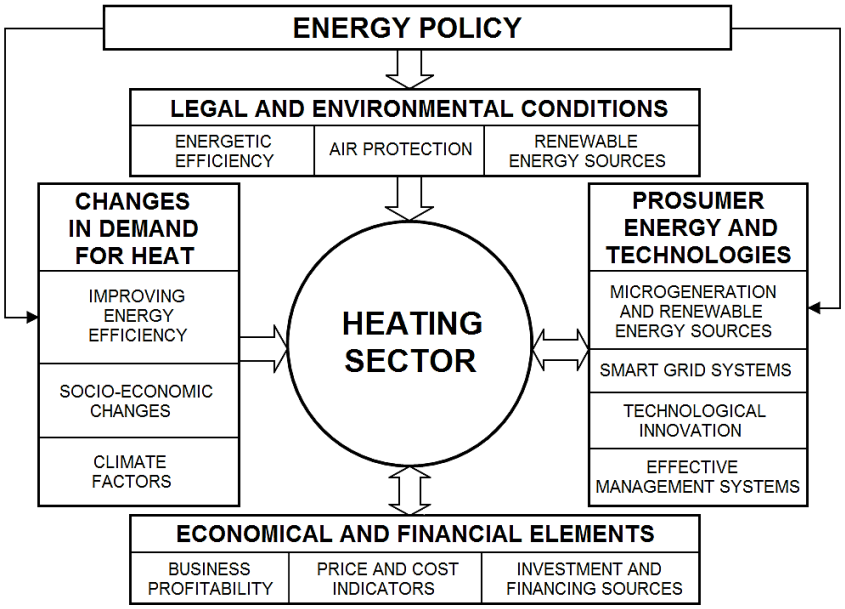


Figure 1. Factors influencing the directions of change in the heating sector.

Source: own study.

Detailed legal solutions and financial instruments resulting from the objectives of the energy policy, as well as current market and local conditions, create a specific framework for the operation of heating companies. Taking this into account with the complexity of impacts on the district heating sector (Figure 1), Table 1 presents the most important factors affecting the operation and development opportunities of district heating companies (Rak, 2018).

Table 1.
Factors affecting the operation and development opportunities of district heating companies

Internal factors	External factors
– economic and financial situation of the company – enterprise development strategy – implementation of technological and organizational innovations – heat generation technology – level of reserves in the heat source – technical condition of heat generation and transmission infrastructure – introduction of IT tools for monitoring and management of the district heating system – management commitment and ability to manage resources – skills, experience and competence of employees operating the heat infrastructure	– macroeconomic conditions – level of fuel prices (impact on costs and profitability of operations) – technical and environmental requirements resulting from legal regulations – programs and funds promoting energy efficiency growth and environmental protection – state financial support for innovative activities – development of energy-efficient construction technologies – development of prosumer energy and microgeneration with RES participation – current weather conditions – reliability of fuel and electricity supply

Source: own study.

Among external factors, technical and environmental requirements, the level of fuel prices, access to external sources of financing (aid funds) and energy-saving technologies (RES, low-energy construction) are of particular importance. Possibilities for the development of district heating companies should be considered in the context of the strategic goals of the state energy policy (EPP2040). They are aimed at, among other: decarbonizing the energy sector, implementing low-carbon technologies, reducing fossil fuel consumption in favor of renewable and alternative energy sources, increasing energy efficiency and reducing carbon emissions. In addition, the size of the city in which it operates (the level of heat demand, the company's potential) matters for a particular enterprise. The diversity of operating conditions and development prospects of district heating companies in Poland depending on the size of the city is illustrated in Table 2.

Table 2.
Determinants of operation and development of district heating companies in different cities

Category	**Large cities**	**Medium cities**	**Small cities**
Strategy	Conservative	Transformational	Adaptive
Demand for heat	Stable	Diversified	Decreases
Heat prices	Below average	Medium	Above average
Finance and technology	Satisfactory	Diversified	Weak
Access to capital	Easy	Diversified	Difficult
Business potential	High	Diversified	Moderate
Environmental requirements	Possible to meet	High challenge	High challenge
Perspective	Good	Diversified	Bad
Fuel	Coal/gas	Coal/gas/biomass	Gas/biomass
Innovative activities	Modernization of generating units and distribution networks taking into account realistic forecasts of heat demand - reducing emissions, heat losses and operating costs		

Source: based on Rączka, Rubczyński, 2017, p. 14; Mazur, 2017, pp. 21-22.

Achieving stable development under the conditions of the energy transition, while ensuring the security of heat supply, improving energy efficiency and environmental indicators, requires the adoption of a long-term strategy by district heating companies. As part of it, it is necessary to comprehensively modernize the existing infrastructure and implement innovative technological solutions (Wojdyga, Chorzelski, 2017; Rak, 2018; Chwieduk et al., 2020; Wrzalik, 2022; Talarek et al., 2023).

3. Threats to operations in the assessment of local heating companies

A detailed analysis of the threats to operations and their relevance was carried out using the desk research method, analyzing data contained in the activity reports for 2019 for the group of 158 (out of 250 companies) local district heating companies listed in Table 3, broken down by city size and type of business - licenses held (Wrzalik, 2022). The threat factors to operations

indicated by local district heating companies, according to the hierarchy of their importance, are shown in Figures 2 and 3.

Table 3.
Number of local district heating companies indicating threats to their operations in 2019 reports

Size of city	Number of local district heating companies indicating threats									
	WPIDO		WPID		W		PIDO		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Small < 20 thousand inhabitants	5	62.5	51	56	1	100	5	45.5	62	55.9
Medium 20-100 thousand inhabitants	11	73.3	60	69	2	100	6	40	79	66.4
Large < 20 thousand inhabitants	8	72.7	7	100	1	100	1	100	17	85
Total	24	70.6	118	63.8	4	100	12	44.4	158	63.2

WPIDO - companies that generate heat and purchase it from other generators, and then transmit and distribute it, WPID - companies that comprehensively serve customers by generating, transmitting and distributing heat to customers, W - heat producers that generate heat and sell to companies engaged in the transmission and distribution of heat to customers, PIDO - distribution companies that transfer and distribute heat purchased from producers.

Source: own research.

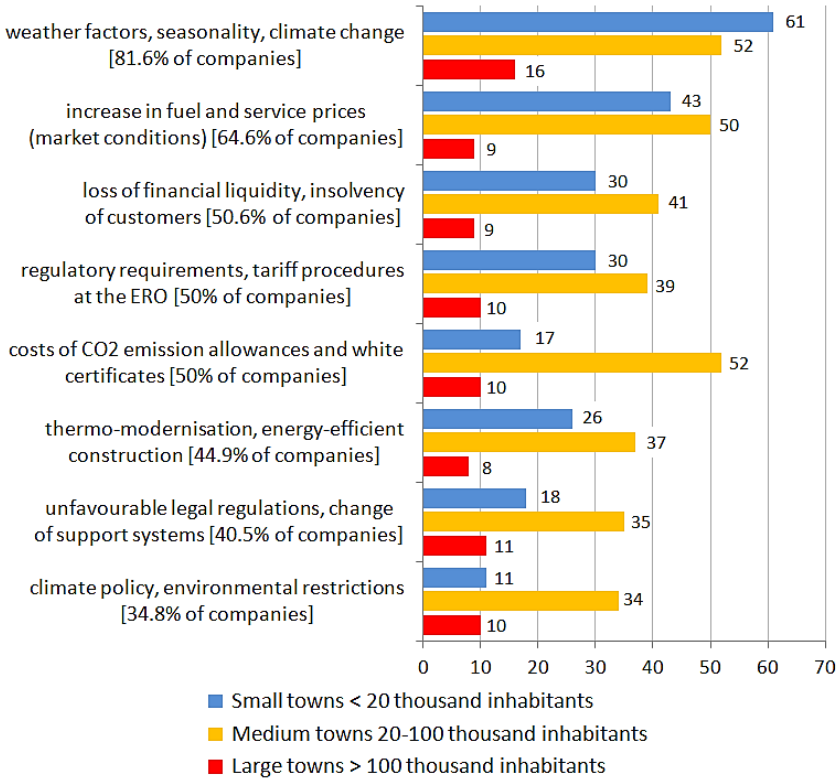


Figure 2. Threat factors to operations indicated by local district heating companies by city size, quantified (n = 158 of 250).

Source: own research.

The companies indicated (81.6%) weather factors (temperature, season length) and climate change as the most important threat, as they have a decisive impact on the volume of heat sales and, as a result, together with prices, on sales revenue.

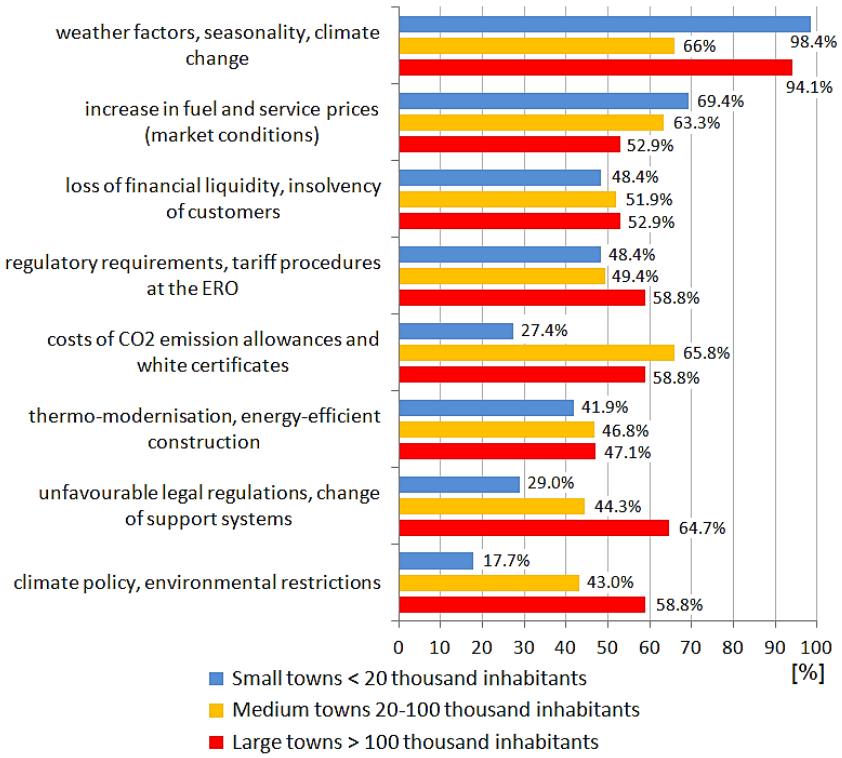


Figure 3. Threat factors to operations indicated by local district heating companies (n = 158 out of 250) by city size in percentage terms (percentage from sample of cities: 17 large, 79 medium and 62 small).

Source: own research.

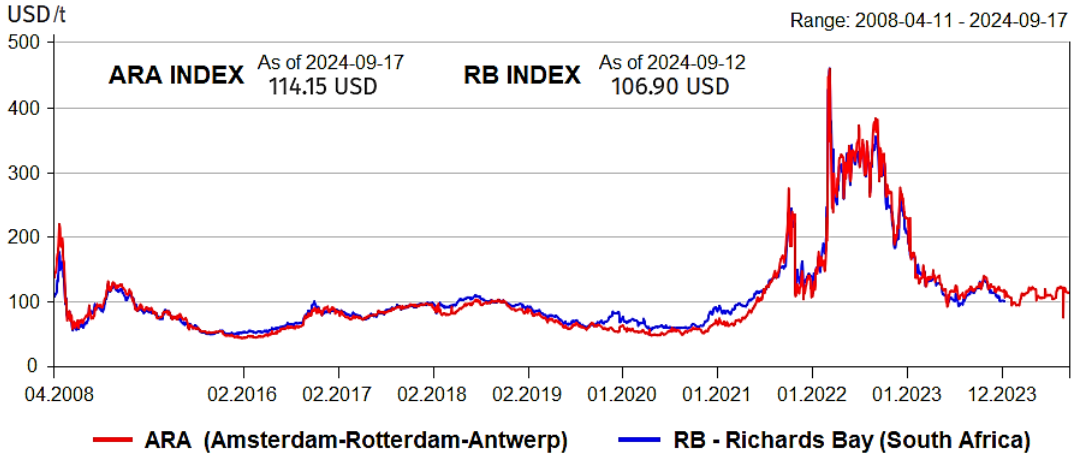


Figure 4. Quotations of coal prices on world markets in historical terms.

Source: based on https://www.wnp.pl/gornictwo/notowania/ceny_wegla/?zakres=5, 18.09.2024.

The second most important threat indicated is the increase in prices of fuels and services (64.6%), with the percentage of indications being highest for companies operating in small towns (69.4%). The accuracy of this assessment is confirmed by the changes in quotations of coal and gas prices on world markets, presented in Figures 4 and 5. Next, heating companies mention the threat of loss of financial liquidity (50.6%) due to the amount of operating costs and insolvency of customers, regulatory requirements, especially tariff procedures at the ERO (50%), and the increase in the cost of purchasing CO_2 emission allowances (50%).

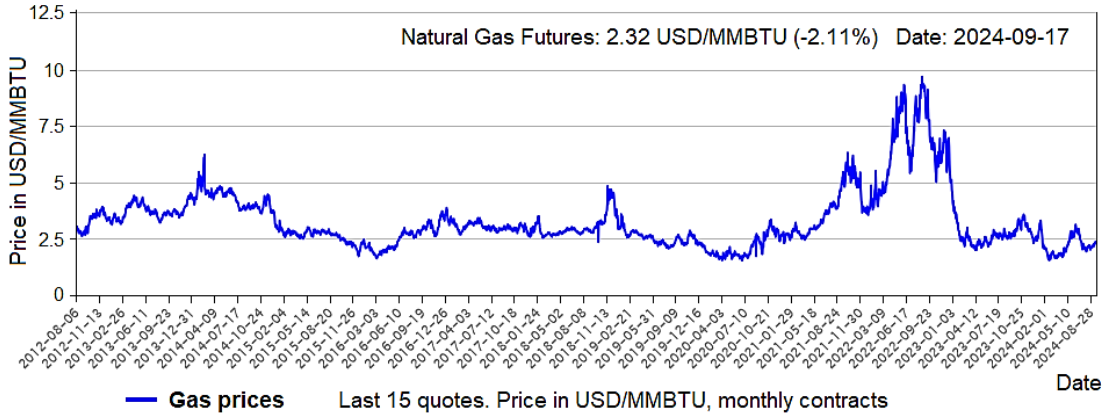


Figure 5. Quotations of gas prices on world markets in historical terms.

Source: based on https://www.wnp.pl/gazownictwo/notowania/ceny_gazu/?zakres=10000, 18.09.2024

The increase in the cost of emission allowances (due to the size of the capacity of sources above 20 MW_t, there is an obligation to participate in the EU ETS) primarily affects heat producers (W and WPID groups) and, due to the size of the heating company, those operating in medium-sized cities (65.8%). The scale of the problem is illustrated by the historical dynamics of CO_2 allowance prices shown in Figure 6, which exceeded EUR 80/tCO2 in December 2021 reaching a peak of more than EUR 105/tCO2 in March 2023.

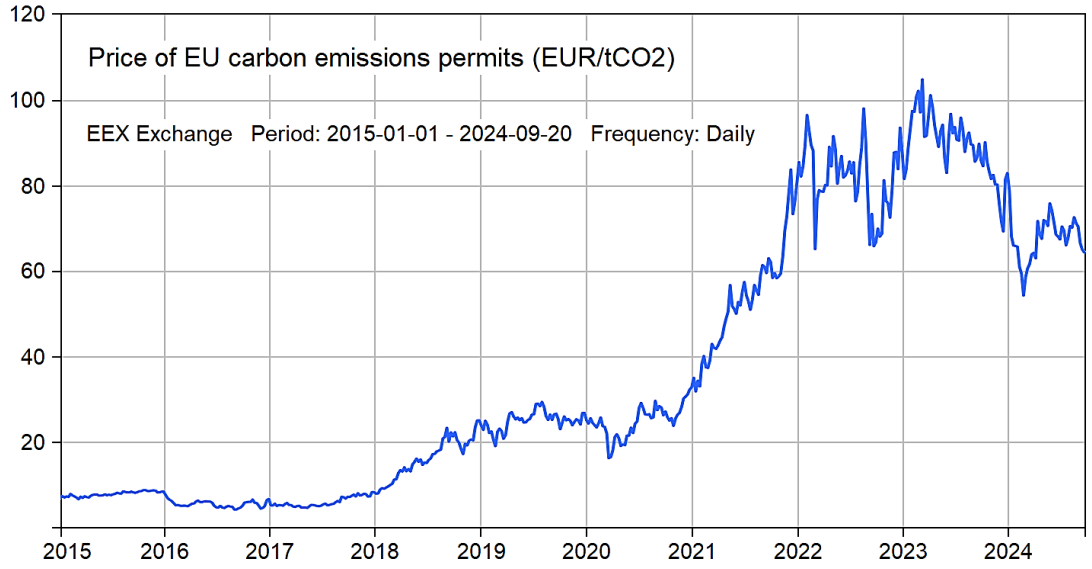


Figure 6. Price dynamics of CO_2 emission allowances in historical terms.

Source: https://tradingeconomics.com/commodity/carbon, 20.09.2024.

A noticeable price increase has been occurring since the beginning of 2018, i.e. since CO_2 allowances became a financial instrument (non-heat operators can purchase them). According to many companies, this is an unjustified increase of a speculative nature. It should be added that heating companies do not have the possibility to purchase allowances directly on the exchange and have to use intermediaries.

4. Impact of major threats on the condition of the Polish district heating sector

The most recent data available to the public on the heating sector in Poland (URE, 2023) indicate that rising operating costs for companies (including fuel, energy and CO2 emission allowance prices) have caused a significant decline in the profitability of the heating industry from 9.68% in 2016 to -22% in 2022 (Figure 7). Other financial indicators of the sector also deteriorated during the period - the level of total debt increased from 0.38 to 0.59 while liquidity decreased from 0.67 to 0.55 (URE, 2023, p. 22).

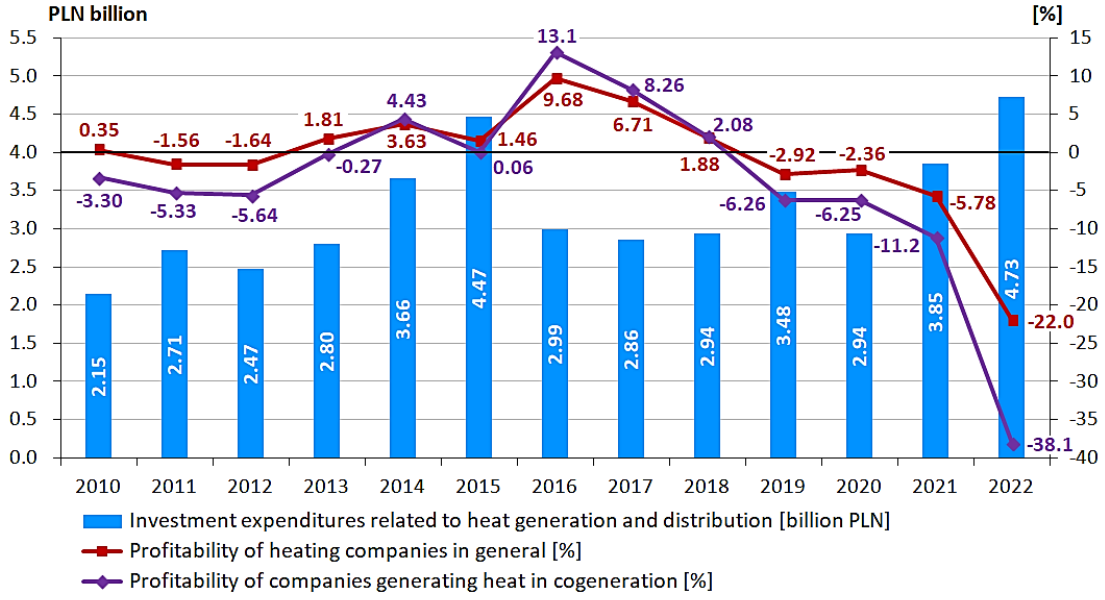


Figure 7. Investment expenditures and profitability of licensed heating companies in 2010-2022. Source: own study based on report URE, Energetyka cieplna w liczbach - 2022, pp. 18, 31.

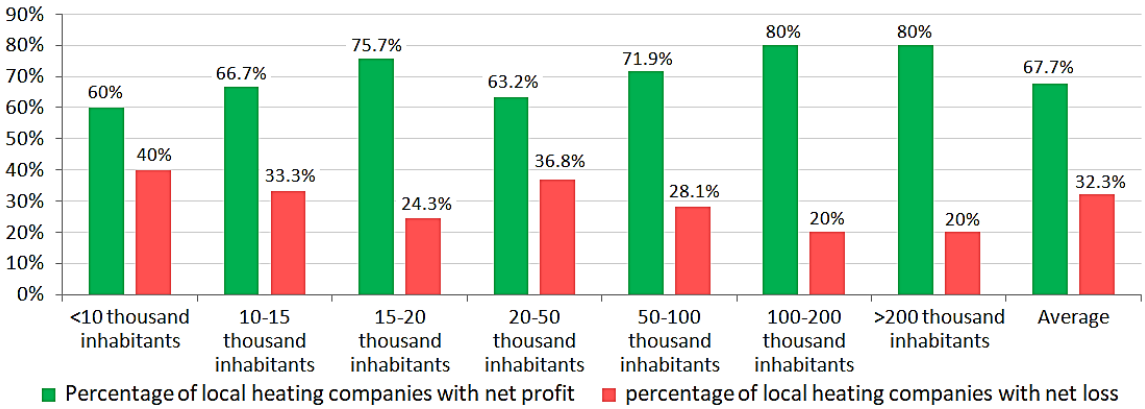


Figure 8. Distribution of financial results for 2019 of 248 local heating companies by city population. Source: own research.

Referring to the situation of individual local district heating companies, the research indicated (Wrzalik, 2022) that almost 1/3 of them made a net loss in 2019 (Figure 8). The relatively slightly better financial performance of district heating companies operating in

small cities (67.9% have a net profit) than in medium-sized cities (65.5%, respectively) is due to the fact that they generally do not have to buy CO_2 allowances.

The deterioration in the profitability of heating companies is influenced by the ERO's statutory regulation of heat prices (protecting the interests of heat consumers). The tariff requirement prevents companies from responding quickly and flexibly to dynamic changes in key cost components (CO_2 emission allowances, fuel and electricity prices), which do not feed through into current heat tariff prices and rates. This is especially true in the 2021-2023 period, when heat sales prices (Table 4) in 2021-2022 grew more slowly than the cost components (fuel and allowance prices, cf. Figures 4-6) while in 2023 the surge in heat prices was accompanied by radical reductions in coal and gas prices, almost to pre-2021 levels.

Table 4.
Average sales prices of heat generated in non-CHP units owned by licensed companies

Year	Average heat sales prices [in PLN/GJ] for generation units that are not CHP units				No. of Information of the President of the Energy Regulatory Office
	fired with coal fuels	fired with gas fuels	fired with heating oil	constituting renewable energy sources (RES)	
2014	42.48	75.66	161.23	46.99	10/2015
2015	41.52	75.24	109.60	46.44	17/2016
2016	40.23	71.47	88.96	44.13	21/2017
2017	39.65	66.87	84.87	43.11	25/2018
2018	41.89	63.55	80.71	44.20	21/2019
2019	46.67	71.94	94.29	44.85	18/2020
2020	50.38	72.43	113.30	46.46	18/2021
2021	51.91	72.02	75.66	46.12	17/2022
2022	74.67	94.91	82.72	65.31	18/2023
2023	119.37	173.96	165.23	103.09	16/2024

Source: based on https://www.ure.gov.pl/pl/cieplo/ceny-wskazniki/7904,Srednie-ceny-sprzedazy-ciepla-wytworzonego-w-nalezacych-do-przedsiebiorstw-posia.html, 25.09.2024.

The increase in the price of CO_2 emission allowances is now significantly affecting the costs of the district heating business and translating directly into the price of heat.

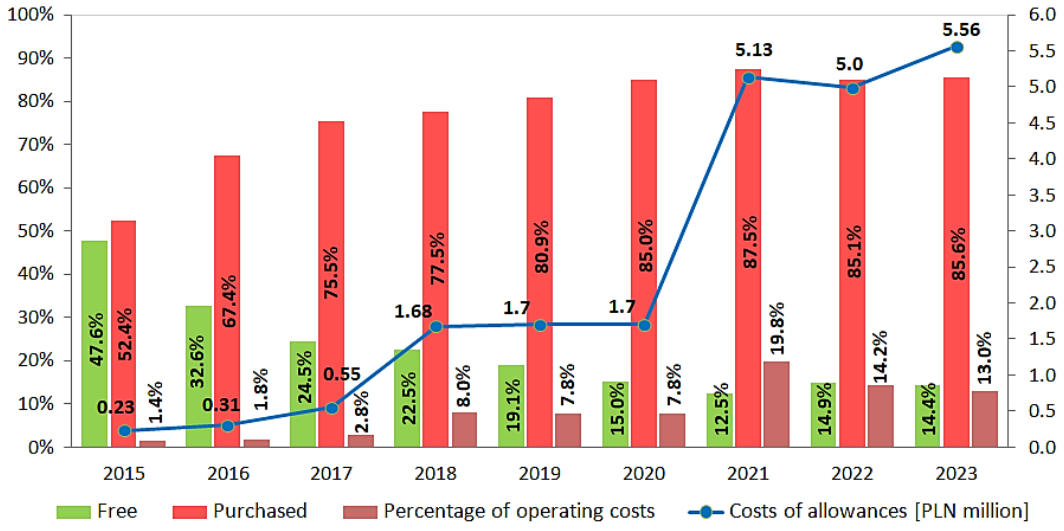
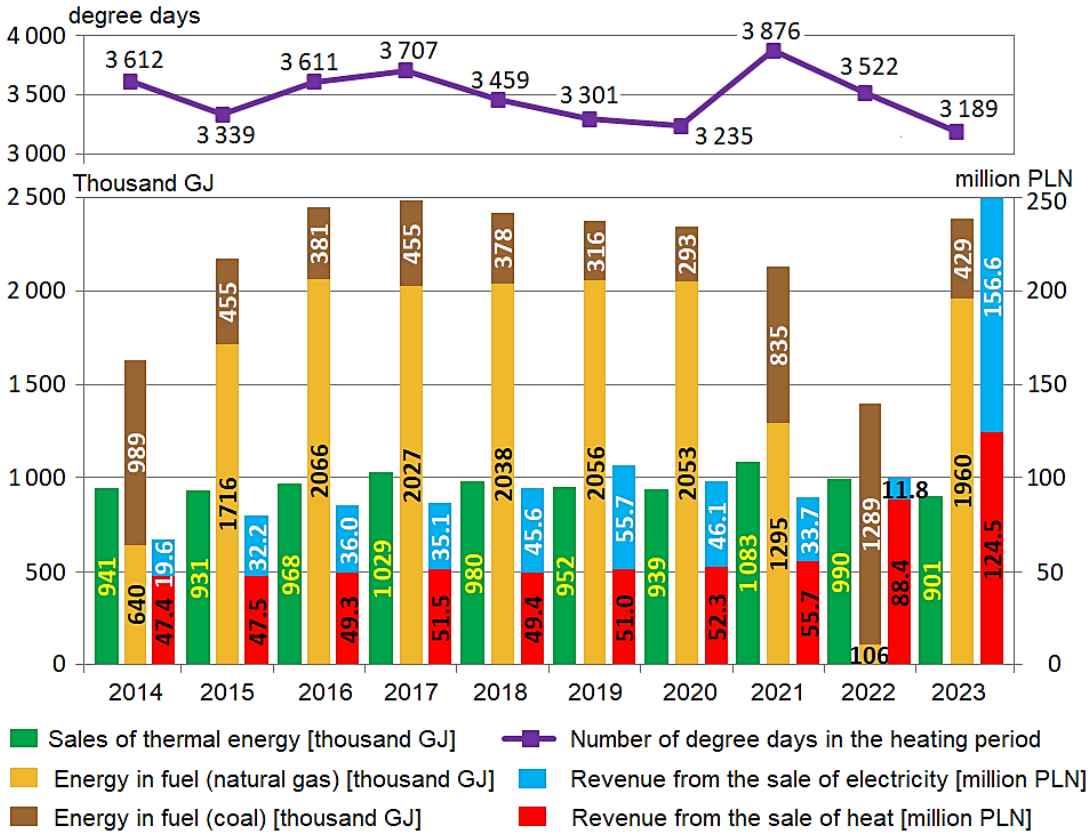


Figure 9. The structure and cost of CO_2 emission allowances in MEC Szczecinek from 2015 to 2023.
Source: own study based on the activity reports of MEC Szczecinek for 2019 and 2023.

Figure 9 shows, using the example of the selected company, the increase in the cost of purchasing emission allowances (a steady decline in free allowances) and the impact on the cost structure of district heating operations over the period 2015-2023 - an increase from 1.4% to almost 20% in 2021. As the price level of emission allowances remains high, as a result, allowance costs are often the second-highest component of thermal power generation costs (after fuel consumption costs).

Another unfavorable phenomenon that became apparent in 2021-2022 was the financial problems of cogeneration companies, for which heat tariffs are approved using the so-called simplified method based on the previous year's prices (ERO, 2023, p. 23). This is illustrated by the case of PEC Siedlce, for which selected data on heat production and sales are shown in Figure 10. The inability to change heat prices in the tariff with a sharp increase in gas prices forced the company to shut down its gas-fired CHP plants for 1.5 years and use only coal-fired sources for that period. The lost revenue from the sale of electricity and cogeneration premium caused the company to incur a net loss of PLN 5.87 million in 2022, but the following year, after gas prices were reduced and the CHP sources were put back into operation, it made a net profit of more than PLN 40.2 million (PEC Siedlce, 2024).



Electricity sales revenue does not include proceeds from cogeneration certificates of origin, cogeneration premium and participation in the Power Market, and heat sales revenue for 2023 does not include compensation for heat.

Figure 10. Selected figures for the production and sale of heat in PEC Siedlce in 2014-2023.

Source: own study based on the activity reports of PEC Siedlce for 2019 and 2023.

Regardless of the current threats to the district heating business, a key challenge is the need to continue with the transformation of the district heating market. It is estimated that in order to meet the requirements of the "Fit for 55" package in the area of decarbonization, it is necessary to spend between PLN 276 billion and PLN 418 billion on the transformation of the district heating sector in Poland, depending on the adopted investment scenario (PTEZ, 2023). At the current level of investment expenditures in the district heating sector (Figure 7), this would be a process that would take 60 to 90 years, so according to the ERO, external sources of financing are necessary (URE, 2023, p. 5).

5. Summary

The article attempts to determine whether local district heating companies operating in Poland are able to identify existing external threats to their operations, which is an essential element in formulating a business development strategy. The study was carried out by desk research method of analyzing found data from activity reports for 2019 for a group of 158 out of 250 local district heating companies, divided by city size.

The research showed that managers at licensed local heating companies can correctly identify existing threats to their operations. These are external threats over which the companies have no control. The results made it possible to systematize the operational threat factors mentioned by local heating companies according to the hierarchy of their importance. The largest number of companies pointed to weather factors, especially in winter (temperature), projecting the demand of customers for heat for heating purposes and determining the length of the heating season. This is measured by the number of degree days correlated with the volume of heat sales (see Figure 10), which, with the prices included in the tariff, determines the size of the company's revenues. Also important are the market risks affecting the cost side, i.e. increases in fuel prices (gas, coal, biomass), and, for several years now, the cost of CO_2 emission allowances related to the EU's stringent climate and energy policy. Difficulties in balancing the revenue and cost sides are created by the tariff procedures at the ERO, i.e. the heat sales prices in approved tariffs do not reflect the current costs incurred. This is especially true for companies generating heat from cogeneration sources, where simplified tariffs apply. With the occurrence of extraordinary events and unexpected dynamic increases in fuel prices in the markets, as was the case in 2021-2023, heat companies have incurred losses.

In my opinion, there are no comprehensive studies in the literature on the risks to the operations of companies in the Polish district heating sector of such scope (research method, research sample size, quantitative approach) and such a degree of detail, including verification of the impact of major risks on the performance of the entire sector, as well as selected individual

local companies. A study with a similar theme (Iwaszczuk, A., Iwaszczuk, N., 2022) is based on an analysis of the scientific literature and the macroeconomic environment, as well as interviews with employees from the heating industry. The presented results are a qualitative analysis of the impact of the identified risks for these companies, but the article does not provide information on the research sample (number of companies, their potential).

In summary, a long-term threat to the Polish heating sector is the EU's climate and energy policy, which calls for a shift away from fossil fuels and climate neutrality by 2050, in terms of carbon emissions. This is particularly challenging for the Polish district heating sector, which currently uses more than 66% carbon fuels (URE, 2023). Since municipalities are responsible for supplying heat under current regulations, it must be delivered to residents. It is therefore to be feared that the huge costs of the energy transition will be included in the price increase not only for heat, but also for electricity, i.e. they will be passed on to consumers of these energy carriers. Ultimately, the costs will be borne by society as a whole.

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