Assessment of the impact of the EU „Fit for 55" package on the transformation of the district heating sector in Poland

Report by Polish Association of Professional Combined Heat and Power Plants

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Preface

Dear Sirs,

the security of supply of heat and electricity to the residents of Poland is a key condition that should determine all investment processes implemented in the power industry. This has taken on particular importance in view of the global impact of the ongoing war in Ukraine and, on the other hand, the need for investment to meet the ambitious goals of the EU climate and energy policy leading to the achievement of carbon neutrality in 2050.

While the broader process of transformation of the large-scale district heating sector has definitely accelerated in recent years, the overriding issue was still the direction and trajectory of these changes. For the past two years, intensive work has been going on at the EU forum on the regulations included in the "Fit for 55" package, in which great attention was paid to, among other things, the area of decarbonization of the large-scale district heating.

From the industry's perspective, any provision that conditions the applicability of a particular technology or fuel has a huge impact on the overall investment processes carried out within individual district heating systems. Therefore, the Polish Association of Professional Combined Heat and Power Plants (Polskie Towarzystwo Elektrociepłowni Zawodowych) (PTEZ) was actively involved in consultations accompanying the work on the "Fit for 55" package. Thanks to the efforts of the administration, Polish Members of the European Parliament and the sector as a whole, including PTEZ-affiliated generators, the final agreed legislative solutions are definitely a better reflection of the Polish specificity of large-scale district heating compared to the proposals of July and December 2021.

In this report, PTEZ experts have assessed the impact of key regulations agreed upon as part of the "Fit for 55" package on the transformation of the district heating sector in Poland, pointing out the costs of the process for the entire industry, as well as feasible scenarios and technology options for district heating systems of different sizes. This is the first analysis of its kind, which is also an important contribution to the continuing discussion on the energy transition in Poland.

Although the legislative process in the European Union has already entered the final straight, the next challenge for effective implementation of the decarbonization goals will be to implement the provisions of the most important directives into national law. For this reason, the report also includes proposed directions for the implementation of selected regulations into national legislation, combining the expectation that they will provide valuable input in the process of adapting the Polish legal order.

I wish you an interesting reading!

Wojciech Dąbrowski
President of the Management Board
of the Polish Association of Professional
Combined Heat and Power Plants

1. Determinants of the district heating sector in Poland

1.1. The district heating sector in statistical terms

Broadly defined, district heating is divided into large-scale district heating, i.e. district heating systems consisting of district heating networks with generating units, and small-scale district heating, i.e. any individual heat source in buildings or households. The large-scale heat is used for heating purposes in 40.4% of households in Poland[1], or approx. 6 million. Based on data from the Statistics Poland (GUS), heat consumption in Poland in 2021 was 444.3 thousand TJ, of which 36.9% (163.9 thousand TJ) resulted from household needs.[2]

According to the data available indicated the situation as of the end of 2021, 392 companies held licenses issued by the President of the Energy Regulatory Office (ERO) for the generation, transmission, distribution and trading of heat (a total of 810 individual licenses for a given type of heat supply business). Detailed data on the characteristics of the licensed heating industry from 2002 to 2021 are shown in Table 1.

Table 1: Potential of the licensed district heating in 2002-2021[3]

Details	2002 r.	2020 r.	2021 r.	Zmiana 2021/2002 [%]	Zmiana 2021/2020 [%]
Number of licensed district heating companies	894,00	387,00	392,00	-56,71	1,55
Number of companies participating in the study	849,00	399,00	407,00	-53,00	2,01
Installed capacity in MW	70 952,80	53 271,10	54 109,60	-24,92	1,57
Contracted capacity* in MW	38 937,00	34 665,54	35 021,10	-10,97	1,03
Length of networks** in km	17 312,50	22 123,11	22 223,03	27,79	0,45
Employment in jobs	60 239,00	28 737,00	28 106,00	-52,30	-2,20
Total heat sales*** in TJ	469 355,50	343 690,65	385 599,00	-26,77	12,19
Heat returned to the network*** in TJ	336 043,00	257 377,29	285 771,00	-23,41	11,03
Heat delivered to network-connected consumers*** in TJ	298 938,10	224 500,80	250 439,00	-24,90	11,55

* Contracted capacity in 2003, no data on contracted capacity was collected in 2002
** Since 2004, the length of the network also includes low-parameter networks (so-called external consumer systems)
*** Definitions of these categories are provided in the Methodological Notes section of the report "Heat power engineering in numbers – 2021."

Licensed district heating companies have a diverse and fragmented technical infrastructure, which is defined by two basic values: installed thermal capacity and the length of the district heating network. In 2021, the installed thermal power was 54,109.6 MW (in 2020. – 53,271.10 MW), and the achievable capacity was 54,164.2 MW. In 2021, licensed district heating companies had district heating networks with a length of 22,223 km (vs. 22,123.1 km in 2020).

Table 2 summarizes the length of the district heating networks in Poland and their development since 2002. It is worth noting that the largest share is made up of district heating networks with a length of more than 50 km. At the same time, the data shows the highest growth rate for this category.

Table 2: Length of district heating networks in Poland[4]

Length of networks [km]	2002	2020	2021
Poland	**17 312,5**	**22 123,1**	**22 223,0**
3 and below	326,5	36,3	33,6
3-5	402,4	90,8	85,1
5-7	431,2	90,9	110,9
7-10	580,7	335,2	330,0
10-20	1 597,1	1 269,5	1 205,2
20-50	2 545,1	3 075,5	2 997,2
More than 50	11 429,5	17 224,9	17 460,9

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1 Energy consumption in households in 2018, Statistics Poland, Warsaw, January 2020

2 Consumption of fuels and energy carriers in 2021, Statistics Poland, Warsaw, December 2022.

3 Own study based on "Heat power engineering in numbers – 2021", Energy Regulatory Office, Warsaw, December 2022.

4 Ibidem

The ten licensed entities had an installed capacity of sources exceeding 1,000 MW each, and their combined generating capacity accounted for more than 1/3 of the generating capacity of all licensed sources. These companies were also active in the area of electricity generation.

Energy companies operating in the field of heat generation produced 425.1 thousand TJ of heat in 2021, including heat recovered in technological processes, an increase of 7.9% over the previous year. Detailed information on the production of licensed heat, as well as the volumes of heat delivered to the network and consumers, is shown in Figure 1.

Chart 1: Structure of district heating companies by installed capacity [MW] in heat sources in 2021[5]

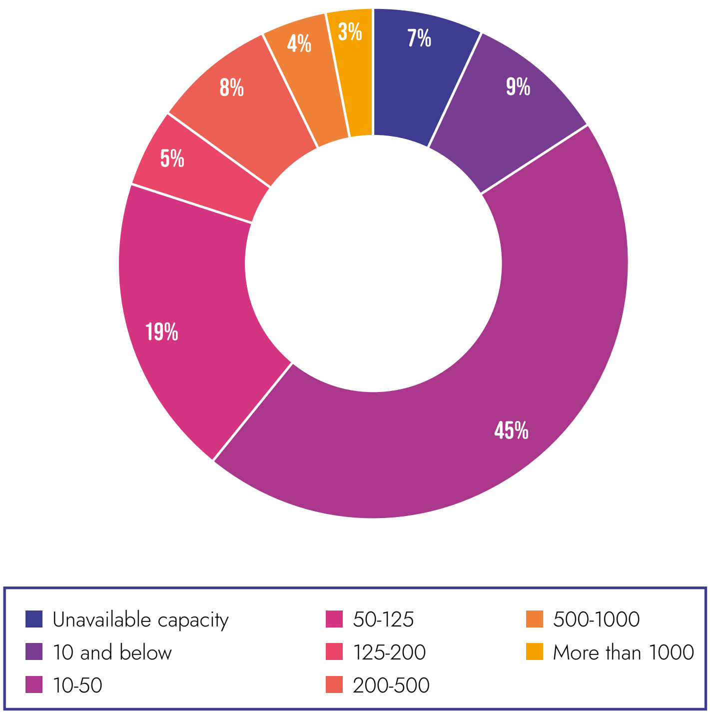
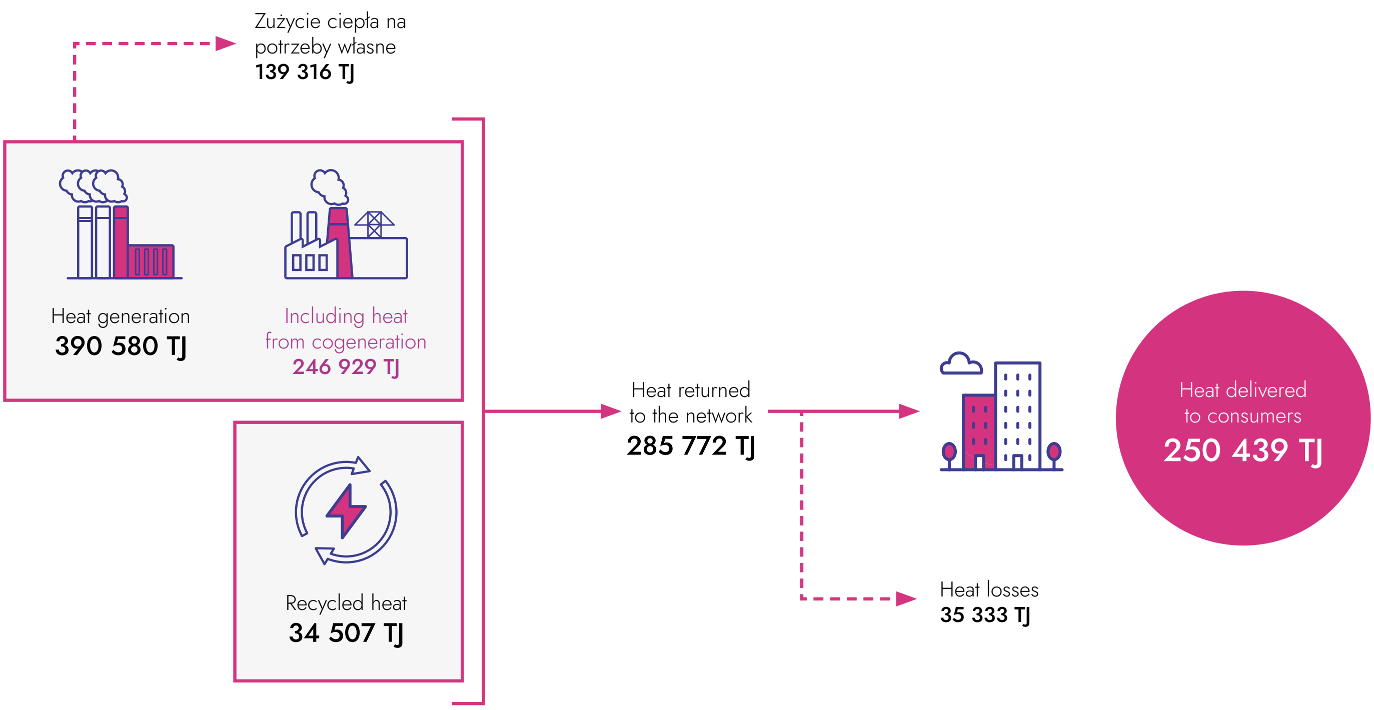


Figure 1: Heat generation in Poland in 2021[6]

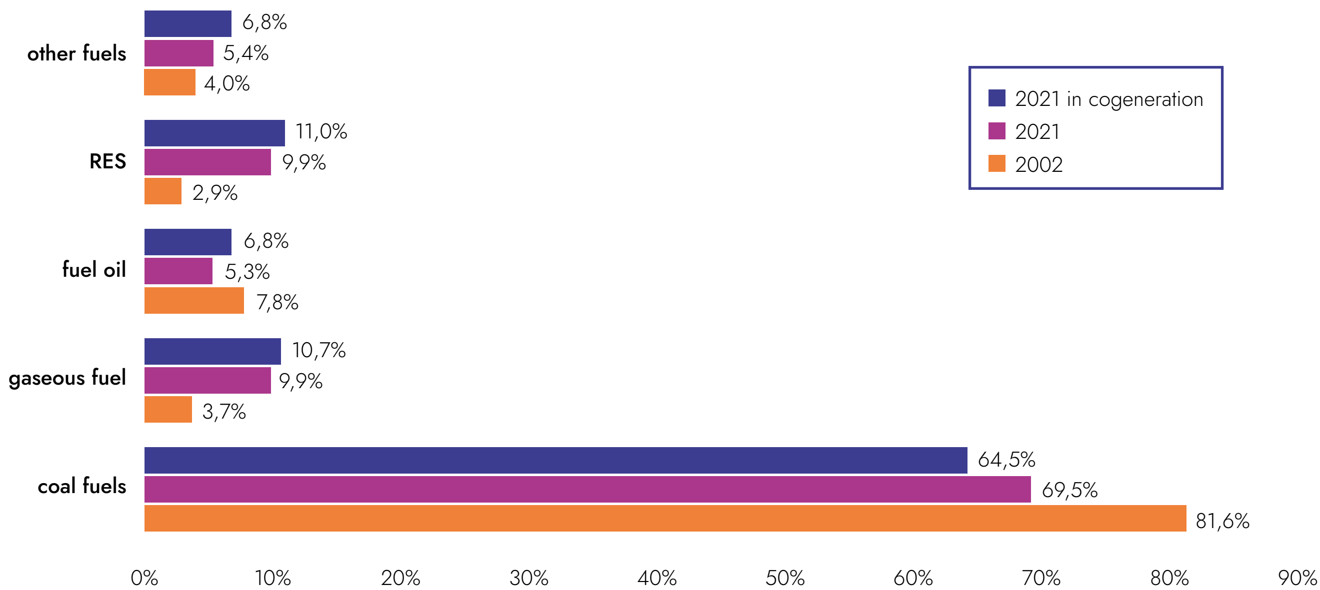


5 Ibidem
6 Ibidem

Of the total heat production of licensed energy companies in 2021, the share of heat produced by cogeneration was 63.2% (down 2 pp. compared to 2020). Of the 378 companies generating heat in 2021, 133 of them (i.e. 35.1%) also generated heat in cogeneration.

The licensed district heating sector continues to be dominated by coal fuels, which accounted for 69.5% of fuels consumed in heat sources in 2021 (2020 – 68.9%, 2019 – 71%, 2018. – 72.5%, 2017 – 74.0%). Since 2002, the share of coal fuels decreased by 12.2 pp, while an increase in the share of gaseous fuels – by 6.2 pp and renewable energy sources (RES) – by 7 pp – was observed. The structure of fuels in 2002 and 2021 is shown in Chart 2.

Chart 2: Structure of fuels consumed for heat generation in 2002 and in 2021, and for cogeneration in 2021[7]



It should be noted that the diversity of fuels used to generate heat is somewhat greater among companies generating heat in cogeneration (heat and power plants). This group of companies is also dominated by coal fuels, but a third are other fuels, including 11% of renewable sources, 10.7% of natural gas and 6.8% of fuel oil.

In 2021, the volume of total heat sales by licensed district heating companies (including resale to other entities) amounted to 385,598.57 TJ. This represents an 11.86% increase over 2020. The average single-component price of heat sold from all licensed heat-generating sources was PLN 47.65/GJ, up by 7.49% from the 2020 price. At the same time, the average price of heat sold from licensed heat-generating sources without cogeneration was PLN 53.31/GJ, while the average single-component price of heat sold from licensed heat-generating sources with cogeneration was PLN 45.27/GJ. It is also worth pointing out that the cost of heat generation – and thus the level of its price – is closely correlated with the type of fuel used for this generation as illustrated in Table 3.

7 Ibidem

Table 3: Prices for heat generated in 2021[8]

Details	2019 [PLN/GJ]	2020 [PLN/GJ]2	2021 [PLN/GJ]	Change 2020/2019 [%]	Change 2021/2020 [%]
Average price of heat generation	40,97	44,33	47,65	8,2	7,49
Hard coal	40,34	43,88	47,27	8,77	7,72
Brown coal	25,09	28,03	31,58	11,72	12,68
Light fuel oil	73,75	58,4	56,57	-20,81	-3,13
Heavy fuel oil	34,95	37,16	39,58	6,33	3,52
High methane natural gas	52,17	53,64	57,53	2,82	7,25
Natural gas	43,34	46,06	53,79	6,28	16,79
Biomass	42,65	45,77	47,44	7,31	3,65
Other renewable energy sources	36,53	37,71	33,49	3,23	-11,19
Other fuels	37,84	44,08	47,42	16,49	7,57

The level of revenue earned by district heating companies is fundamentally influenced by the volume of heat sales, which depends on the thermal needs of customers and the type of fuel consumed at the source. These in turn shape average heat prices and the range of services provided to customers. Consumers' thermal modernization efforts, higher average temperatures of the winter months, and increasing levels of energy savings by consumers are the reasons for the reduction in heat demand, which consequently translates into lower revenues for companies.

In 2021, as in previous years, an increase in both total costs from district heating operations (up 23.21%) and costs of running district heating operations (up 24.22%) was observed. The increase in the cost of greenhouse gas emission allowances, destabilization in the fuel market (mainly natural gas) and an increase in the cost of purchasing electricity contributed to the increase in the operating costs of heating companies. These data are illustrated in Table 4.

It should be noted, despite the unavailability of the latest data, that 2022 was also, due to Russia's war with Ukraine and the resulting destabilization of the fuel market, equally difficult in terms of the operating costs.

8 Ibidem

9 Own study based on the Energy Regulatory Office data and G.10.2 reports of the Energy Market Agency

Table 4: Total result on energy activities (electricity and heat) at power plants and combined heat and power plants (2021)[9]

Details	[PLN thousand]
Revenues from sales of electricity and heat	62 584 381,60
Costs of own operations	31 893 915,20
Costs of purchasing energy for resale, costs of remitted property rights, compensatory payment	10 767 745,40
Selling costs	1 032 375,60
Management costs	1 059 946,00
Total cost of revenue from the sale of electricity and heat	44 753 982,20
Result on sales of electricity and heat	17 830 399,40
Other revenues	4 551 046,00
including revenue from the sale of CO_2 emission allowances	1 832 670,30
Other costs	23 183 491,30
including costs of purchasing CO_2 emission allowances	20 928 985,90
Result including other revenues and costs	-802 045,90
Financial revenues	90 244,40
Financial costs	515 423,00
Result including financial revenues and costs	-1 227 224,50

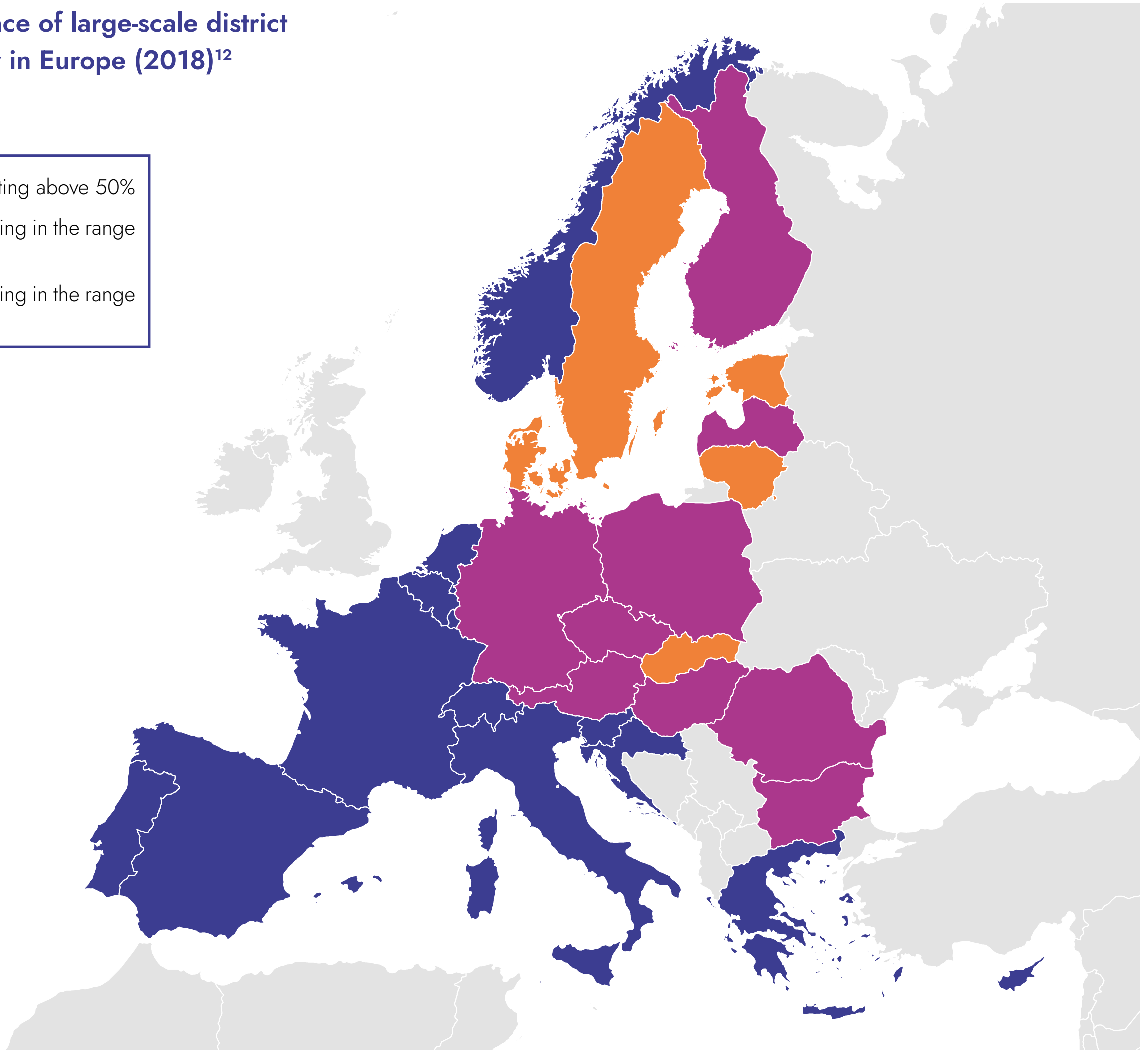
1.2. Polish large-scale district heating sector in comparison with other European countries

The large-scale district heating accounts for a smaller share of the heat market in the European Union (EU). Approximately 10,000 European district heating systems satisfy about 12% of the EU total heat demand1. However, this is above the global average of 8.5% in 2021, according to data published by the International Energy Agency. This clearly shows how much more developed the European large-scale district heating is. 2 The share of district heating is not evenly distributed across Europe. The importance of district heating networks varies significantly from region to region. District heating systems are by far the most common heating solution in northern and eastern European countries (Nordic countries, Baltic states, Poland, etc.), while in the south and parts of western European countries this method of heat supply plays a minor role (e.g. the Netherlands, the UK, France). The share of large-scale district heating in total heat generation in each European country is shown in Figure 2.

10 DHC Market Outlook, Euroheat & Power, 2022
11 Ibidem

Figure 2: Importance of large-scale district heating by country in Europe (2018)[12]

- Share of district heating above 50%
- Share of district heating in the range of 10–49%
- Share of district heating in the range of 10–49%



Some 60 million EU citizens use district heating, with an additional 80 million citizens living in cities that already have at least one district heating system. One indicator of the size and potential of district heating networks is the amount of heat sold to these customers. Poland is the undisputed leader in this list. This situation is illustrated in Chart 3. District heat sales, or the actual amount of heat delivered to final consumers, is one of the key business indicators that indicates a benchmark as to the size of the sector. The volume of heat sold to district heating customers in Poland is almost five times that of Germany and twice that of Denmark, which is the leader in terms of the length of district heating networks.

An additional indicator indicating the size and potential of the sector is the total length of district heating networks (Chart 4). Crucially, this indicator shows the outlook of investors and their confidence in the market, as investments in district heating are made according to a long-term business model. The largest market in terms of network length is Denmark, whose district heating network exceeds 30,000 km in length, where the ratio of network length to population is also high. In this regard, Poland ranked fourth in 2018 behind Denmark, but also Germany and Sweden.

12 Own study based on https://www.wedistrict.eu/interactive-map-share-of-district-heating-and-cooling-across-europe/

Chart 3: Total district heat sales to customers (2011–2019, in GWh)[13]

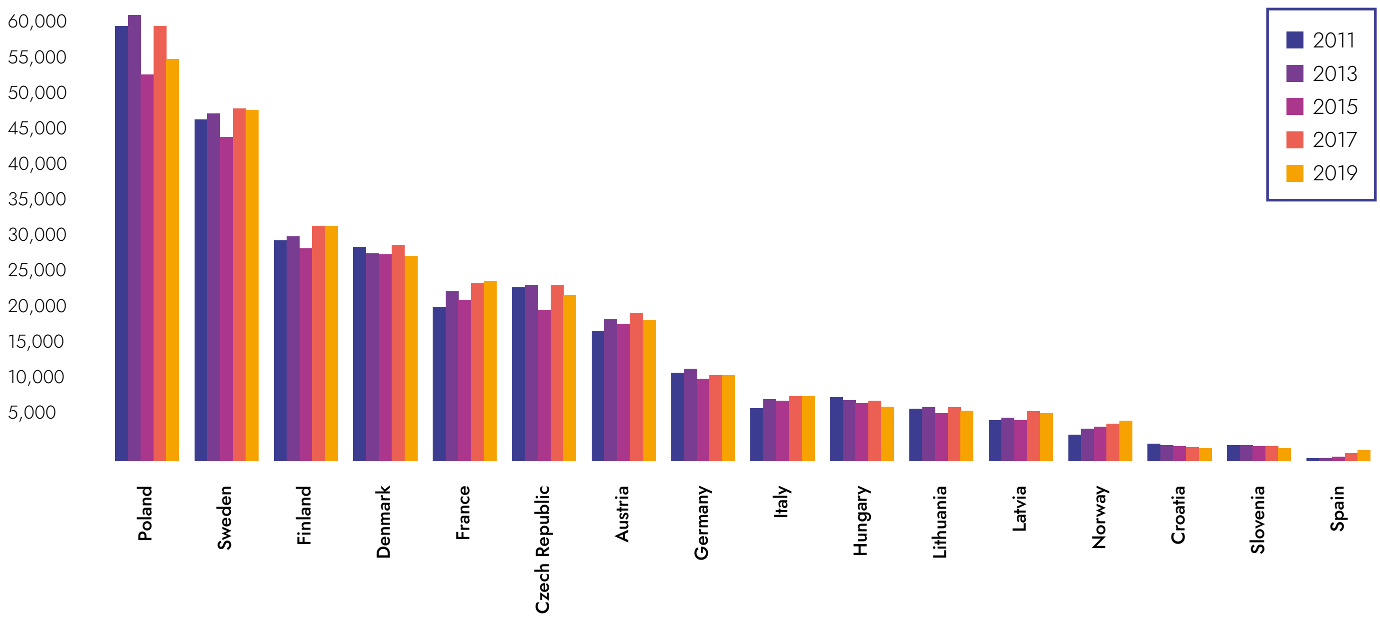
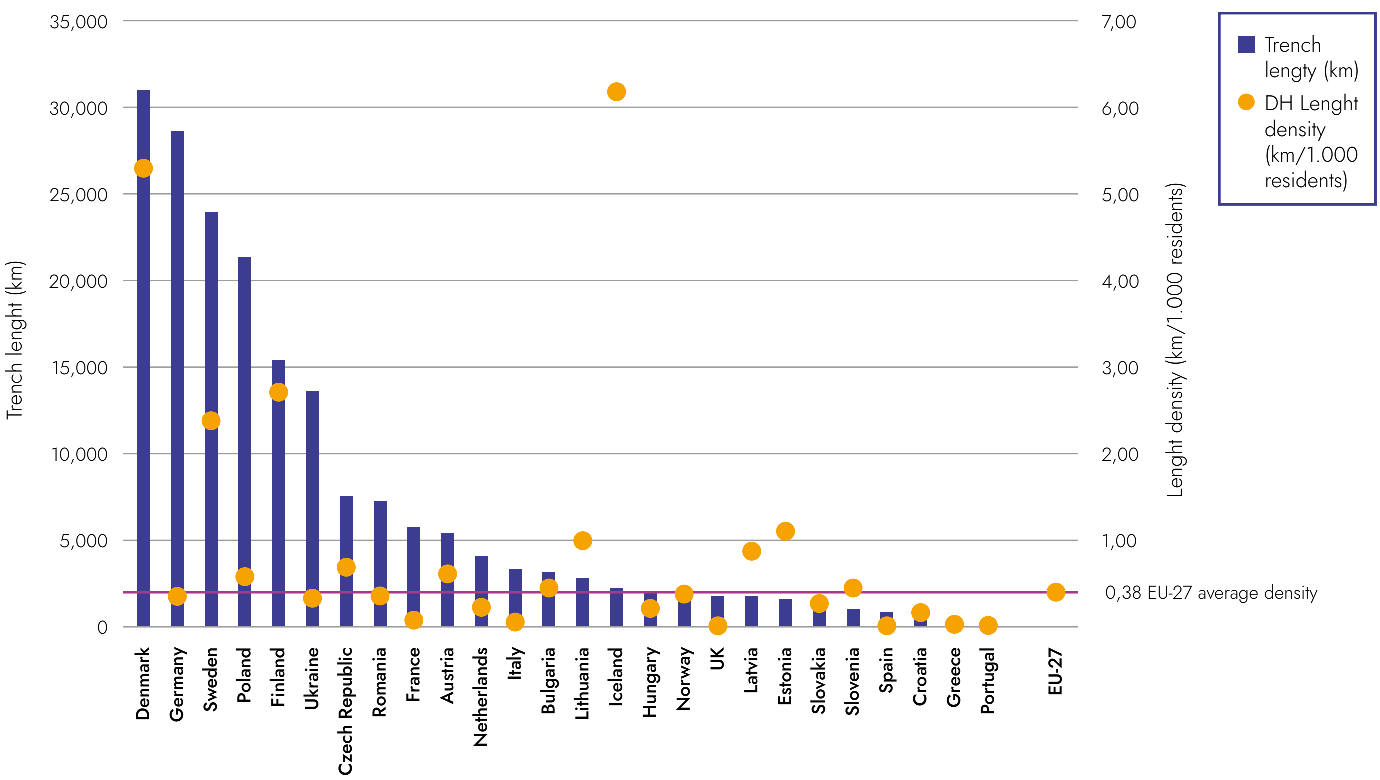


Chart 4: Total length of district heating network in km and network density ratio per 1,000 inhabitants (km/1,000 citizens) (2019)[14]



13 Own study based on the Energy Regulatory Office data (for Poland) and DHC Market Outlook, Euroheat & Power, 2022 (for other countries)

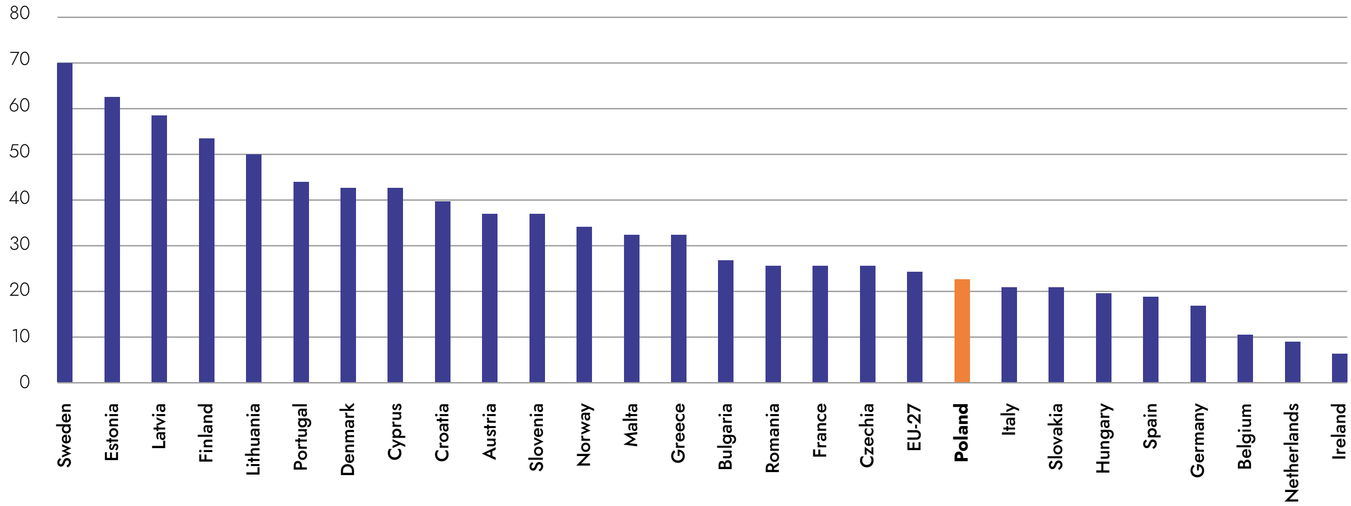
14 Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive Main Report, Tilia, TU Wien, IREES, Öko-Institut, Fraunhofer ISI, 2021

On average, 80% of EU household energy demand is used for space heating and cooling and water heating. Despite its decarbonization potential, the sector is still heavily dependent on fossil fuels. The climate crisis and the ongoing war in Ukraine, have highlighted the urgent need to accelerate the decarbonization of the district heating sector, while taking into account local conditions and characteristics of individual systems. Moving toward more ambitious climate goals – namely, achieving climate neutrality by 2050 – requires a faster transformation in the area of thermal energy production and distribution. Implementing local, sustainable heating solutions is key to providing more renewable heat.

The seven European countries with the highest national share of renewable energy in heating and cooling also have the so-called highest share of RES in district heating (Iceland, Sweden, Estonia, Finland, Latvia, Denmark and Lithuania). This is a clear indication of the direct correlation between heating and the total level of RES in the economy of a given country. As shown in Chart 5, the share of renewable energy in the heating sector in Poland in 2021 was 21%, 1.9 percentage points below the EU average.

Chart 6 shows the so-called fuel mix relating to district heating networks and the share of cogeneration in the total volume of heat generated. In most European Union countries, the share of cogeneration exceeds 50%, in 2018 Poland's result was close to the EU average level of 63%. However, already the structure of fuels used to generate heat in Poland differed significantly from the fuel mix in the European Union. Natural gas was the main source of generated heat in many countries (with a share of 60% or more), such as Bulgaria, Croatia, Hungary, Italy, the Netherlands and Romania. The second major source of heat in the EU is biomass, biofuels and renewable waste. They account for a significant share in many countries, such as Austria, France, Scandinavia and the Baltic states. Coal and peat ranked third in 2018 as the most widely used heat source in the EU. They dominate the fuel mix of Poland, but also Germany, Greece, Slovakia and Slovenia.

Chart 5: Share of renewable energy in the district heating sector (2021)[15]



15 Own study based on Eurostat data

Chart 6: The structure of fuels of district heating networks and the share of cogeneration (2018)[16]

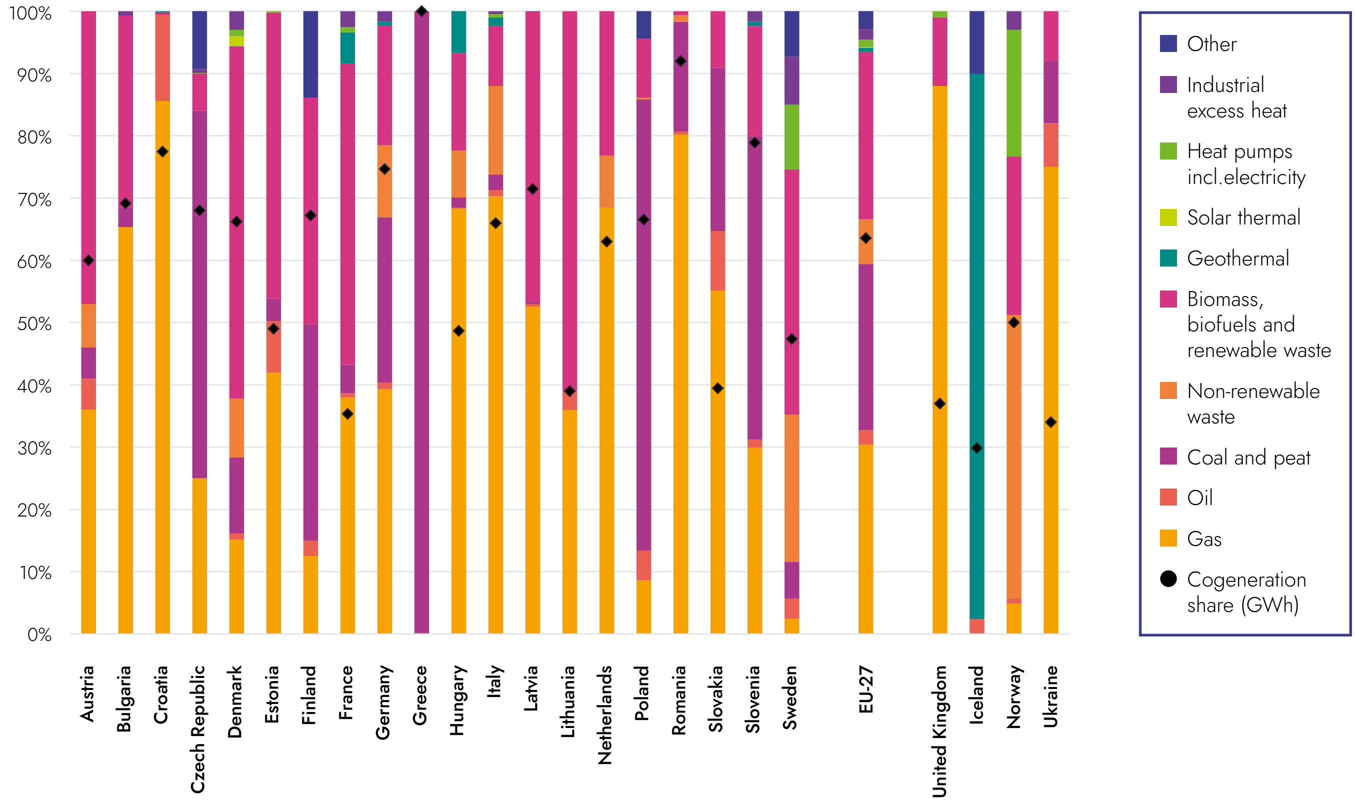
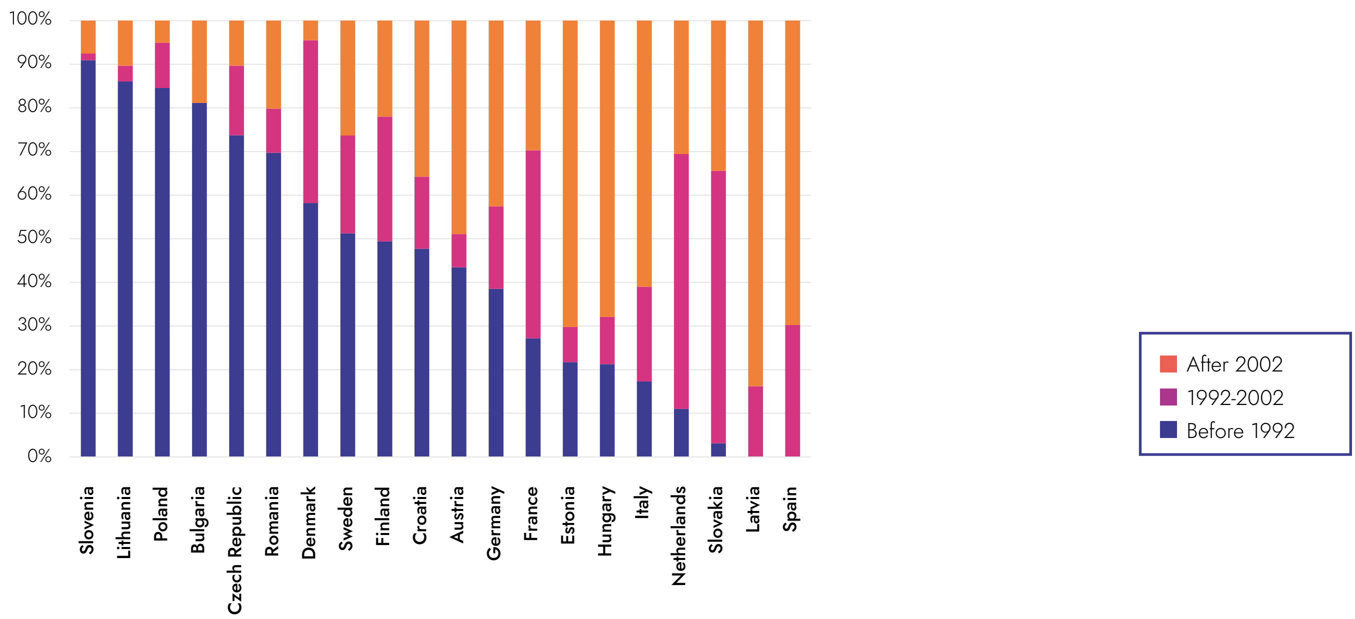


Chart 7: Age structure of cogeneration units in selected member countries (2018)[17]



16 Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive Main Report, Tilia, TU Wien, IREES, Öko-Institut, Fraunhofer ISI, 2021

17 Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive Main Report, Tilia, TU Wien, IREES, Öko-Institut, Fraunhofer ISI, 2021

Figure 3: Share of cogeneration in electricity production in 2019[18]

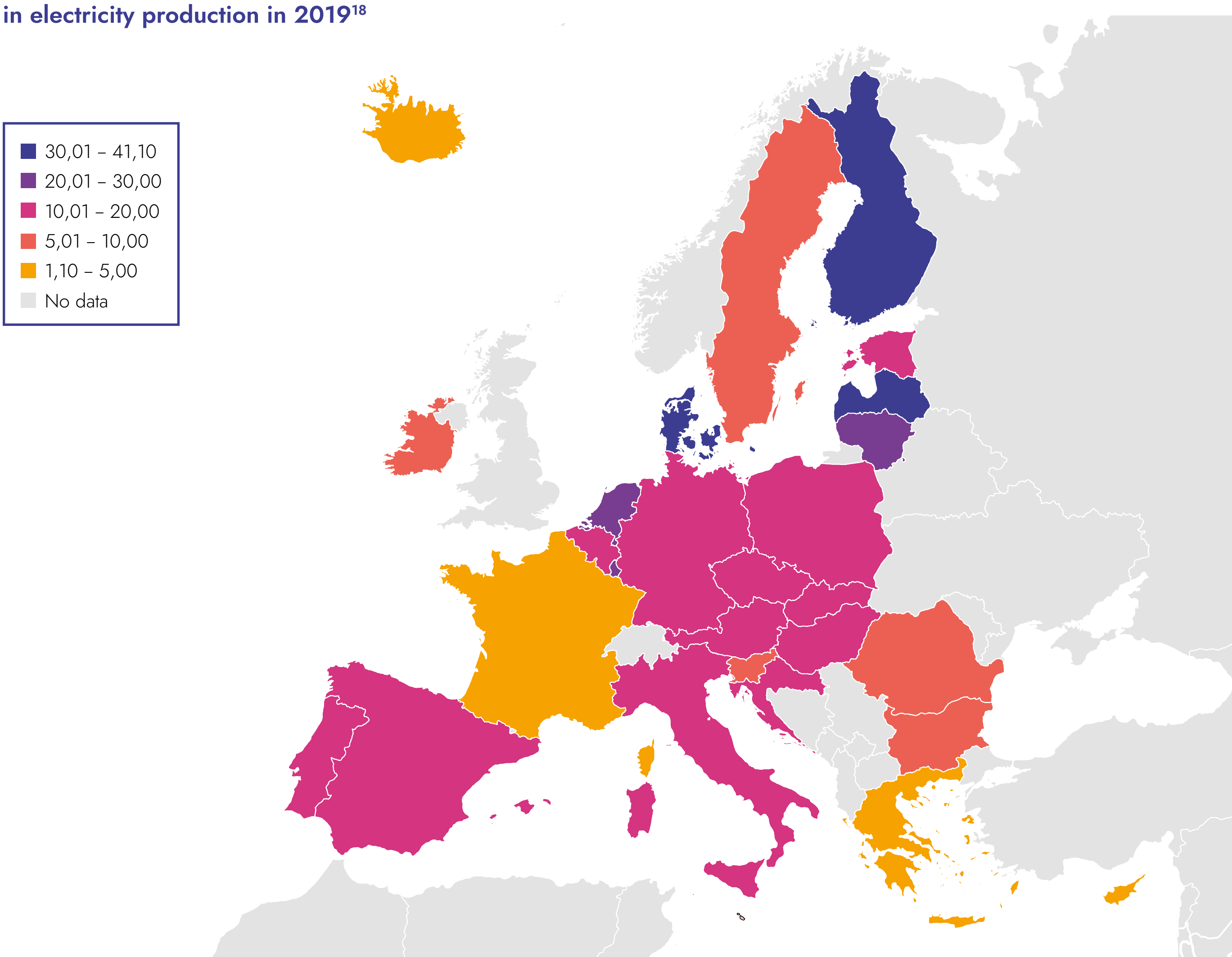


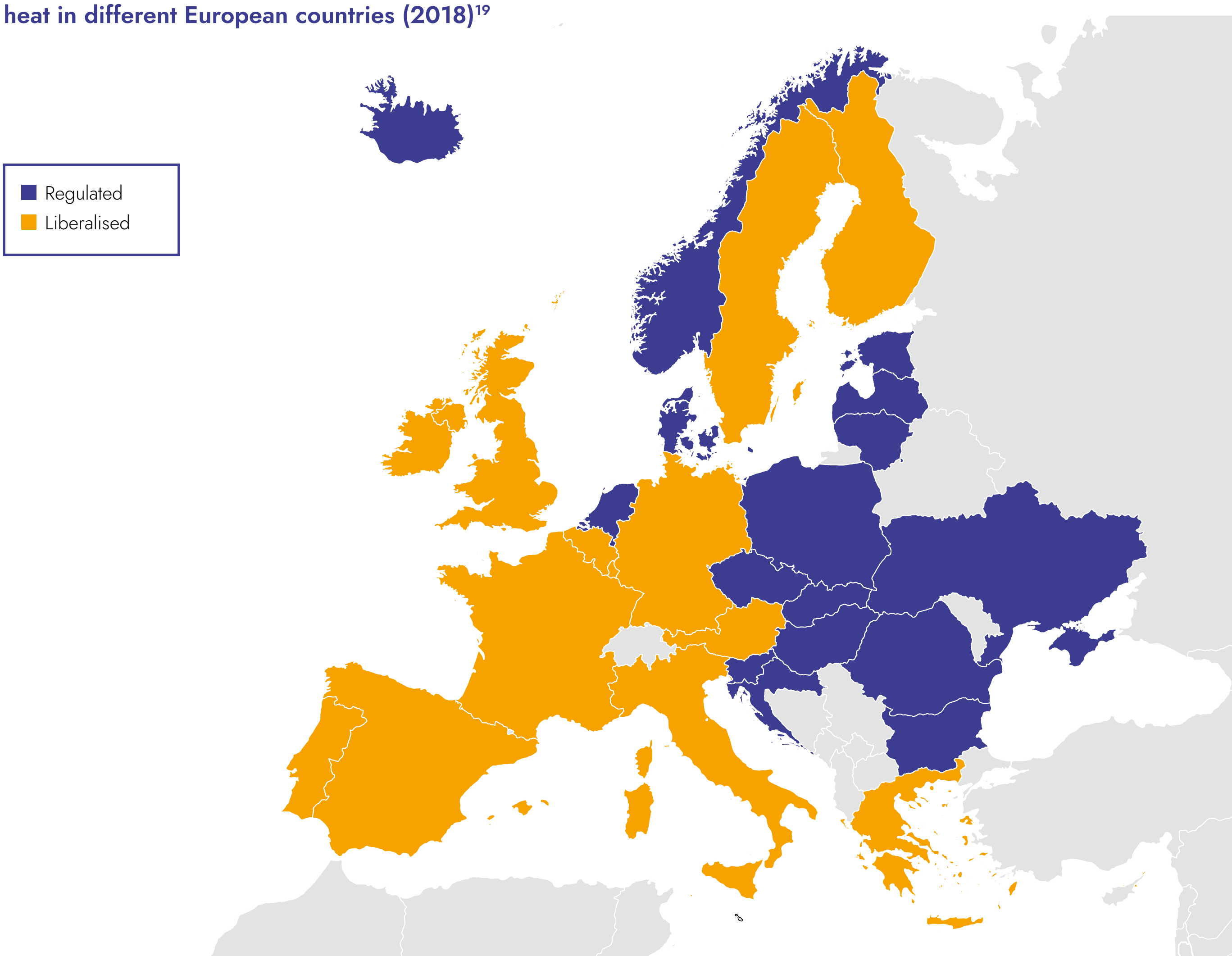
Chart 7 shows the age structure of the resource of cogeneration units in 2018, according to the most recent and available data. Approximately 43% of operating CHP plants were nearly 30 or more years old and were built before 1992. An additional 23% of the CHP plant resources analyzed was built between 1992 and 2002. Against this backdrop, Poland was among the infamous top countries in this statistic, overtaken only by Slovenia and Lithuania.

Cogeneration in 2019 for all EU countries accounted for 12% of electricity production. For Poland, the share of cogeneration in electricity production in 2019 was about 18%, exceeding the EU average. Figure 3 presents the share of cogeneration in electricity generation in 2019 for each EU country.

18 Energy 2022, Statistics Poland, Warsaw, June 2022.

System-based heat prices may be subject to various types of regulations (ex-ante, ex-post control). In more than half of the countries analyzed, heat prices as well as the mechanism for setting them are regulated, as shown in Figure 4, with the degree of regulation varying from country to country. The regulated nature of the district heating sector is due to the existence of the so-called natural monopolies in the area of heat distribution and transmission. Due to the risk of distortion of competition in the district heating sector, there are a number of legal acts aimed at protecting consumers — heat consumers — from unreasonable price increases. Poland, along with Bulgaria, Denmark, Lithuania, Slovakia and the Netherlands, is one of the countries where system-based heat prices are regulated by law, both ex-ante, i.e. by means of tariff approval — and ex-post, i.e. control of their application. The prices are calculated for a year (e.g. Poland) or a longer period (e.g. Lithuania).

Figure 4: Price regulations for system-based heat in different European countries (2018)[19]



19 Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive Main Report, Tilia, TU Wien, IREES, Öko-Institut, Fraunhofer ISI, 2021

1.3. Conditions rising from the location of district heating systems in cities in the context of the matter of distribution of systems

The characteristics of district heating systems and their size in terms of installed capacity in the sources significantly determine the possibility, rate and scope of use of RES plants. Currently, powering solely through RES plants is not a solution to be applied to extensive district heating systems in large cities. Heat distribution in such systems is hampered because the infrastructure is not compatible with RES-based low-temperature sources – efficient use of RES and waste heat requires lowering the water temperature in the district heating network from the current level of 135/70 C to 65/40 C. By contrast, a key element in the implementation of a low-temperature system is the thermal upgrading of buildings and the retrofit of buildings' internal services, which involves high costs. Importantly, the energy sector has no influence on the rate of thermal upgrading processes, which, as a rule, is the responsibility of building owners and managers.

It should be noted that about 40% of Poland's energy companies have an installed capacity of heat sources exceeding 50 MW. These are mainly district heating companies in larger cities with populations of more than 100,000 people, while 20% of the companies have installed capacity in heat sources of more than 125 MW.[20] The vast majority of district heating systems in Poland were built between 1950 and 1970, and were successively expanded in the period afterwards. The systems (both building service systems, transmission and distribution networks and generation units) were designed keeping in mind the city's development, weather and technological conditions, as high-temperature systems, operating at supply parameters of approx. 140 – 150°C. In larger cities, the cogeneration units were installed as the most efficient generation systems, while in smaller cities, district heating systems were installed. Centralized systems made it possible to eliminate individual heat sources with low efficiency and negative environmental impact, significantly reducing smog and improving air quality. The progressive replacement of old district heating networks with networks in the pre-insulated pipe system over the past 20 years has made it possible to reduce the network's operating parameters to approx. 125°C.

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The vast majority of large district heating systems use coal-fired cogeneration units, which have been substantially retrofitted to meet relevant pollutant emission standards. Currently, the main direction of the ongoing transformation processes of large district heating systems is the supply of these systems by natural gas-fired cogeneration units, supplemented by RES plants, the selection of which is determined by the characteristics of a given district heating system and the availability of local resources (such as biomass or geothermal energy).
In large district heating systems, due to the need to install generating units of very large capacity, the transformation of sources to RES poses significant technical, financial and logistical challenges (e.g. due to the necessity to deliver significant quantities of biomass, to ensure the required network water temperature). However, this does not preclude the need for efforts to construct hybrid systems where central generating units will be supplemented by RES plants.
It should be noted that heat generation using solar collectors, heat pumps or ground source heating results in lower temperatures of the heating medium. In contrast, the reduced temperature of the medium in the district heating network requires adaptation of both the network infrastructure and the building service systems used for space heating. These solutions are therefore easier to implement in newly constructed buildings, especially with individual heat sources, where the entire heating system can be designed and constructed from scratch. In addition, it is necessary to maintain a controllable cogeneration unit at the base of the district heating system, given the low stability of RES plants in the context of meeting the variable daily thermal power and operating parameters of the district heating network. In addition, newly constructed cogeneration units will enable the integration of RES energy in the electric power industry by stabilizing the national power system – especially when combined with heat storage allowing their flexible operation. Increasing urbanization and suburbanization requires that the number of buildings connected to the network increase steadily.

20 Heat power engineering in numbers – 2021, Energy Regulatory Office, Warsaw, December 2022.

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A key issue in the context of an attempt to split existing district heating networks into smaller systems is that it would involve a number of technical, logistical as well as formal and legal challenges, which may include:

Acquisition of land for the development of distributed RES plants – given the high degree of urbanization, this may be impossible or may encounter social issues.

Adaptation of the isolated network and building service systems to operate on low-temperature parameters, which should be carried out in parallel. Works on the district heating network may involve reworking areas recently renovated by municipal authorities, which raises problems in terms of obtaining relevant approvals. Isolated supply areas could be created in areas with problems with pressure or temperature management – the so-called "network ends". A few percent of the entire network may be affected, which, with systems above 50 MW, is a small share.

In order to use waste heat, ground source heating and the use of heat pumps, the development of an additional power grid in a heavily urbanized area must be considered. This is due to the need to reduce the temperature of feed water in the district heating network to 90 C and below, which requires a significant increase in the flow rate of water as a heating medium. Changing the parameters of water entails replacing all district heating units and building service systems. In an urbanized municipal area, upgrading a district heating network is a very large organizational challenge and, more importantly, a long-term process.

Retrofitting district heating networks in urbanized areas poses a major logistical challenge due to the need to close communication routes for long periods of time and the lengthy process of obtaining administrative permissions. In addition, in certain city areas it is not technically possible to route new district heating networks or increase the diameters of existing ones.

The process of adapting the district heating network also faces problems related to the ownership arrangement of the network infrastructure, which is most often divided between generation companies and distribution companies, further extending the retrofit period.

1.4. Technologies to support decarbonization of medium and large district heating systems

1.4.1. Gas technologies

1.4.1.1. Gas-fired boilers

Gas-fired boilers used in Poland, due to their short start-up time and fuel cost, are mainly used as peak-load boilers started up during periods of low temperatures and high heat demand. These are water boilers used to pre-heat water from the municipal district heating network. However, it happens that these boilers are the primary facilities in a district heating plant or combined heat and power plant – usually of low capacity. Gas-fired boilers used in the district heating industry in Poland can be divided into once-through boilers – water-tube boilers with a higher capacity (15 to 140 MW_t) and fire-tube boilers (with a capacity from a few to approx. 50 MW_t).

1.4.1.2. Gas turbines in a simple cycle

Simple gas turbine systems are used in systems of combined heat and power plants of lower capacities. The simple system is characterized by low efficiency of power generation, which is related to the high temperature of exhaust gas.

1.4.1.3. Combined cycle gas turbine units

Combined cycle gas turbine units are a development of simple gas turbine systems with heat recovery. Combined cycle gas turbine units are characterized by a very high level of fuel utilization. There are combined cycle gas turbine units with capacities ranging from 42 MW_e to 608 MW_e. In addition to the high efficiency of electricity generation, a major advantage of combined cycle gas turbine systems is the ability to adapt to the forced time-varying volume and structure of generation.

1.4.2. Other technologies

1.4.2.1. Biomass

Biomass can be burned as supplementary fuel in either coal-fired boilers (biomass co-firing) or in dedicated biomass boilers, usually of circulating fluidized bed design. The very process of converting the chemical energy of fuel in the combustion process, and then producing electricity and heat is similar to the process performed when using coal fuel. Biomass units are designed to operate in a district heating base.

1.4.2.2. Heat pumps

These are facilities that use lower heat sources and supply heat to upper heat sources using electricity. Lower heat sources can be atmospheric air, ground and surface water, ground-source heat, waste heat (wastewater treatment plants, industrial plants, data centers), and ambient energy. The higher the temperature of the lower heat source, the more efficient the heat pump system. Heat is transferred via a coolant (working medium) that changes its physical state, resulting in the transfer or extraction of energy. Under the influence of thermodynamic processes, the liquid evaporates at a low temperature and draws heat from the environment (lower heat source), and is then directed to the compressor. The increase in pressure compresses the gas. The working medium heats up and gradually transfers heat to the air or water in the central heating system or water in the domestic hot water system. Once condensed, it flows through an expansion valve that proportions the amount of medium returning to the evaporator. The medium cools and lowers its pressure, and the cycle begins again. Heat pumps, especially when combined with RES sources, can be a complement or alternative to biomass-fired units. A certain difficulty in this regard may be the lack of experience in administrative procedures related to, among other things, the rating of heat from heat pumps and the verification of the RES heat stream from the heat pump.

1.4.2.3. Ground-source energy

Poland lies outside the zones of modern tectonic and volcanic activity, hence it is not currently economically viable to extract steam beds from great depths for electricity generation. There are sedimentary-structural basins filled with hot groundwater of varying temperatures. The temperatures of these waters range from tens to more than 90 C, and in extreme cases reach one hundred and several tens of degrees, which makes them mainly used in district heating industry. The main method to obtain geothermal energy is to create boreholes to geothermal hot water reservoirs. The second borehole is drilled at certain distance from the abstraction borehole, with which geothermal water, after receiving heat from it, is injected back into the bed. As a rule, geothermal waters are highly saline, this is the reason for particularly harsh operating conditions for heat exchangers and other fittings of the systems. Geothermal energy is used in central heating systems as a primary source of thermal energy. The possibility of using geothermal energy is related to the location, as well as the parameters of the source, which affect the installed power and the volume of heat extracted. Geothermal sources are highly dependent on geological conditions. Due to their limited availability, they will only play a role in certain locations and individual district heating systems.

1.4.2.4. Municipal waste

Municipal Waste to Energy Plants (WTE), commonly referred to as waste incineration plants, are facilities that operate a plant designed to recover energy (heat as well as electricity) from municipal waste by thermal treatment. The most commonly used process for thermal transformation of municipal waste is burning it in boilers with a moving grate. This technology allows for a significant reduction in the weight and volume of waste, and offers the possibility of transforming many different types of waste. Due to the large differences in the moisture content of waste, and thus the large fluctuations in the calorific value of fuel, a booster fuel, usually gas or oil, is used when municipal waste is used for energy purposes to ensure the quality of the combustion process. WTE plants allow the use of municipal waste for energy purposes, solving the problem of landfilling. A properly sized plant can operate all year round. However, it should be pointed out that, given the shape of regulations at the EU level on bearing the costs of greenhouse gas emissions, the legitimacy of building new plants should be subject to detailed analysis each time.

1.4.2.5. Alternative/waste fuel (RDF)

RDF (short for Refuse Derived Fuel) is a term used to refer to the calorific fraction of waste with a high calorific value (usually approx. 18 MJ/kg) that is not recyclable. RDF for energy purposes in district heating and combined heat and power plants is used by burning the fuel in grate or fluidized bed boilers. Particularly effective is the use of fluidized bed boilers, which are suitable for the combustion of fuels with varying properties (including calorific value), and allow a wide range of capacity control. As in the case of the Municipal Waste to Energy Plant, it should be pointed out that, given the shape of regulations at the EU level on bearing the costs of greenhouse gas emissions, the legitimacy of building new plants should be subject to detailed analysis each time.

1.4.2.6. Electrode boilers

The operation of an electrode boiler is based on the release of heat by the flow of current through a liquid medium connected to a source of electricity through electrodes. The moist important advantages of electrode boilers include relatively low capital expenditures, low overhaul costs, simplicity of operation, high efficiency, zero CO_2 emissions, no need for fuel storage, high power flexibility and the ability to start up quickly. The use of electrode boilers is correlated with electricity prices.

21 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Fit for 55": achieving the EU's 2030 climate target on the road to climate neutrality COM/2021/550 final Brussels, July 2021.

22 COM(2022) 222 final, European Commission legislative proposal for a draft Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, Directive (EU) 2010/31 on the energy performance of buildings and Directive (EU) 2012/27 on energy efficiency, Brussels, May 2022.

23 COM(2021) 558 final, European Commission legislative proposal for a draft Directive of the European Parliament and of the Council on Energy Efficiency, Brussels, July 2021.

24 COM(2021) 802 final, European Commission legislative proposal for a draft Directive of the European Parliament and of the Council on the energy performance of buildings, Brussels, December 2021.

2. Key regulations in the "Fit for 55" package from the perspective of system-based district heating

EU energy and climate policy regulations will have a particularly significant impact on the further development of system-based district heating in Poland. Given the above, it should be pointed out that it will be necessary to build new zero- or low-carbon generation sources, especially units using renewable energy sources in order to achieve the goal of climate neutrality. In this context, the most important are the provisions in the "Fit for 55" legislative package proposed by the European Commission and – for the most part – already agreed by the European Parliament and the Council[21].

In addition, as a result of the fuel and energy crisis caused by Russia's full-scale military aggression against Ukraine, the European Commission has proposed a package of legislative amendments "REPowerEU"[22]. The package was proposed as the EU's response to the challenges of becoming independent of fossil fuel supplies from third countries as soon as possible and protecting end users, particularly households, which are extremely affected by rising electricity and heat costs.

Given the crucial importance of the "Fit for 55" package, from the point of view of decarbonizing the system-based district heating sector, the remaining part of this chapter describes the main changes resulting from the most important regulations. These also include amendments of:

- ENERGY **EFFICIENCY DIRECTIVE** (EU)[23] (EED)
- ENERGY **PERFORMANCE OF BUILDINGS DIRECTIVE** (EU)[24] (EPBD)
- RENEWABLE **ENERGY DIRECTIVE** (EU)[25] (RED)
- EU EMISSIONS **TRADING SYSTEM DIRECTIVE** (EU)[26] (EU ETS).

25 COM(2021) 557 final, European Commission legislative proposal for a draft Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council, and Directive 98/70/EC of the European Parliament and of the Council with regard to the promotion of the use of energy from renewable sources and repealing Council Directive (EU) 2015/652, Brussels, July 2021.

26 COM(2021) 551 final, European Commission legislative proposal for a draft Directive of the European Parliament and of the Council amending Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 on the establishment and operation of a market stability reserve for the European Union greenhouse gas emission trading scheme and Regulation (EU) 2015/757, Brussels, July 2021.

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It should be pointed out that, as of the time of publication of this report, the revised provisions of the EU ETS Directive had been agreed upon in tripartite negotiations between the European Commission, the European Parliament and the Council (the so-called trilogues) and were formally adopted by the European Parliament and the Council in April 2023. The revised directive was published in the Official Journal of the EU on May 16, 2023. In the case of the EED and RED directives, the trilogues were completed in March 2023, with the development of preliminary inter-institutional agreements. The least advanced is the legislative process for the EPBD, where the initial negotiating positions of both the Council and the European Parliament have already been adopted, giving the opportunity to start trilogues[27].

2.1. Energy Efficiency Directive (EED)

The revised EED establishes, in Article 4, an EU target to reduce energy consumption by 11.7% by 2030, compared to projections in the Reference Scenario 2020. The target for primary energy consumption is indicative, while the target for final energy consumption is binding at the European Union level. In 2030, the EU's final energy consumption is to be no more than 763 Mtoe, and the EU's indicative primary energy consumption target is no more than 992.5 Mtoe. National contributions are non-binding, as is the application of the new Annex I with the methodology for calculating country-specific targets. At the same time, while determining national contributions, member states may exceed the figure resulting from the application of the formulas in Annex I by no more than 2.5%. In addition, the revised directive includes new powers of the European Commission if member states do not follow the indicative trajectory for meeting the target. The rate of new annual final energy savings, whose increase is regulated in Article 8 of the recast directive, will also be revised. Member states will provide new annual savings averaging 1.49% of final energy consumption over the period from 2024 to 2030, that is: 1.3% in 2024–2025, 1.5% in 2026–2027, 1.9% in 2028–2030 and 1.9% of annual savings after 2030.

As far as district heating is concerned, including the direction of the sector transformation, the new rules for recognizing district heating and cooling systems as efficient systems are crucial. According to Article 24 section 1 of the revised EED, an efficient district heating and cooling system must meet the following criteria:

by December 31, 2027

The system uses at least 50% of renewable energy, 50% of waste heat, 75% of cogeneration heat, or 50% a combination (mix) of these sources.

from January 1, 2028

The system uses at least 50% of renewable energy, 50% of waste heat, 50% of combination of renewable energy and waste heat, 80% of heat from high-efficiency cogeneration, or at least a combination of heat injected into the district heating system where the share of renewable energy is at least 5% and the total share of renewable energy, waste heat or high-efficiency cogeneration is at least 50%.

from January 1, 2035

The system uses at least 50% of renewable energy, 50% of waste heat, 50% of combination of renewable energy and waste heat, or a system in which the total share of renewable energy, waste heat or high-efficiency cogeneration is at least 80%, and the total share of renewable energy or waste heat is at least 35%.

from January 1, 2040

The system uses at least 75% of renewable energy, 75% of waste heat, or 75% of combination of renewable energy and waste heat, and at the same time the total share of renewable energy, waste heat and high-efficiency cogeneration is at least 95% with a minimum share of RES or waste heat of 35%.

from January 1, 2045

The system uses at least 75% of renewable energy, 75% of waste heat, or 75% of a combination of renewable energy and waste heat.

from January 1, 2050

The system uses only renewable energy, waste heat, or a combination thereof.

Data	Warunek OZE lub/i ciepła odpadowego	Warunek jedynie z kogeneracją	Warunek mieszany (kogeneracja+ciepło odpadowe+odnawialne)
Do 31 grudnia 2027	50%	75% (bez wysokiej sprawności)	50% (bez wysokiej sprawności kogeneracji)
Od 1 stycznia 2028 do 31 grudnia 2034	50%	80% wysokosprawnej kogeneracji	50% (min. 5% OZE)
Od 1 stycznia 2035 do 31 grudnia 2039	50%	Brak	80% (min. 35% OZE lub ciepła odpadowego)
Od 1 stycznia 2040 do 31 grudnia 2044	75%	Brak	95% (min. 35% OZE lub ciepła odpadowego)
Od 1 stycznia 2045 do 31 grudnia 2049	75%	Brak	Brak
Od 1 stycznia 2050	100%	Brak	Brak

27 At the time of the report's publication in May 2023, tripartite negotiations between EU institutions had not yet begun.

In addition to the criteria described above, based on the shares of renewable energy sources, waste heat and high-efficiency cogeneration, there is a new alternative way of meeting the definition which can be selected by member states, which assumes that a system characterized by the maximum amount of greenhouse gas emissions per unit of heat or cooling supplied to end users can be considered efficient:

- by December 31, 2025: 200 grams/kWh;
- from January 1, 2026: 150 grams/kWh;
- from January 1, 2035: 100 grams/kWh;
- from January 1, 2045: 50 grams/kWh;
- from January 1, 2050: 0 grams/kWh, and member states can select how to meet the definition within a specified time frame.

District heating systems at the time of their construction must meet the criteria appropriate at that time according to one of the methodologies described above. In addition, member states will ensure that in the case of either the construction of new district heating systems or the substantial retrofit of generating units, there is no increase in the use of fossil fuels other than natural gas in existing sources compared to the average consumption of the previous 3 years, and that no new source in the system uses fossil fuels, excluding units using natural gas that could be built by 2030.

With regard to high-efficiency cogeneration – the agreed revision of the Directive provides for the introduction (in the revised Annex III) of a new limit for direct carbon dioxide emissions, which for fossil-fuel-based units is set at 270 g CO_2/kWh of energy produced, and will apply to new units and significantly retrofitted units (i.e. retrofit costing more than 50% of the investment costs of a new comparable unit) after the transposition date of Annex III. For cogeneration units operating prior to the entry into force of the revised directive, the provisions of Annex III provide for the possibility of derogation from the application of the emission criterion until January 1, 2034, provided that such units have an emission reduction plan to achieve the threshold of 270 g CO_2/kWh by January 1, 2034. It should be emphasized that meeting the indicated emission limit determines whether a generating unit has the status of high-efficiency cogeneration, consequently affecting whether a district heating system meets the efficient criteria.

An important obligation that will be imposed on operators of existing district heating systems (with the contracted capacity of more than 5 MW) that do not meet the criteria for an efficient system is the need to prepare a plan every five years, starting from January 1, 2025, to improve the efficiency of primary energy use, reduce transmission losses and increase the share of heat supply from renewable sources, and include measures for these systems to achieve efficient status. The plan is to be adopted by a competent authority.

Regulations related to district heating system planning, including at the local level, will also be strengthened. According to Article 23 of the revised EED, at the time of the update of the integrated national energy and climate plans, member states will also submit a comprehensive assessment of district heating and cooling to be developed in cooperation with key stakeholders. Within the framework of these strategies, solutions based on efficient district heating and cooling systems are to be promoted. In addition, local governments and municipalities with a population of more than 45,000 will develop, in cooperation with all key market players, local district heating and cooling plans which will focus on assessing the condition of infrastructure, analyzing heating equipment and systems in buildings, available technologies, as well as possible sources of financing for investments in low-temperature district heating networks, among others.

The directive will enter into force 20 days after publication in the Official Journal of the European Union. The time limit for transposition of the directive into the national law of member states was set at 2 years after the date of entry into force.

2.2. EPBD revision

The regulations included in the new EPBD are yet to be agreed in trilogues between the European Commission, the European Parliament and the Council. On October 25, 2022 the Transport, Telecommunications and Energy (TTE) Council approved the general approach which is the Council's position in negotiations with the European Parliament and the European Commission. Subsequently, on March 14, 2023, the plenary of the European Parliament voted on the report of the Committee on Industry, Research and Energy (ITRE) on the EPBD, which is the Parliament's position for the upcoming trilogue.

The aim of the EPBD revision is to introduce provisions that will enable achievement of zero-carbon by 2050 for, in principle, the entire EU building stock, which is currently responsible for 36% of EU greenhouse gas emissions[28]. To achieve this goal, member states will develop national building renovation plans which will set milestones leading to net zero-carbon buildings. National building renovation plans will be submitted to the European Commission every five years and will replace the current long-term renovation strategies.

With regard to the district heating, the most important are the provisions for definitions and criteria for new net zero-carbon buildings in the context of primary energy demand coverage sources, increased requirements related to the energy performance of existing buildings, and the overall framework and pace of the phase-out of fossil fuels from the building sector, including district heating and cooling systems. Due to the unfinished works on the EPBD, the positions of the Council

28 OM(2020) 662 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Renovation Wave for Europe – greening our buildings, creating jobs, improving lives, Brussels, October 14, 2020.

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and the European Parliament in the areas mentioned above are summarized below.

The Council's general approach calls for the maximum energy consumption of new and renovated net zero-carbon buildings to be determined at the member state level in national renovation plans. Among the identified possible sources for meeting primary energy needs of these buildings were the energy from efficient district heating and cooling systems, as defined in Article 24 of the recast EED. This means that the possibility of continuing to connect buildings to efficient district heating systems that do not rely solely on renewable energy and waste heat would be maintained beyond 2030.

In light of the Council's position, for existing residential buildings, member states would be expected to set their own maximum thresholds for primary energy consumption and develop a trajectory for reducing energy consumption with a view to achieving a net zero-carbon building stock by 2050. The trajectory would cover the period from 2025 to 2050 and would determine the number of buildings renovated each year. Member states would ensure that the average primary energy consumption (calculated in kWh/(m2/year) of the entire housing stock was at least equivalent to energy efficiency class D by 2033. Member states would ensure that the average primary energy consumption of the entire housing stock is at least equivalent by 2040 to a value determined at national level, resulting from a gradual reduction in average primary energy consumption from 2033 to 2050, in accordance with national targets for net zero-carbon building stock.

In its general approach, the Council proposes that, with few exceptions, member states will not be allowed to offer financial incentives for the purchase of fossil fuel boilers (including natural gas boilers) from January 1, 2025. In national building renovation plans, member states would be expected to identify measures leading to the decarbonization of heating and cooling, including through local district heating and cooling networks, and the gradual phasing out of fossil fuels from the sector, with a view to complete phasing out of fossil fuel boilers by 2040 at the latest.

The European Parliament's position was that new residential buildings would have to meet zero-carbon criteria starting from 2028 (for new buildings in use or owned by public authorities, starting from 2026). In principle, the demand of net zero-carbon buildings would be met solely by energy from renewable sources – generated and stored on-site, within energy communities, or by district heating and cooling systems. However, where, due to the nature of the building or the lack of access to renewable energy from district heating systems, full compliance would not be technically or economically feasible, the remainder or all of the total annual primary energy consumption may also come from an efficient district heating and cooling system, as defined in Article 24 of the new EED. This means that the possibility of continuing to connect buildings to efficient district heating systems that do not rely solely on renewable energy and waste heat would be maintained beyond 2028, however not as a rule, but as an exception to the rule.

For existing buildings, member states would be expected to determine a trajectory for improving building energy classes for 2040 and 2050. In addition, requirements for the minimum energy class of buildings are proposed to be tightened:

Existing buildings and public building modules would have to reach at least energy performance class E after January 1, 2027 at the latest, and at least class D after January 1, 2030

Existing non-residential buildings and building modules, other than public ones, would reach at least class E after January 1, 2027 at the latest, and at least class D after January 1, 2030

Existing residential buildings and building modules would reach at least class E after January 1, 2030 at the latest, and at least class D after January 1, 2033

Member states could exempt public social housing from reaching the relevant energy classes if such renovations are not cost-neutral or would lead to rent increases

It is also allowed to exclude strictly defined residential buildings from the criteria by a decision of the European Commission, but this can apply to a maximum of 22% of residential buildings. The solution is provided to apply until January 1, 2037

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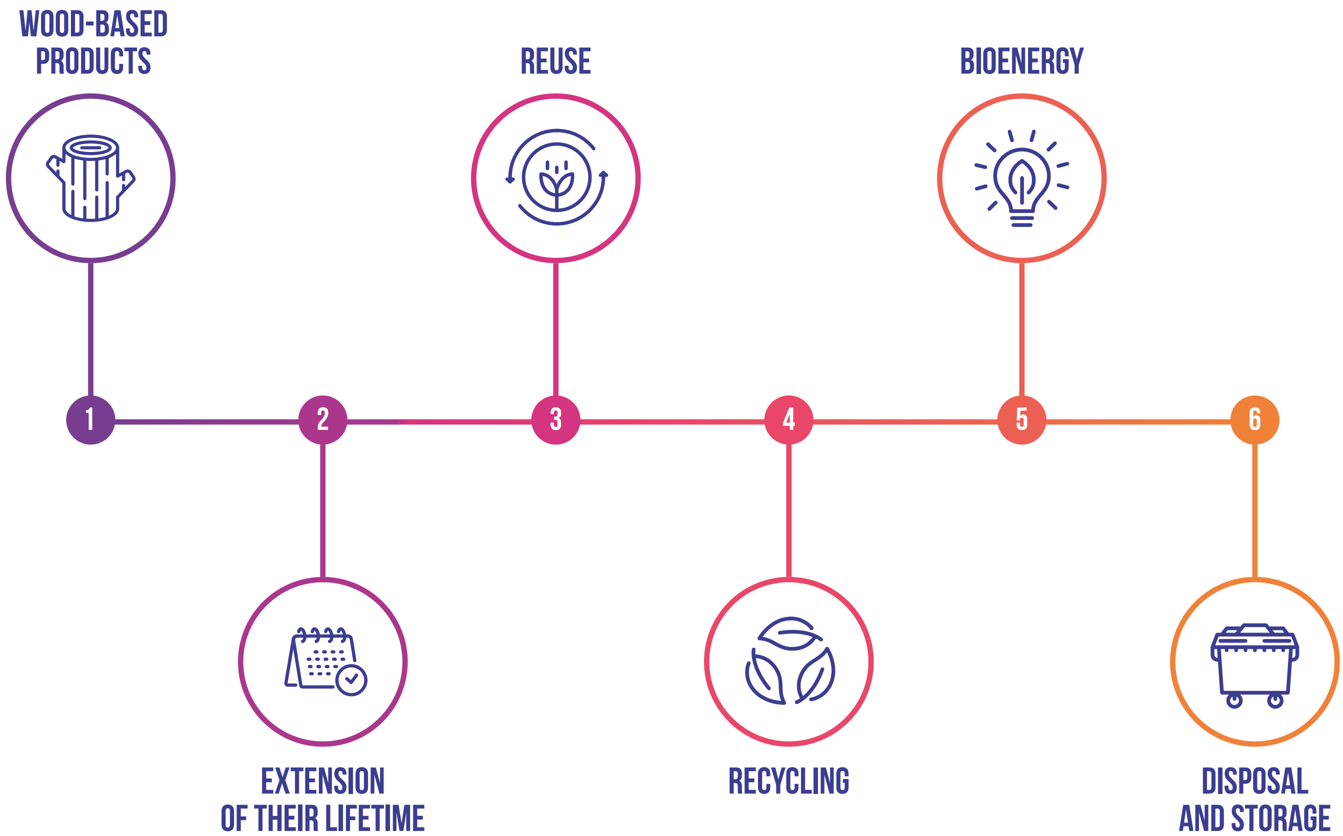
The European Parliament proposes that from January 1, 2024, member states should not be allowed to offer financial incentives for the purchase of fossil fuel boilers, and that there should be no exceptions to the rule. One of the elements of national building renovation plans is to phase out fossil fuels use in buildings by 2035, in principle in existing buildings, and if the European Commission assesses that this is not feasible by that date, by 2040 at the latest. The issue in question also applies to district heating. Further installation of equipment using fossil fuels would be allowed, as long as such equipment is certified to run on renewable fuels such as biofuels or hydrogen.

2.3. RED revision

According to the revised RED, agreed during the trilogues, a Europe-wide binding target of at least 42.5% of the share of energy from renewable sources in gross final energy consumption in 2030 has been set, up from the 32% share agreed under the previous RED revision in 2018. An additional indicative target of 2.5% of the share of energy from renewable sources in gross final energy consumption in 2030 has also been agreed, which, if realized, will enable the achievement of 45% at the EU level. A higher overall target will consequently translate into increased sectoral targets and the establishment of those for new sectors e.g. industry. The nature and size of targets for increasing the share of renewable energy sources for both heat and cold will have the greatest impact on district heating. In addition, the revised directive sets out rules for third-party access to district heating systems, rules for crediting electricity generated from renewable energy sources toward district heating targets, and a new indicative target for the share of renewable energy in buildings. Under the agreed Article 23 of the revised RED, the new overall targets binding at national level for heat and cold from renewable energy sources are 0.8 pp in the 2021–2025 period and 1.1 pp in the 2026–2030 period, with non-binding additional targets for member states also agreed. For Poland, the target is set at the level of 0.8 pp in the 2021—2025 period and 0.5 pp in the 2026—2030 period. The revised directive sets a non-binding target at the member state level for the share of energy from renewable sources of 49% in the total final energy consumption in the buildings sector by 2030. Among the measures to enable member states to implement this target is the connection of buildings to efficient district heating and cooling systems, as referred to in the EED. According to the agreement reached, an indicative target of an average increase in the share of energy from renewable sources of 2.2 pp per year over the 2021—2030 period has been set for the district heating sector. In addition, the possibility of crediting electricity from renewable energy sources for district heating purposes has been introduced. Member states interested in using this mechanism will be required to inform the European Commission and report energy volume data as part of their integrated national energy and climate plans, in accordance with Article 3 of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action[29]. Regarding third-party access to district heating systems, member states are encouraged to connect renewable energy offered by these parties in district heating systems with a capacity of more than 25 MW_t. There are exemptions to this rule related to technical aspects of the operation of the systems, as well as when the particular district heating system meets the requirements of an efficient district heating and cooling system as defined by the EED.

Sustainability criteria for the use of biomass for energy purposes have also been made more strict, including by making the cascading principle mandatory for forest biomass. According to the agreement reached, member states will ensure that the forest biomass is used in the following order:



29 Dz. U. L 198 z 22.6.2020, str. 13—43

These rules are to be taken into account when designing support systems, in order to avoid potential distortions in the materials market. Member states may use the derogation if it is related to ensuring energy security or the characteristics of the local market for the use of forest biomass that does not meet the requirements for its reuse or biomass from forestry-related activities. In addition, member states may not, as a rule, provide new direct support or renew existing support schemes for the generation of electricity solely from biomass fuels. By 2027, the European Commission will assess the justification for further restrictions on the use of the forest biomass in a special report. Additionally, the capacity threshold of biomass facilities where the fuel burned must meet sustainability criteria has been lowered from 20 to 7.5 MW_t. Requirements for member states to monitor and report to the European Commission on the use of the forest biomass will also be expanded. According to the agreement, by December 31, 2030 at the latest, energy from biomass fuels can be counted towards the renewable energy share targets when support was provided prior to the entry into force of the amended RED, and the nature of the support ensures that it was provided in the form of long-term support for which a fixed amount was set at the beginning of the support period and provided that the support system provides a mechanism to ensure that there is no over-support.

The Directive will come into force 20 days after its publication. The time limit for transposition of the directive into the national laws of member states is December 31, 2024.

2.4. Revision of the EU ETS Directive

The level of ambition under the ETS for stationary plants, including power sector and industry, includes a 62% reduction in greenhouse gas emissions by 2030 compared to emissions in 2005. Under the amended Article 9 of the EU ETS Directive, the linear reduction factor, affecting the volume of greenhouse gas emission allowances entering the market each year, will increase from the existing 2.2% to 4.3% from 2024, and then to 4.4% from 2028. In addition, the volume of greenhouse gas emission allowances will be reduced once by 90 million in 2024 and by 27 million in 2026. In the market stability reserve, which is responsible for preventing a surplus of allowances on the market, the factor will be 24% until 2030, and allowances accumulated in the reserve above 400 million will be automatically deleted. The new parameters of the system are aimed at accelerating the departure from the use of carbon-intensive fuels through the rising costs associated with the purchase of greenhouse gas emission allowances.

Under the amended provisions of the EU ETS Directive, instruments aimed at uncontrolled increases in prices of emission allowances will be strengthened. Under the mechanism specified in Article 29a, 75 million of allowances will be automatically released from the market stability reserve for a period of 5 months if the average price of allowances for the preceding 6 months is 240% higher than the average for the preceding 2 years. The European Commission will publish monthly average prices for both periods, as well as the price that allowances would have to reach for the mechanism to be applied. Such intervention can occur only once every 12 months.

The powers of the European Securities and Markets Authority (ESMA) will also be expanded, and it will conduct analyses of the OTC market and derivatives, as well as the operational trading activities, categories and speculative behavior of market participants to minimize the risk of the allowances market abuse. If the analyses show market irregularities, the European Commission will propose legislative changes. Added insights regarding spot market transactions are also to be directly available to national regulators.

Member States must allocate the entire proceeds from the sale of allowances to finance broad climate measures (until now it was at least 50%), such as investments in renewable energy sources, energy efficiency, retrofit and development of energy systems, including district heating networks and electromobility, among others. Member States will be required to report in detail on activities financed with funds raised from the sale of emission allowances. The rules for obtaining support from the Retrofit Fund will also be revised: In the case of Poland, up to 20% of the funds may be used to finance non-priority activities, including those related to the construction of natural gas units, as long as they comply with the "do no significant harm" principle, in accordance with Regulation (EU) 2020/852 on establishing a framework to facilitate sustainable investment, amending Regulation (EU) 2019/2088[30]. In addition, funds from the Retrofit Fund for the construction of sources using natural gas must be dictated by considerations of ensuring energy security. Decisions on financing these investments can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be made by the end of 2027 at the latest. In the case of Poland, from the national pool of the Retrofit Fund of approx. 96 millions of allowances in total[31], it will be possible to finance gas investments from the sale of about 15 millions of allowances worth up to €1.2 billion (assuming an average allowance price of €80 per ton). In addition, Poland will receive an additional 75 millions of allowances, as part of a 2.5% increase in the Retrofit Fund allocation.

From the point of view of district heating, the new rules for allocating free emission allowances are crucial. This is because additional conditionality rules have been introduced for the allocation of these allowances, according to which 20% of the free allowance allocation to plants will depend on the implementation of the results of an energy efficiency audit, within the meaning of the EED, as long as these measures have a payback period of less than 3 years. The amended directive also stipulates that the values of the indicators for the allocation of free emission allowances for the 2026–2030 period are determined by reference to 2021–2022 and the annual reduction rate, with the values of the indicators decreasing in the range of 0.3% to 2.5% per year. This represents a reduction in current volumes in the range of 6% to 50% for BMs used between 2026 and 2030. According to the European Commission's estimates, operators of some 290 plants working for district heating systems in Poland will be able to receive an additional 30% allocation of free allowances between 2026 and 2030 in exchange for undertaking investment activities with at least the same outlay as this additional aid, resulting in significant emission reductions by 2030. For this purpose, it will be necessary to develop by May 1, 2024 a plan to achieve climate neutrality by 2050 at the level of individual plants with specific milestones, starting in 2025 and every 5 years thereafter.

Another – important for the district heating sector – change in the EU ETS Directive will be the start of verification and reporting of greenhouse gas emissions from municipal WTE plants from January 1, 2024. By July 31, 2026, the European

30 OJ L 198 of 22.6.2020, p. 13–43
31 PTEZ's own estimates


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Commission will produce a report assessing the viability of including municipal WTE plants in the ETS starting in 2028, with a possible derogation until December 31, 2030.

The amended directive also includes a provision requiring the European Commission to submit a report to the European Parliament and the Council by July 31, 2026, potentially including a legislative proposal to reduce, starting in 2031, the capacity threshold above which a given plant would be eligible to participate in the EU ETS.

One of the most important changes introduced by the revised EU ETS directive concerns the start of operation (from the beginning of 2027) of a new emissions trading system for buildings and road transport. In certain cases, its implementation may be postponed for a year. Specifically for buildings, this will involve the necessity to have allowances surrendered against verified emissions by entities that grant authorizations to market fuels used for combustion in the building sector, i.e. also combined heat and power plants with a fuel capacity of less than 20 MW_t (not covered by the current scope of the system). The activities covered by the new system also include cogeneration plants and district heating plants that supply heat to residential buildings and industrial facilities, including through district heating systems. Under the new allowance trading system, the linear reduction factor will be 5.1% by the end of 2027 and 5.38% from 2038. As part of the introduction of measures to protect energy consumers, a mechanism has been implemented to counteract excessive increases in the prices of emission allowances. If their average price remains above €45 per ton (the estimated averaged price of emission allowances in this system) for a period of 2 months, additional 20 millions of allowances released from the market stability reserve will enter the market. The mechanism will be able to be applied once a year and will remain in effect until the end of 2029, when a review of the average price level enabling this measure is scheduled.

The amended text of the EU ETS Directive will enter into force 20 days after publication. The deadline for transposition of the directive into the national laws of Member States was set for December 31, 2023, and the new regulations are to be applied from January 1, 2024, with a few exceptions for the emissions trading scheme for buildings and road transport, which will be effective from June 30, 2024.

3. Key assumptions used to determine optimal technology options

This section presents the macroeconomic and market assumptions and technical assumptions adopted for the multi-option economic model, which determines the most cost-optimal options for implementing the "Fit for 55" package with regard to individual heat markets that differ in size and demand structure. The technology options were selected in such a way that a one-time investment process would have the potential to meet regulatory requirements in the run up to 2050. The various technologies in the stack are selected prioritizing both the lowest cost of heat generation and the achievement of at least the minimum volumes of heat from high-efficiency cogeneration, RES and waste heat, as specified in the definition of an efficient district heating system. The heat markets were divided according to the contracted thermal capacity:

- up to 20 MW_t
- from 20 to 50 MW_t
- from 50 to 100 MW_t
- from 100 to 300 MW_t
- from 300 to 500 MW_t
- above 500 MW_t

Four options of technological combinations are proposed for each heat market, which allow a given district heating system to meet the criterion of an efficient district heating system in successive time frames, as defined by Article 24 section 1 of the EED.

The analysis was performed for the period 2023 – 2050. Every year, the model recalculates the most cost-effective heat sources, taking into account not only meeting the requirements of an efficient district heating system, but also variable costs of production, and – for each year – it arranges the stack of generating units by writing them into the demand derived from the heat profile for a given option of the district heating system. This means that the heat production of each unit is based on the demand of a given market and the margin situation in a given year. The generating units with the lowest variable cost operate at the base of the district heating system.

3.1. Macroeconomic and market assumptions

The key factors influencing the selection of optimum technologies for heat generation are macroeconomic and market assumptions. This analysis adopts the most current set of assumptions, which were prepared by PTEZ members in April 2023 and which are presented in Charts 8–14.

Chart 8: EUR/PLN exchange rate[32]

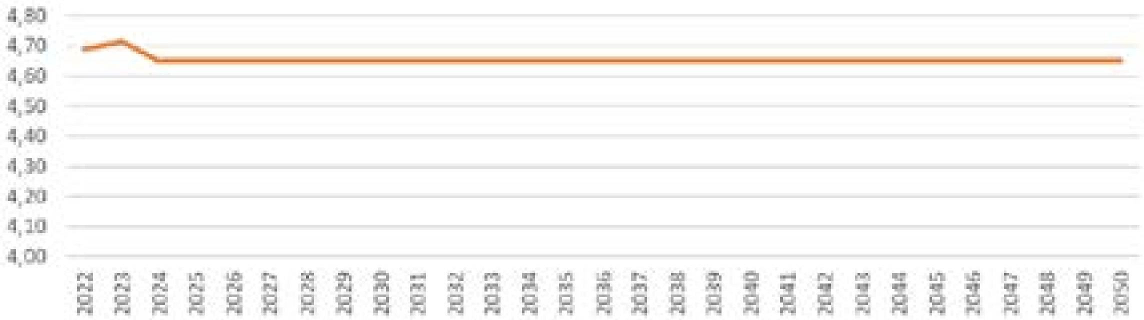


Chart 9: CPI inflation forecast Poland[33]

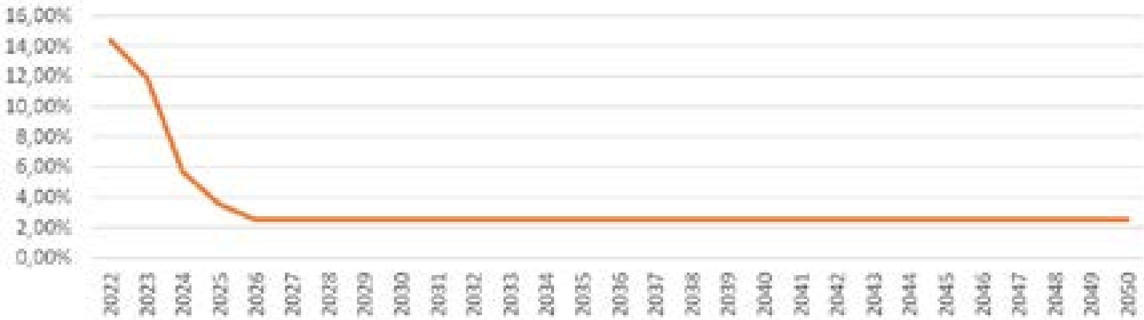
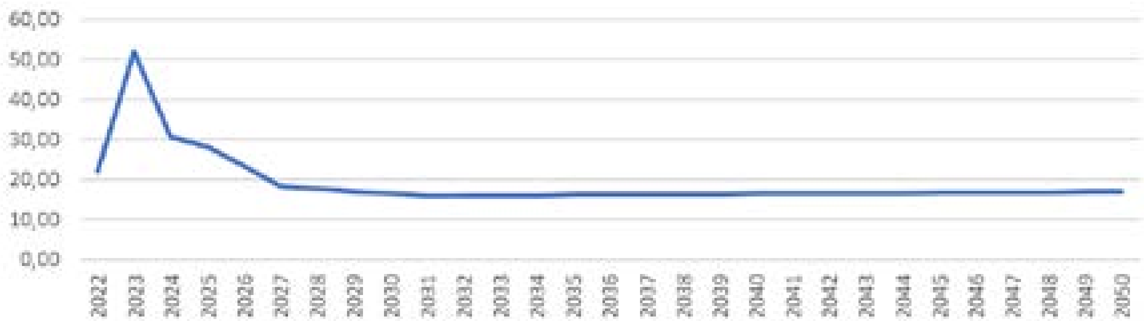


Chart 10: Coal price forecast [PLN'22/GJ][34]



32 PTEZ's own study based on the Guidelines of the Ministry of Finance on the use of uniform macroeconomic indicators, October 2022

33 PTEZ's own study based on data from the National Bank of Poland – Current projection of inflation and GDP (published on March 10, 2023) and the Guidelines of the Ministry of Finance on the use of uniform macroeconomic indicators, October 2022

34 PTEZ's own study – based on current quotations and the World Energy Outlook November 2022 – European Union; Stated Policies Scenario report

35 PTEZ's own study – based on current quotations and the World Energy Outlook November 2022 – European Union; Stated Policies Scenario report

Chart 11: Natural gas price forecast [PLN’22/GJ][35]

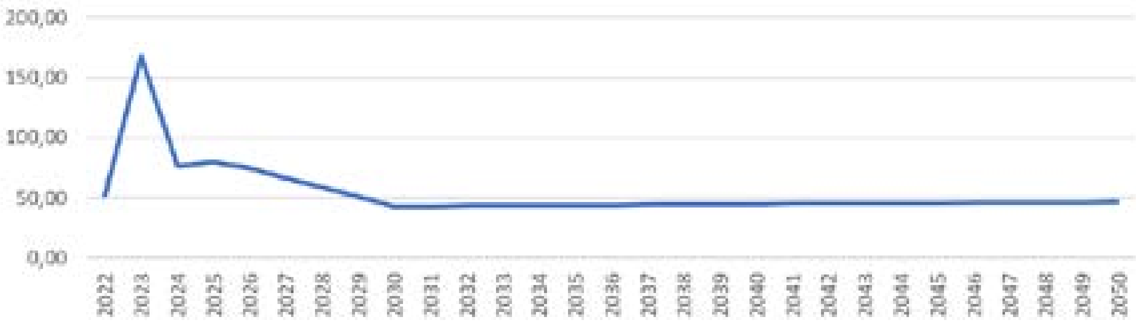


Chart 12: Biomass price forecast [PLN’22/GJ][36]

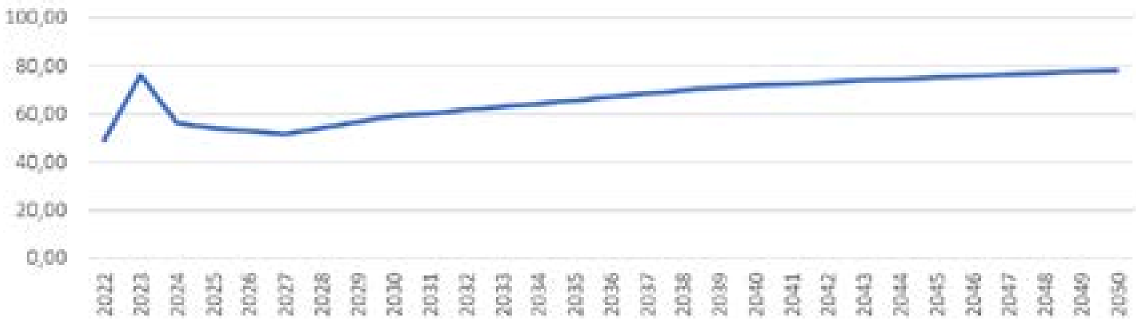


Chart 13: Price of greenhouse gas emission allowances [PLN’22/t][37]

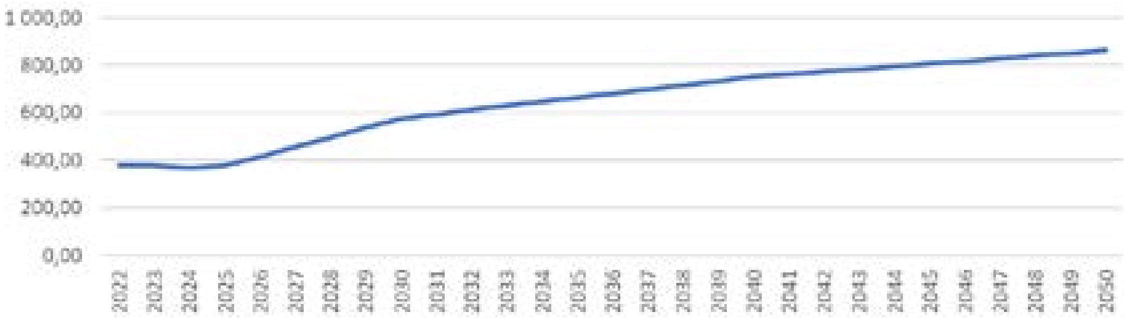
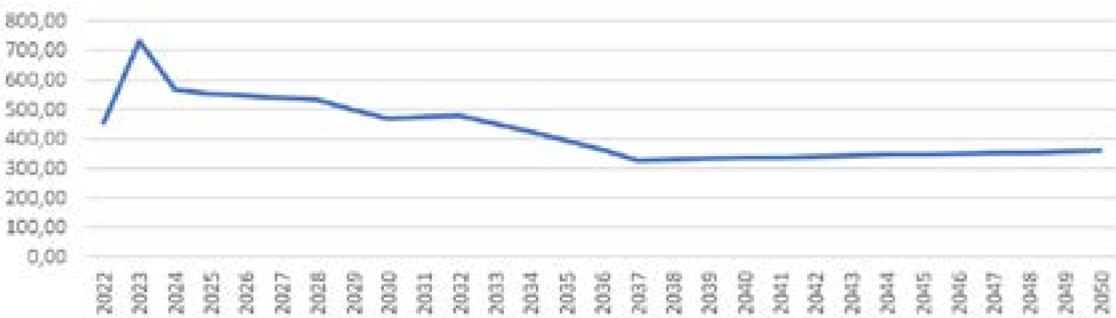


Chart 14: Forecast of electricity prices in the wholesale energy market [PLN’20/MWh][38]



36 PTEZ’s own study based on contracted data and PTEZ Members’ biomass price forecasts

37 PTEZ’s own study based on current quotations and analysis of World Energy Outlook November 2022 – European Union; Announced Pledges Scenario (APS) CO_2 prices for electricity, industry and energy production

38 PTEZ’s own study based on the adopted cost assumptions and the assumption of an electricity market margin of 30 PLN’22//MWh for the more profitable technology among condensing coal-fired units and new CCGT gas units. The electricity price forecast shown in chart 8 in the long term takes into account anticipated changes in the fuel mix due to, among other things, the development of nuclear power and offshore wind power, as well as the gradual reduction in the operation of conventional units.

3.2. Technical and economic assumptions

Table 5 includes the key technical and economic assumptions for each type of technology.

Table 5: Technical and economic assumptions[39]

Technology	Fuel	Overall efficiency [%]	CAPEX 2022 prices [mPLN/MW$_e$]	CAPEX 2022 prices [mPLN/MW$_t$]	OPEX [% CAPEX]
Coal-fired cogeneration	hard coal	85%	N.A.	1,50	5,0%
Coal-fired boilers (WR)	hard coal	85%	N.A.	1,37	5,0%
Gas-fired boilers	high methane natural gas	95%	N.A.	0,93	1,0%
OCGT	high methane natural gas	82%	8,40	N.A.	2,2%
CCGT	high methane natural gas	86%	9,00[1)2)]	N.A.	2,2%
Gas engines	high methane natural gas	85%	8,15	N.A.	5,0%
Oil-fired boilers	high methane natural gas	95%	N.A.	0,80	0,5%
Biomass-fired boilers	biomass	85%	N.A.	3,80	2,0%
Biomass-fired cogeneration	biomass	85%	15,00[1)]	N.A.	3,0%
Heat pumps	electricity	320%	N.A.	4,50	1,3%
Geothermal energy	electricity		N.A.	11,40	2,0%
Electrode boilers	electricity	99%	N.A.	0,70	0,5%
WTE PLANT	Waste	85%	90,00[3)]	N.A.	5,0%

1) Refers to electric power output of full cogeneration.
2) A unit with a steam heat section was adopted as the CCGT for reference.
3) The benchmark for the WTE plant is about 5,400 PLN'22 per ton of waste in terms of electric power output of cogeneration.

Proven technologies for which there is now operational experience in Europe were adopted for the analysis. In addition, taking into account, the need to adapt district heating systems by 2028, no consideration was given to technologies for which manufacturers are at the stage of obtaining licenses and it is not viable to commission these sources within the specified time frame in accordance with the requirements of the "Fit for 55" package, such as small SMR nuclear reactors. As of the date of the report, there is no reliable data on capital expenditures, costs and there is no operating experience. The time schedule for the world's first reactor of this type is also constantly being pushed back in time, so the aforementioned technology was not analyzed as part of this report.

Other assumptions included:

- The level of remuneration costs at the level of PLN 11.4 thousand in 2022 per month / FTE; the number of FTEs was varied depending on the technological mix in the option.
- Weighted average cost of capital WACC of 8%.
- CIT tax of 19%

39 PTEZ's own study on the basis of experience from its operations

3.3. Examples of heat markets

The regulations being processed as part of the "Fit for 55" package resulting from the goals of the EU's climate and energy policy will affect the long-term prospects for district heating development. The proposed legal solutions (especially in the area of energy performance of buildings) will cause:

- Increased pace of thermal retrofit of existing buildings to reduce final and primary energy demand;
- Tightening technical guidelines for new residential construction toward high energy efficient and passive houses.

This will result in a degradation of the heat market, understood as a reduction in heat demand for the existing mass of buildings and lower demand from new connections of buildings from the primary and secondary markets (with reduced demand for central heating), which will have a significant impact on the structure of individual heat markets.

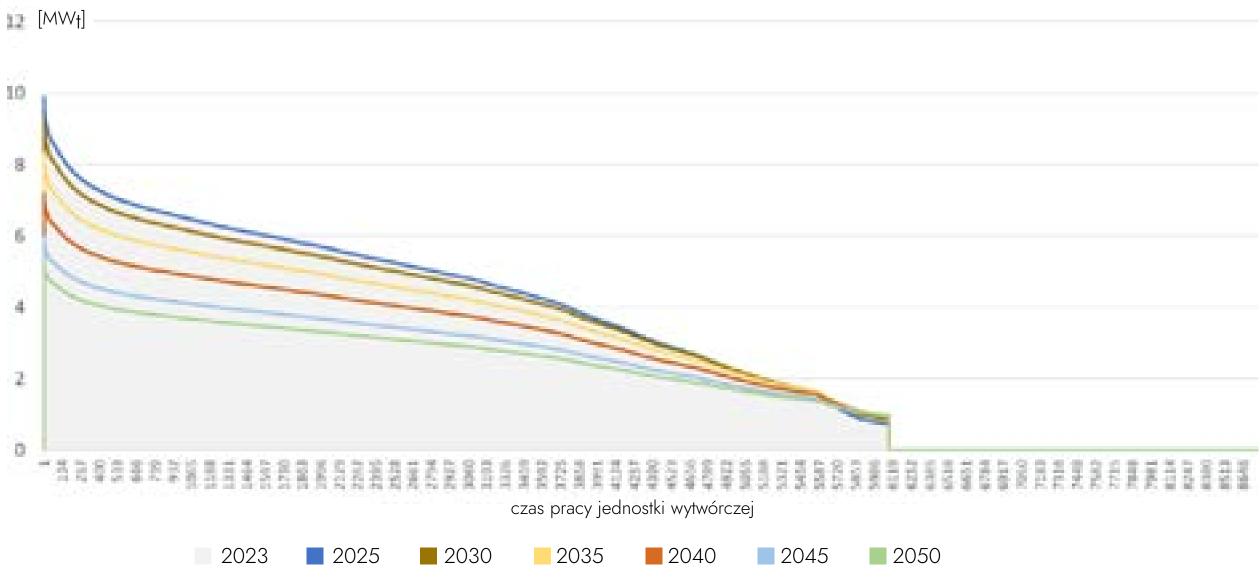
The effect of the above conditions on the level of heat demand will depend on the initial state of thermal retrofit of buildings currently connected to the district heating system. Changes in demand resulting from the introduction of savings due to rising heat prices are already being observed in district heating systems. For the purposes of the analysis, it was assumed that the buildings connected to the district heating system had mostly undergone at least partial thermal retrofit in the past.

Ultimately, a decrease in heat demand is projected, which will not be able to be fully compensated for by new central heating connections.

The rate of degradation of heat markets will depend on the duration of the validity of new regulations (possible transition mechanisms) and the potential for new connections. We currently expect volume loss of 30% to 40% by 2050 (in smaller markets with limited contracted capacity for hot water heating).

Chart 15 presents the heat market for contracted thermal capacity between 0 and 20 MW_t (a market currently outside the EU ETS). In Poland, more than 90% of such markets have no hot water and the district heating network is used for central heating. In these cases, domestic hot water is provided by local heaters in the buildings.

Chart 15: Heat market with contracted capacity of 10 MW_t [40]



40 PTEZ's own study

Charts 16 and 17 present examples of heat markets in the capacity ranges of 20 to 50 MW$_t$ and 50 to 100 MW$_t$. These markets are characterized by a relatively low share of hot water demand relative to larger cities and systems. This demand can be noticed in particular in the summer period.

Charts 18 through 20 present the heat demand of Poland's largest district heating systems, which are located in cities of more than 200,000 people.

Four different technology options were analyzed for each market, which are technically feasible and will enable the requirements of an efficient district heating system to be met over successive time frames, as defined in the EED.

Chart 16: Heat market with contracted capacity of 35 MW$_t$ [41]

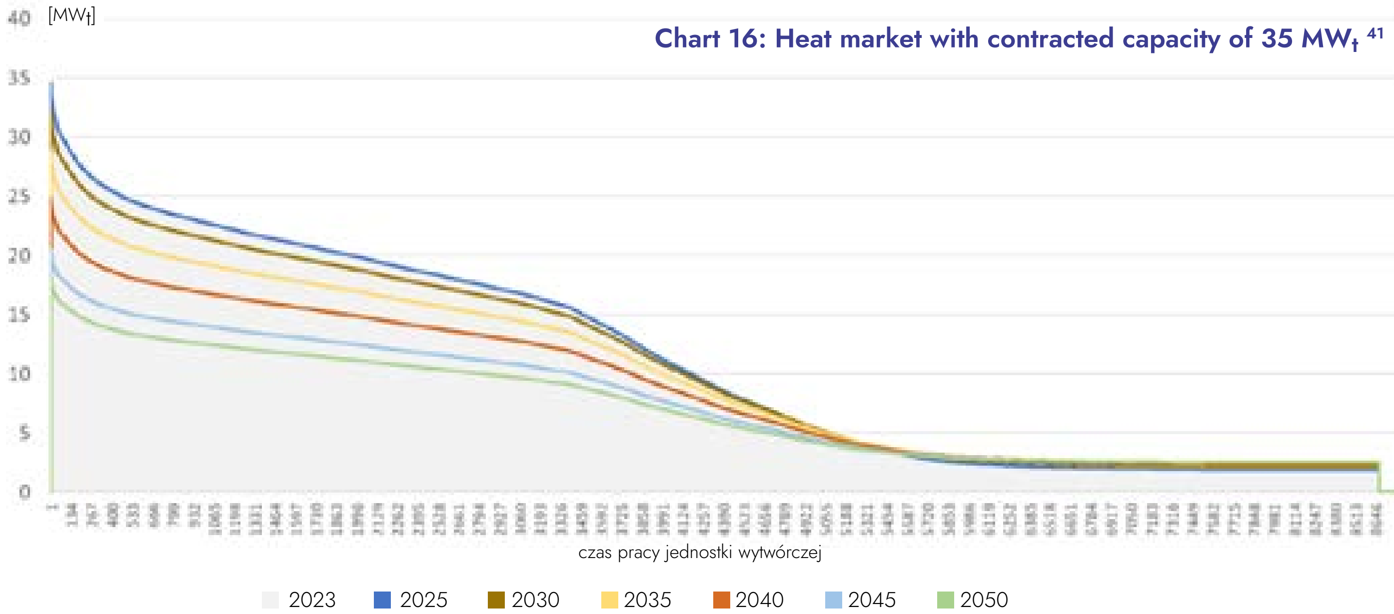
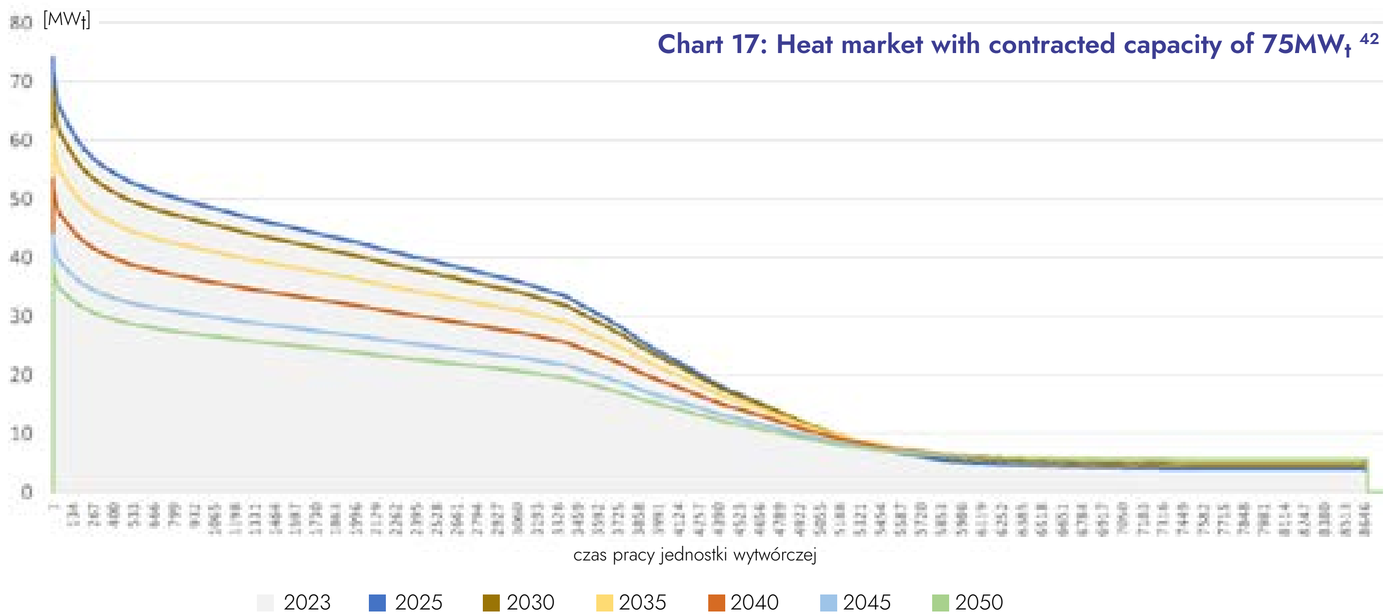


Chart 17: Heat market with contracted capacity of 75MW$_t$ [42]



41, 42, 43, 44, 45 PTEZ's own study

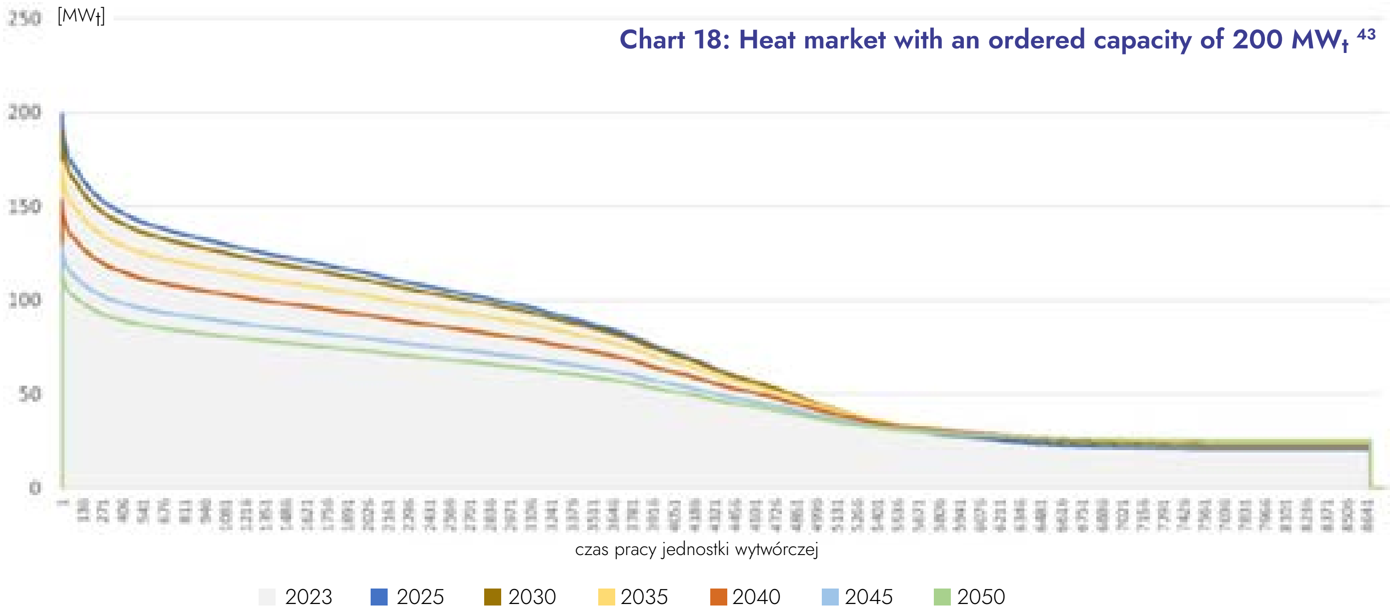


Chart 18: Heat market with an ordered capacity of 200 MW$_t$ [43]

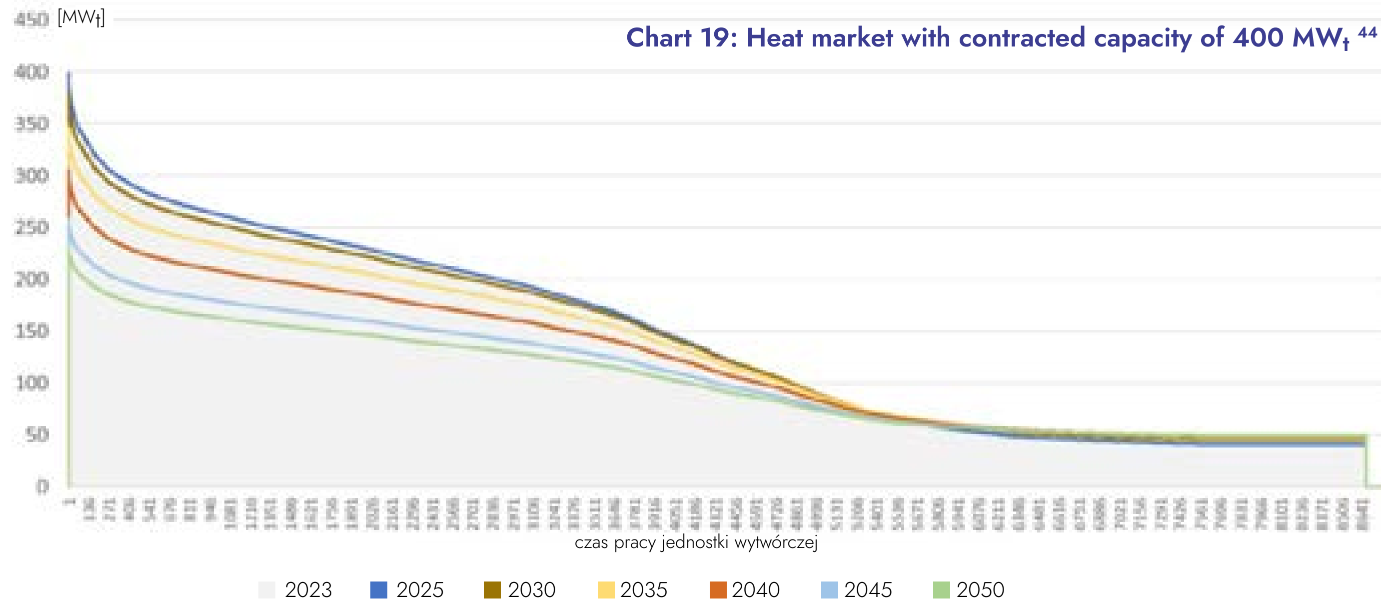


Chart 19: Heat market with contracted capacity of 400 MW$_t$ [44]

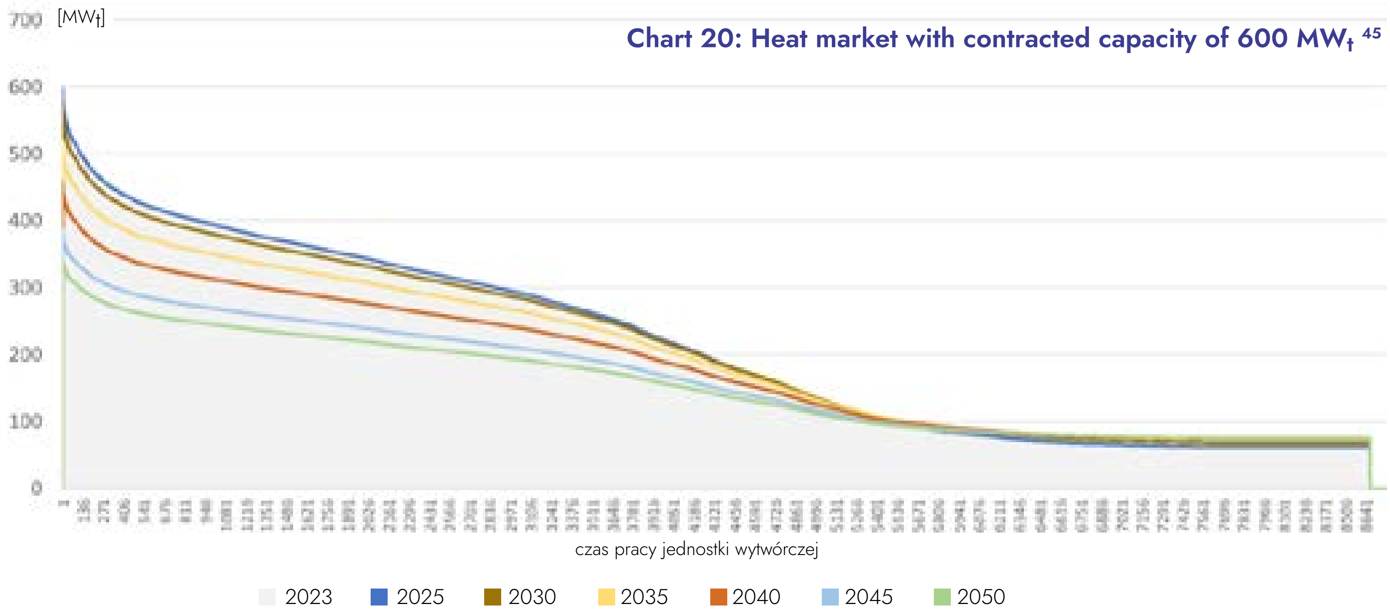


Chart 20: Heat market with contracted capacity of 600 MW$_t$ [45]

3.4. Technology options

The analysis was prepared on the basis of technological options, which were developed for each heat market from each power range, taking into account forecasts of the development of heat demand. A detailed summary of technology options is presented below. It should be noted that the installed thermal capacity assumed for the source is about 120% of the network's peak demand. Options that include heat pumps include additional power in peak units, due to the limited capacity of this technology during periods of low temperatures, in order to secure power during peak heat demand.

It is important to note that globally the proposed options do not include biomass cogeneration units. This is due to the following conditions, among others:

- definitely higher capital expenditures compared to non-cogeneration biomass boilers with a similar effect to meet the criteria relating to the definition of an efficient district heating system;
- higher demand for biomass fuel for cogeneration units, which will be important under conditions of shortage of supply of this fuel on the market;
- technology options with biomass cogeneration units generate higher LCOH values due to high levels of capital expenditures and limited profitability of biomass-fueled electricity generation over the long projection period.
- considerations related to participation in operational support systems for biomass-fired cogeneration units. Participation in RES auctions is hampered by the unpredictability of the biomass market resulting in the inability to secure contracts with suppliers for the period of generation of electricity sold as a result of the auction and, consequently, the inability to size a reasonable bid. In the case of the cogeneration bonus auction, the problem stems from a common basket for all types of fuels, of which biomass has the highest generation costs.

At the same time, it should be emphasized that the above barriers do not preclude the use of this technology when planning new investments. The decision to launch an investment should be considered on a case-by-case basis, taking into account local conditions (including fuel availability), regulatory conditions and the financial capabilities of the investor.

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Heat market from 0 to 20 MW_t

OPTION 1

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, 1.5 MW_t gas engines, 7 MW_t gas water boilers and 3.5 MW_t biomass water boilers are in operation.

OPTION 2

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, 10 MW_t biomass water boilers and 2 MW_t gas water boilers are in operation.

OPTION 3

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, 2 MW_t heat pumps and 11.5 MW_t biomass boilers are in operation; the district heating network is supplied with 0.5 MW_t waste heat.

OPTION 4

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, 5 MW_t gas engines and 6.5 MW_t biomass boilers are in operation; the district heating network is supplied with 0.5 MW_t waste heat.

Heat market from 20 to 50 MW_t

OPTION 5

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 0.5 MW_t waste heat, 15 MW_t gas engines are in operation, 25 MW_t biomass water boilers and 4.5 MW_t gas water boilers are installed.

OPTION 6

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 0.5 MW_t waste heat, a 14 MW_t OCGT system is in operation, 30.5 MW_t biomass boilers are installed.

OPTION 7

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 0.5 MW_t waste heat, a 15 MW_t CCGT system is in operation, 9.5 MW_t electrode boilers and 20 MW_t biomass boilers are installed.

OPTION 8

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 0.5 MW_t waste heat, 44.5 MW_t biomass boilers are in operation, 4 MW_t heat pumps are installed.

Heat market from 50 to 100 MW_t

OPTION 9

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 1.0 MW_t waste heat, 30 MW_t gas engines, 49 MW_t biomass boilers and 10 MW_t gas water boilers are in operation.

OPTION 10

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 1.0 MW_t waste heat, a 30 MW_t CCGT system, 59 MW_t electrode boilers and 10 MW_t heat pumps are in operation.

OPTION 11

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 1.0 MW_t waste heat, a 30 MW_t OCGT system, 19 MW_t gas boilers and 40 MW_t biomass water boilers are in operation.

OPTION 12

- WR-type (coal-fired) water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 1.0 MW_t waste heat, 89 MW_t biomass boilers are in operation, 4 MW_t heat pumps are in operation.

Heat market from 100 to 300 MW_t

OPTION 13

- Coal-fired cogeneration and WR-type water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 3.0 MW_t waste heat, 50 MW_t gas engines, 60 MW_t biomass boilers, 70 MW_t gas boilers and 57 MW_t electrode boilers are in operation.

OPTION 14

- Coal-fired cogeneration and WR-type water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 3.0 MW_t waste heat, a 70 MW_t CCGT system, 50 MW_t heat pumps, 50 MW_t biomass boilers and 117 MW_t electrode boilers are in operation.

OPTION 15

- Coal-fired cogeneration and WR-type water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 3.0 MW_t waste heat, a 70 MW_t OCGT system, 95 MW_t biomass boilers and 72 MW_t electrode boilers are in operation.

OPTION 16

- Coal-fired cogeneration and WR-type water grate boilers are in operation until 2027.
- As of 2028, the district heating network is supplied with 3.0 MW_t waste heat, 70 MW_t biomass boilers, 30 MW_t gas engines and 137 MW_t gas boilers are in operation.

Heat market from 300 to 500 MW_t

OPTION 17

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 6.0 MW_t waste heat, 115 MW_t biomass boilers, 145 MW_t gas boilers, 50 MW_t gas engines and 164 MW_t electrode boilers are in operation.

OPTION 18

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 6.0 MW_t waste heat, a 100 MW_t CCGT system, 95 MW_t biomass boilers, 20 MW_t ground source and 259 MW_t gas boilers are in operation.

OPTION 19

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 6.0 MW_t waste heat, 80 MW_t gas engines, 50 MW_t heat pumps, 110 MW_t biomass boilers and 284 MW_t electrode boilers are in operation.

OPTION 20

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 6.0 MW_t waste heat, 110 MW_t biomass boilers, 50 MW_t heat pumps, 80 MW_t gas engines and 284 MW_t gas boilers are in operation.

Heat market above 500 MW_t

OPTION 21

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 10.0 MW_t waste heat, a 200 MW_t CCGT system, 180 MW_t biomass boilers, 330 MW_t gas boilers.

OPTION 22

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 10.0 MW_t waste heat, 600 MW_t biomass boilers and 110 MW_t electrode boilers are in operation.

OPTION 23

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 10.0 MW_t waste heat, 160 MW_t biomass boilers, 20 MW_t ground source and 530 MW_t gas boilers are in operation.

OPTION 24

- By 2027, coal-fired cogeneration and WP water boilers are in operation.
- As of 2028, the district heating network is supplied with 10.0 MW_t waste heat, 200 MW_t gas engines, 150 MW_t biomass boilers, 50 MW_t heat pumps and 360 MW_t electrode boilers are in operation.

4. Data on large-scale heat markets in Poland

Table 6 describes the actual large-scale heat markets in Poland which were divided by contracted thermal capacity in the following ranges:

- up to 20 MW_t;
- from 20 to 50 MW_t;
- from 50 to 100 MW_t;
- from 100 to 300 MW_t;
- from300 to 500 MW_t;
- above 500 MW_t (the analysis adopted a 600 MW_t heat market model).

Table 6: Division of heat markets in Poland into benchmark markets[46]

Capacity range [MW]	Total installed capacity [MW]	Total available capacity [MW]	Heat generation [GJ]	Share of installed capacity in total market [%]	Share of achievable capacity in total market [%]	Share of heat generation in total market [%]
0 - 20	1 992	1 593	12 229 197	4,2%	4,1%	4,6%
20 - 50	4 402	3 587	23 668 458	9,3%	9,1%	8,9%
50 - 100	5 876	4 750	32 182 001	12,4%	12,1%	12,0%
100 - 300	9 062	7 269	47 491 829	19,2%	18,5%	17,8%
300 - 500	6 035	5 235	25 315 476	12,8%	13,3%	9,5%
500 +	19 903	16 797	126 335 239	42,1%	42,8%	47,3%
Total	**47 270**	**39 231**	**267 222 200**	**100%**	**100%**	**100%**

In order to estimate the scale of capital expenditures, the amount of fuel required and the impact on final heat prices for end users, this analysis uses a benchmark calculated on the basis of heat generation in heat markets by capacity range, as presented in Table 7.

Table 7: Summary of analyzed heat markets – analysis scaling[47]

Capacity range [MW]	Heat generation in actual heat markets in Poland [GJ]	Example heat markets for analysis [GJ]	Number of heat markets in given capacity ranges [#]
0 – 20	12 229 197	99 387	123
20 – 50	23 668 458	348 774	68
50 – 100	32 182 001	747 372	43
100 - 300	47 491 829	2 203 239	22
300 - 500	25 315 476	4 406 478	6
500 +	126 335 239	6 609 718	19

46, 47 PTEZ's own study based on data from the National Center for Emission Balancing and Management

5. Analysis results

This section presents the results of an economic analysis to determine the capital expenditures that need to be incurred to bring Poland's district heating sector into compliance with the key decisions of the "Fit for 55" package. The overarching assumption of the analysis is that district heating systems will meet the criteria for an efficient district heating system contained in the new EED.

In the analysis, the technology options were selected in such a way that a one-time investment process would have the potential to meet regulatory requirements in the run up to 2050. The various technologies in the stack are selected prioritizing both the lowest cost of heat generation and the achievement of at least the minimum volumes of heat from high-efficiency cogeneration, RES and waste heat, as specified in the definition of an efficient district heating system.

It should also be noted that there may be new opportunities around 2040 related to the option of converting existing gas generating units to allow the use of green hydrogen, biomethane or biogas, which should further increase the potential to accelerate the decarbonization of the district heating sector.

The adoption as a boundary condition of a given modeled district heating system's fulfillment of the "efficient district heating system" criterion is due to the crucial importance of this status for the operation of a given system. Its loss is associated with serious consequences for both energy companies engaged in heat generation and heat transmission and distribution, including, among others:

- a significant restriction on the possibility of obtaining investment support for the construction or modernization of the district heating network;
- the actual lack of market development opportunities for connecting new consumers and buildings;
- destabilizing the operation of the district heating network resulting from the need to connect RES plants, particularly to connect a large number of small RES plants (which will not equate to a large volume of heat from RES);
- the emergence of stranded costs resulting from the construction of generating units that guarantee energy security;
- allowing end users to disconnect from the district heating network;
- the emergence of more individual heat sources (not only using RES),

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but also it has an impact on air quality, as emissions of harmful substances and greenhouse gases will increase due to the aforementioned effects, and the phenomenon of low emissions will worsen. Thus, it has important implications for all parties involved in local heat markets.

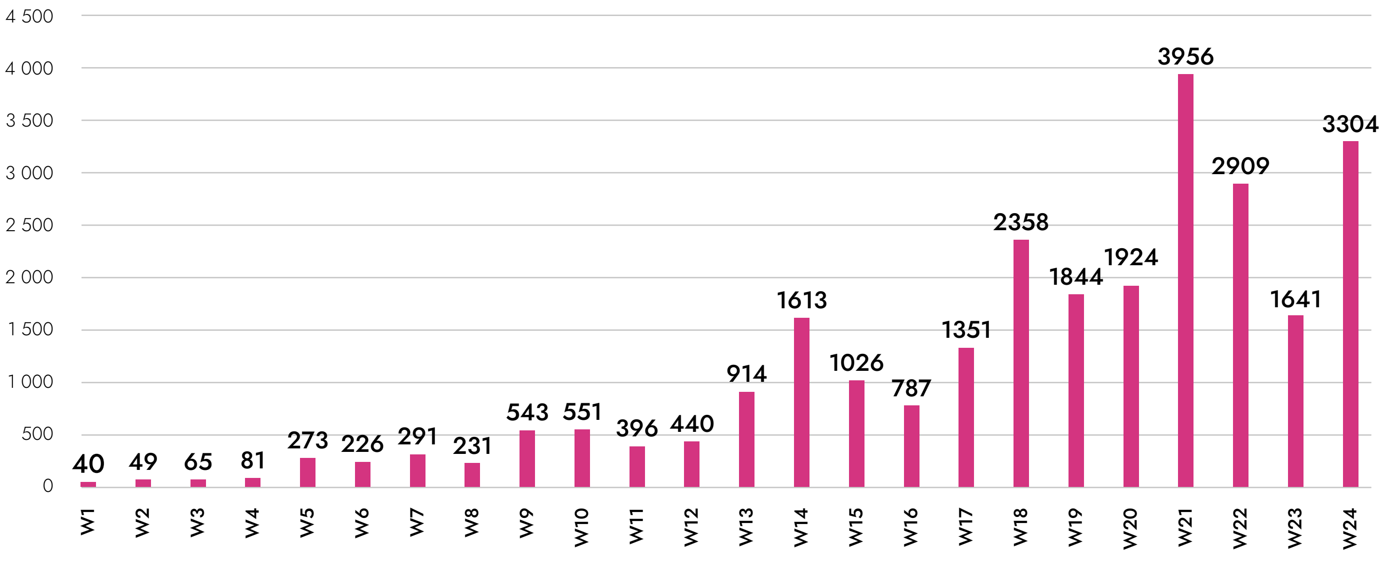
The mathematical optimization model used in the analysis aims to minimize the total cost of heat generation in district heating systems. It comprises the following components:

- CAPEX – which includes capital expenditures;
- OPEX – which includes the cost of fuel, the cost of greenhouse gas emission allowances and fixed operating costs;
- Period of analysis – 2023–2050.

The model, based on a typical ordered heat demand curve, calculates the used thermal capacity of the sources. Based on the thermal efficiency of the sources, a work stack is established in order from the most efficient (i.e. the cheapest) source after the variable cost of generation. The model takes into account regulatory requirements, i.e. the need to meet the criterion of an efficient district heating system, which involves taking into account the required shares of heat from RES or waste heat or heat from high-efficiency cogeneration in a given district heating system. Such a stack of units fills the demand of the heating market in each of the options. As a consequence of the above, there are years where heat from RES installations is not the cheapest, but must be produced for regulatory reasons, or a surplus of RES is obtained in relation to the requirements to meet the criterion of an efficient district heating system, when it is cheaper than other generating units. The analysis assumes that heat generation based on RES electricity supplied from the national power system and documented, for example, by a PPA contract, is 100% considered RES heat, according to the revised RED.

The model is intended to calculate the averaged discounted unit heat price on generation, which ensures the profitability of a given option at IRR = 8% over the period 2023 – 2050. The model discounts all expenditures (CAPEX, OPEX), takes into account revenues from the sale of electricity, and assumes that electricity from high-efficiency cogeneration is supported by the high-efficiency cogeneration support mechanism at PLN 114'22/MWh, and then determines a heat price that results in NPV = 0 over the entire forecast period. Nominal capital expenditures for each technology option are shown in Chart 21.

Chart 21: Nominal capital expenditures for individual technology options [mPLN][48]



48 PTEZ's own study based on analytical model

Taking the results of the analysis into account, it should be assumed that in individual heat markets, depending on the contracted capacity and the option of development of generation sources, it will be necessary to invest between PLN 40 million and PLN 3,956 million in a single market (for a market with a capacity of 600 MW_t, in the case of larger heat markets, it should be expected to incur more expenditures than those described in options 21–24). The level of capital expenditures to bring individual system heat markets in line with the requirements of an efficient district heating system is summarized in Table 8.

Table 8: The level of capital expenditures to bring individual system heat markets in line with the requirements of an efficient district heating system[49]

Capacity range [MW]	Minimum expenditures [million PLN]	Average expenditures [million PLN]	Maximum expenditures [million PLN]
0 – 20	40	59	81
20 – 50	226	255	291
50 – 100	396	482	551
100 – 300	787	1 085	1 613
300 – 500	1 351	1 869	2 358
500+	1 641	2 953	3 956

Taking into account the number of heat markets in Poland in the proposed capacity ranges, it should be concluded that it will cost from PLN 94 billion in the minimum capital expenditures option to PLN 178 billion in the maximum capital expenditures option, taking into account additionally the capital expenditures related to the implementation of the relevant connection infrastructure (to the power network, to the gas network) for the gas options, to meet the requirements set out in the final settlements of the regulations amended in the "Fit for 55" package. However, it is important to point out the likelihood of a non-inflationary increase in capital expenditures due to: the need to modernize the entire segment at the same time (the opening of a large work site), the saturation of the contractors' market, the interruption of the supply chain due to the geopolitical situation. These aspects are important given the assumed time schedule and evolutionary shape of the definition of an efficient system. The capital expenditures shown above are for generation sources and do not include expenditures related to retrofit of district heating networks and consumer facilities. Capital expenditures for this segment, mentioned in subsection 5.2, were estimated at between PLN 76 billion and PLN 100 billion and between PLN 106 billion and PLN 140 billion, respectively.

The effect of development and retrofit of the district heating sector is an integral part of the increase in the price of heat for end users. The single-component heat price, through which investors will be able to allocate funds for the development of generating units and ensure the profitability of their enterprises, is shown in Chart 22. The prices shown are the prices of heat generation, and, thus, do not include the costs of heat distribution and transmission.

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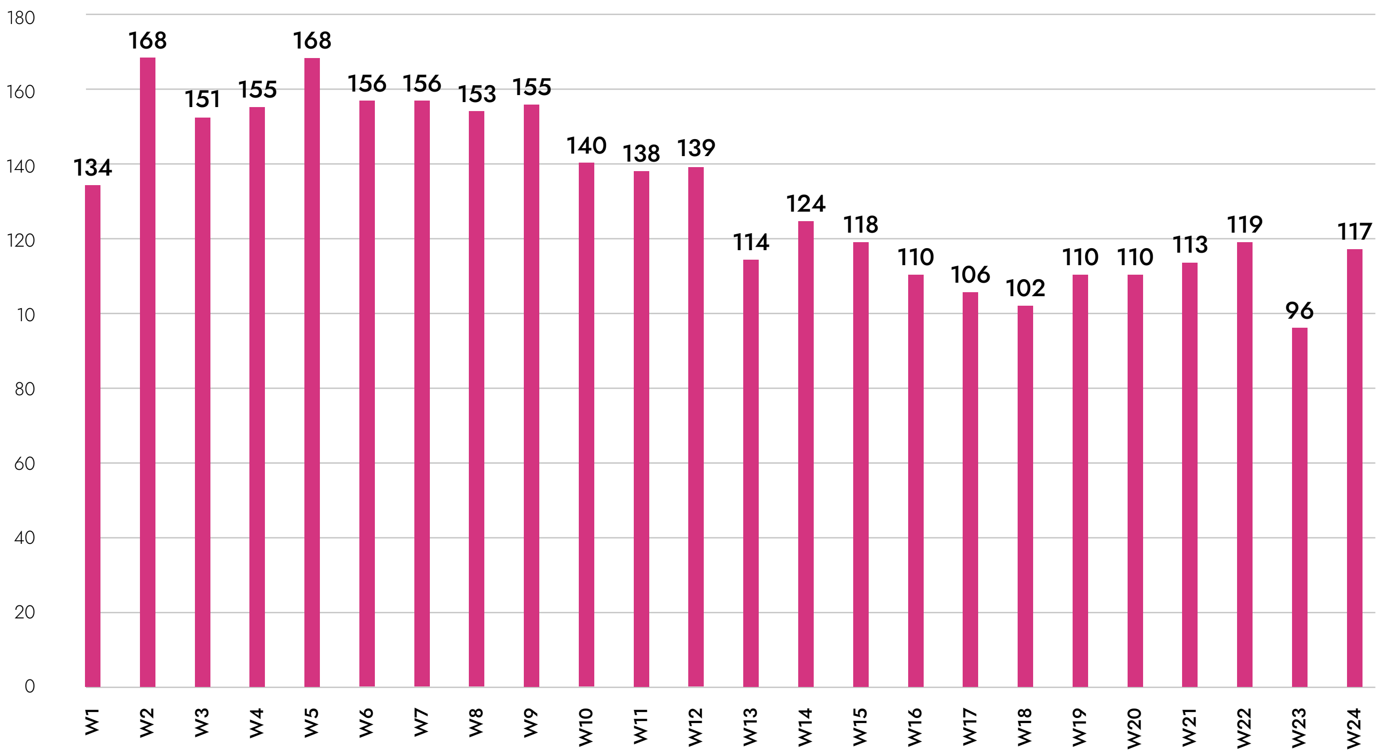
Chart 22: Single-component heat prices for end users [PLN'22/GJ][50]



5.1. Fuel demand considerations

5.1.1. Availability of biomass

If investors are willing to implement technology options with the maximization of the share of biomass in heat generation, the demand for this fuel in the first period would be approx. 25 million tons per year, which, given the conditions of the biomass market, is an unrealistic option. In the scenario of minimizing the share of biomass in the district heating sector by 2040, the demand would be about 5 million tons per year, after which it jumps to about 13 million tons per year due to the tightening of conditions for meeting the criterion of an efficient district heating system. A necessary condition for enabling such a volume of biomass is the gradual expansion of the biomass market, which is not feasible from the standpoint of demand and the logistics of fuel supply. For comparison – during one of the best years for the biomass market in Poland, 6.5 million tons of biomass were burned across the electricity and district heating sectors, followed by problems with lack of availability. Biomass fuel demand is shown in Chart 23.

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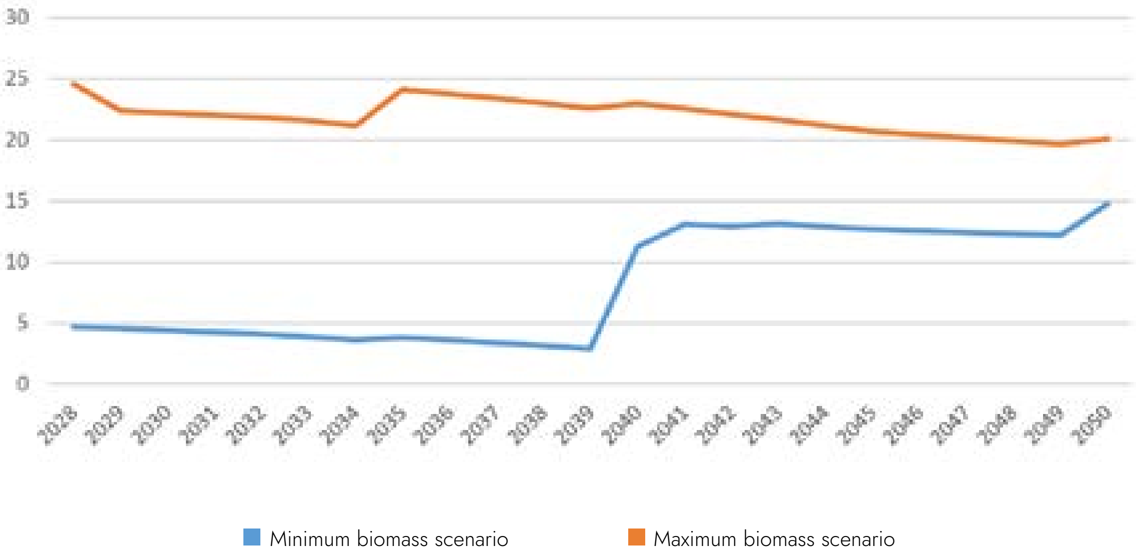
Chart 23: Biomass demand [million tons][51]



In the case of biomass fuel demand, it should be noted that in Poland CHP and heating plants are located in cities, which further creates logistical problems. This causes numerous protests from residents due to significant inconvenience on the side of congested streets and social unrest, which ultimately translates into the inability to implement scenarios with high biomass use in CHP plants.

In addition, it should be noted that the maximum potential for biomass use in the sector is approx. 5 million tons per year (currently less than 4 million tons per year are burned in the sector), assuming a developed and secure biomass market. This results in the fact that only small heat markets with an ordered thermal capacity of less than 50MW_t can meet the requirements of the Fit for 55 settlement in such a way, in terms of the required amount (increment) of heat from RES in the district heating system (allowing to meet the criterion of an efficient district heating system). In the case of large district heating systems, operating in locations such as Wrocław, Kraków, Warsaw, Gdańsk, the śląsko-dąbrowska Agglomeration, for example, where there is no available generation technology on an appropriate scale, an adequate volume of fuel (albeit biomass) is not available to meet the targets for the incremental share of heat from RES should it be implemented into national legislation in the form of a mandatory increment in each district heating system. For example, in order for obtaining a 20% share of heat from RES in Warsaw's district heating system, approx. 1.2 million tons of biomass would have to be obtained annually, which is impossible due to both demand and logistical considerations. The maximum share of RES heat generated from biomass in these heat markets could be 5%, assuming that the difficulties associated with the unstable market for this fuel are overcome. This is because it is characterized by very little predictability, with the vast majority of fuel contracted on a month-to-month basis, and market tools such as long-term contracts, the stock market or price indexes do not function.

To a significant extent, this is due to the fact that the biomass supply market faces significant logistical, regulatory and geopolitical barriers. As indicated above, especially in large cities, the transportation and storage of biomass poses a major logistical challenge. Another factor that significantly limits the use

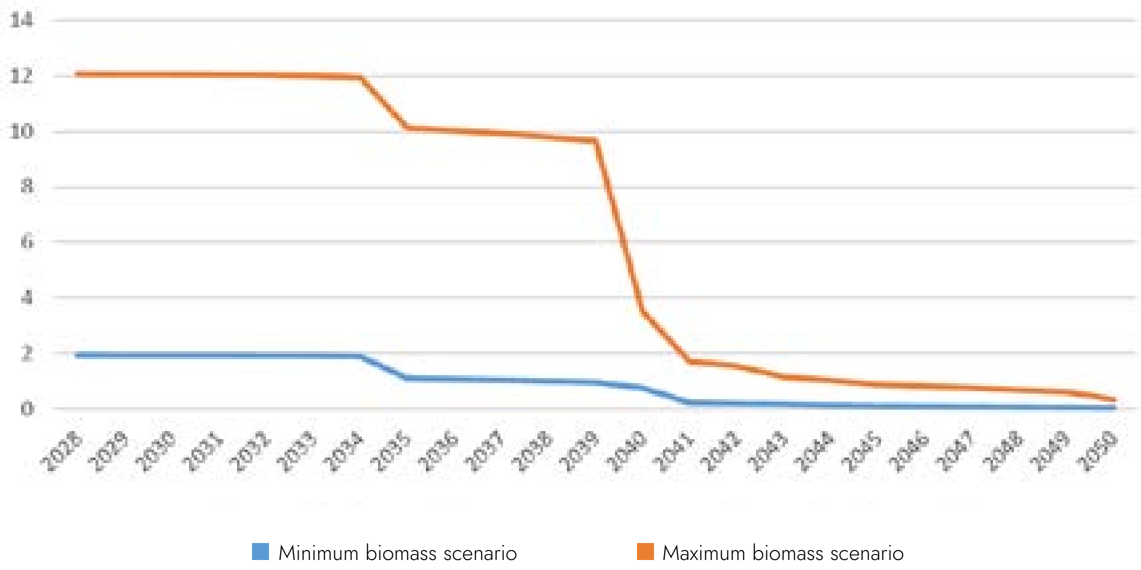
51 PTEZ's own study based on model results

of biomass is the requirement to certify the entire production chain of these fuels against constantly tightening sustainability criteria (SDC). The certification system affects the supply and price of biomass fuels, and applies from the stage of raw material acquisition to the stage of final use, taking into account all links in the supply chain. Poland's geopolitical location is also not without influence on the biomass market. The armed conflict in Ukraine has significantly reduced the supply of fuel, as it has resulted in the blocking of Belarus and Ukraine, the two main import destinations (Poland currently imports approx. half of the needed fuel). It should be mentioned that further tightening of requirements for biomass (especially forest biomass), as envisaged in the revised RED directive, may further limit the availability of this raw material for energy purposes. In conclusion, the biomass market will face deepening constraints over the next few years, which may have a negative impact on investment decisions in this type of generation source.

5.1.2. Availability of gas

Chart 24 shows gas demand under two scenarios: with the selection of options with the largest share of gas sources and the minimum share of gas sources.
Based on ERO data for 2021[52], gas use in the district heating sector is approx. 3 billion cubic meters. This data, compared to Chart 26, illustrates the scale of the technological and investment challenges facing Poland's district heating sector and associated infrastructure. It is also important to point out the considerations related to the network gas market and the overall shape of the investments carried out, related, among other things, to the need for energy companies to cover the full costs associated with the construction of connection pipelines. The possible availability of green gases (biogas, green hydrogen or others), would allow conversion of gas units (low cost to about 30% share) and possible extension of their use to achieve further requirements to meet climate and energy policy goals.

Chart 24: Gas demand [bcm][53]



52 Heat power engineering in numbers – 2021, Energy Regulatory Office, Warsaw, December 2022.
53 PTEZ's own study based on model results

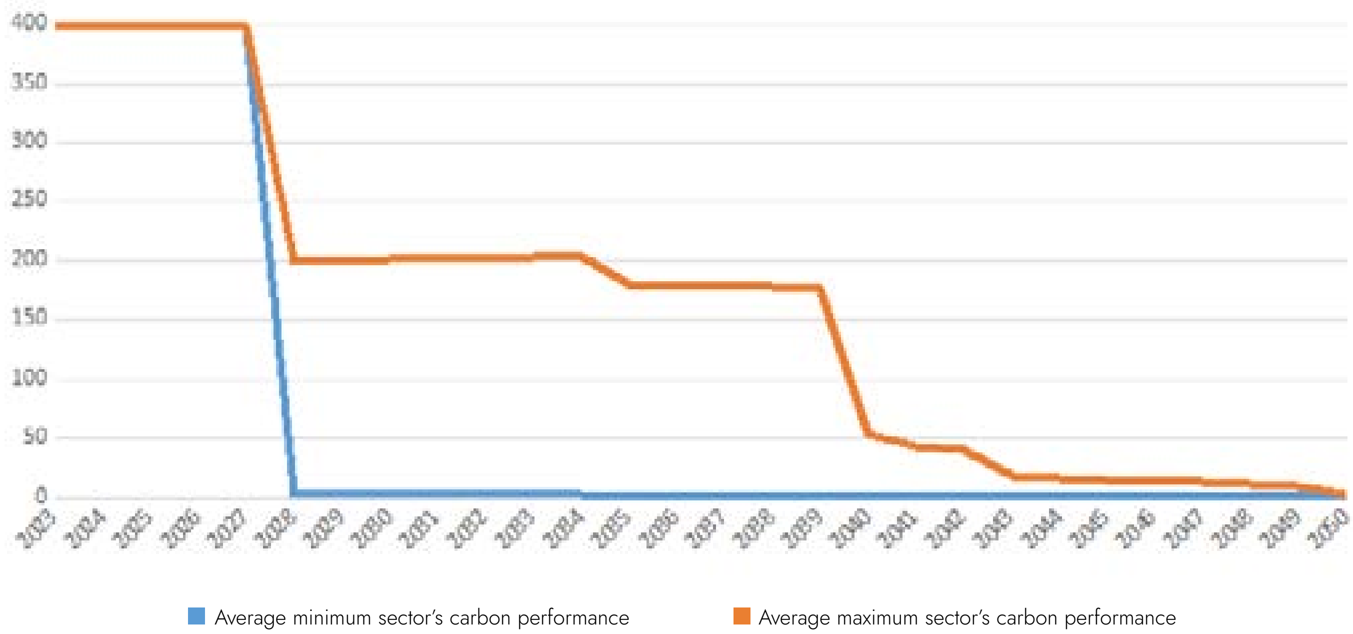
5.1.3. The impact of changing the generation mix on the carbon performance of the district heating sector

The analyses also included an assessment of the impact of implementing investments to meet the requirements of the final settlements of the "Fit for 55" package on the carbon performance of the district heating sector in Poland. The results in the two scenarios are presented in Chart 25, which shows that if the most ambitious scenarios for the use of RES in the district heating sector in Poland are to be pursued, the sector's carbon performance will be marginal, but at this point it should be noted that there will be a logistical and technical problem related to the lack of fuel availability.

In a scenario in which gas is used to a greater extent in co-generation units, the sector's carbon performance will also be significantly reduced and the requirements of the "Fit for 55" package will be met, but gas demand will increase nearly 4-fold from year to year, which is also technically unfeasible in terms of securing sufficient supplies of the fuel. This may also be hampered by the scope of planned investments specified by the gas transmission system operator in Poland (i.e., GAZ-SYSTEM) in the National Ten-Year Transmission System Development Plan for 2022–2031[54], which, despite its high level of ambition in terms of the investments to be made, did not foresee the need to switch to gas as an intermediate fuel in such a short timeframe as is implied by the definition of an effective district heating system.

The analysis also included a projection of the generation mix in the district heating sector over the 2050 horizon based on the model results. Chart 26 and Chart 27 show possible scenarios for changing the mix in different technological configurations that meet the requirements of the "Fit for 55" package.

Chart 25 Projection of CO_2 carbon performance of the heating sector in Poland depending on the development scenario [kg CO_2/MWh of total energy][55]



54 National Ten-Year Transmission System Development Plan for 2022 – 2031 developed by OGP-Gaz-System and agreed with the ERO President, 2021.
55 PTEZ's own study

Chart 26: Projection of the share of heat production from gas-fired cogeneration depending on the development scenario[56]

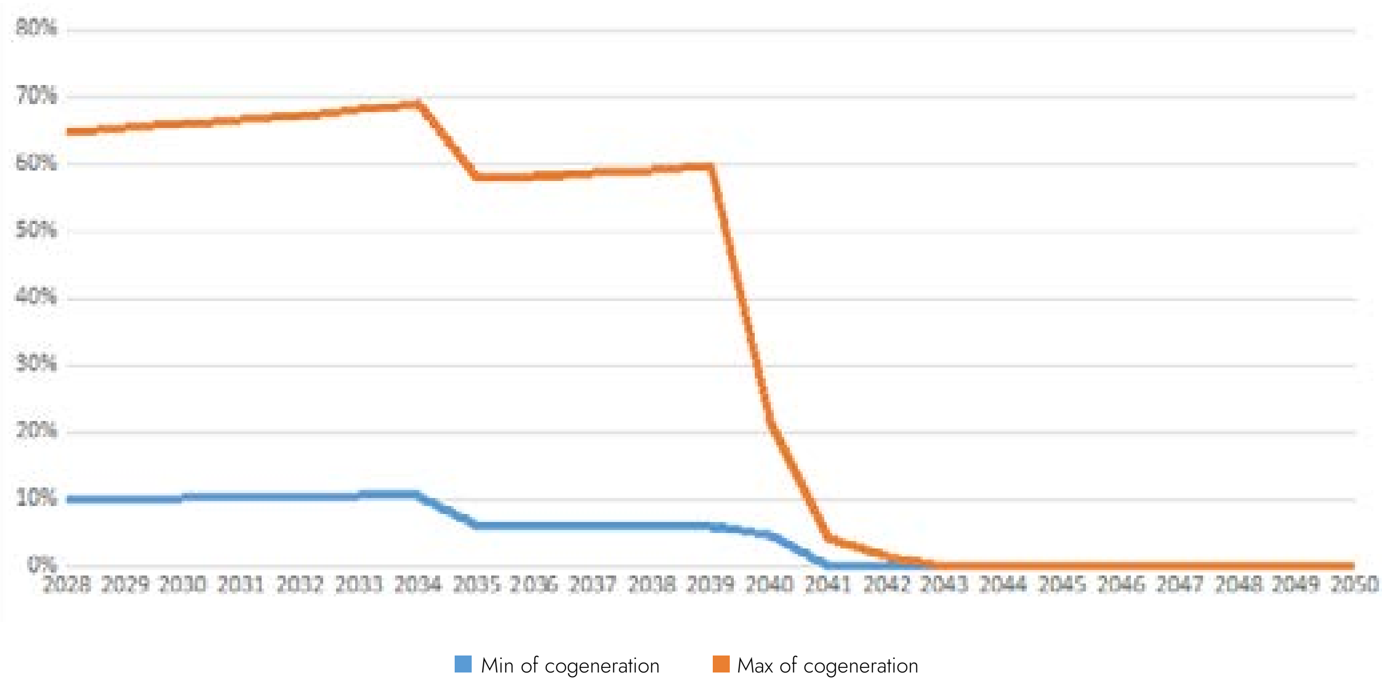
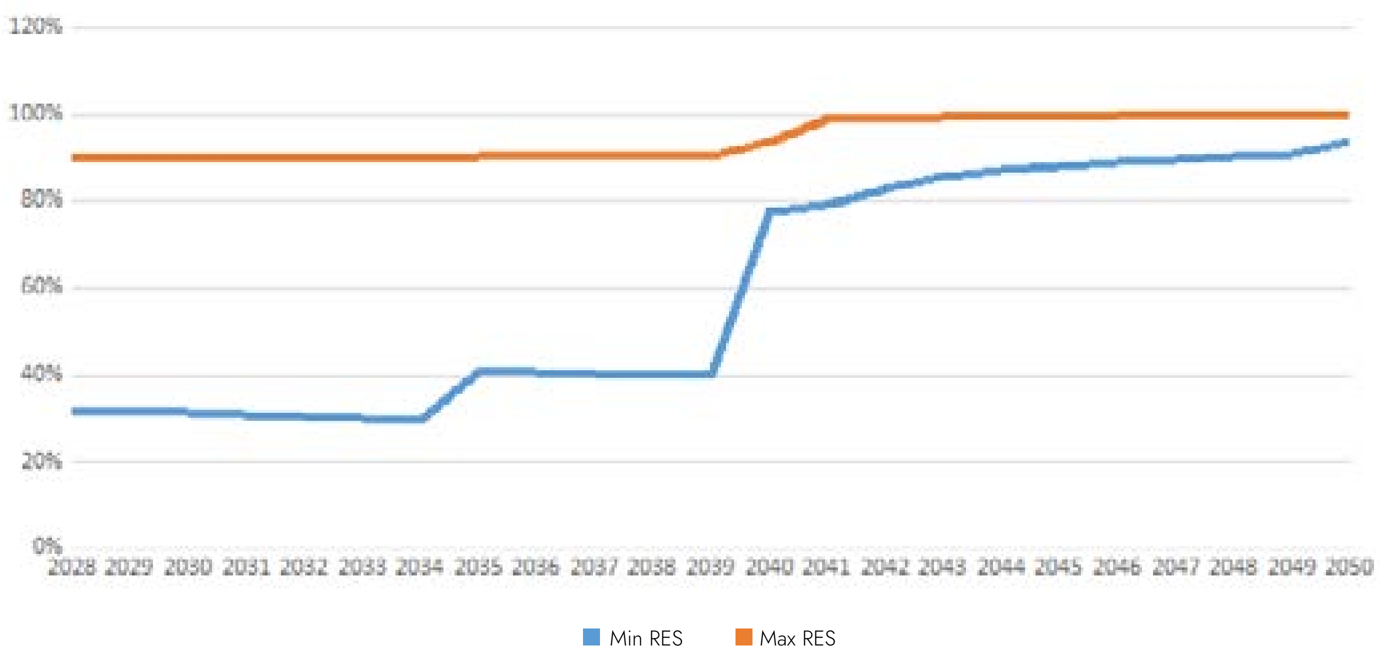


Chart 27: Projection of the share of heat production from RES and waste heat depending on the development scenario[57]



56, 57 PTEZ's own study

5.2. Conditioning related to infrastructure and receiving facilities

5.2.1. Conditions of the district heating networks

In Poland, the district heating sector, as shown in subsection 1.2, is highly developed compared to other countries in Europe. In Poland, heat generation in cities is centralized and heat is supplied by district heating systems over large areas. It supplies an average of 40 to 60% of the population in a given region. Accordingly, the number of district heating networks and district heating customers is significantly higher than in other European countries.

In Poland, district heating networks have a total length of more than 22,000 kilometers. Adapting the heat generation sector to future regulatory requirements will involve great expenditures to modernize such extensive heat transmission and distribution infrastructure. As part of this analysis, due to the impossibility of obtaining accurate data on the diameters of individual district heating networks, it was decided to estimate the scale of capital expenditures necessary for this segment in order to adapt high-temperature networks (present in Poland) to the requirements under the Fit for 55 package for heat quantity and quality, i.e. upgrading to low-temperature pre-insulated networks. In order to estimate the scale of capital expenditures, the 2020 price list for replacement of district heating networks was used, as shown in Table 9, and assumptions were made regarding the diameter of individual district heating networks.

Table 9: Price list for replacement of district heating networks depending on diameter[58]

District heating networks made of pre-insulated pipes	Unit of measure	Unit price in PLN
32/110 mm (two-pipe system in a trench)	m	1506
40/110 mm	m	1873
50/125 mm	m	2241
65/140 mm	m	2608
80/160 mm	m	2975
100/200 mm	m	3343
125/225 mm	m	3710
150/250 mm	m	4078
200/315 mm	m	4445
250/400 mm	m	4812
300/450 mm	m	5180
350/500 mm	m	6539
400/560 mm	m	9407
500/630 mm	m	12058

58 PTEZ's own study based on market price lists

The analysis adopted the average diameters of the district heating networks in each system based on Table 10 and the data for valuing capital expenditures contained in Table 11.

Table 10: Average diameters of heating networks[59]

Diameter of district heating pipes in Polish systems [mm]	Average distribution of pipe diameters using several district heating systems as an example [%]	Length of district heating networks in Poland with a given cross-section [km]
up to 100	54%	11946
100-200	23%	5088
200-300	7%	1549
300-400	3%	664
400-500	7%	1549
> 500	6%	1327

Table 11: Adopted price list and diameters for valuation of capital expenditures[60]

Adopted diameter	Pricing [PLN/m]
50/125	2241
100/200	3343
150/250	4078
200/315	4445
250/400	4812
500/630	12058

Based on the above data and the assumptions made, it should be concluded that the modernization of the heat transmission and distribution infrastructure to adapt it to low-temperature networks on the capital expenditure side will amount to approx. PLN 76 billion. Assuming that some of the assumptions made are subject to the risk of data inaccuracy, and taking into account the current phenomenon of high inflation and the lack of available materials, which also affects price increases, it is estimated that capital expenditures could increase up to PLN 100 billion.

It should also be pointed out that the calculations do not take into account the very difficult to estimate increase in capital expenditures due to claims of landowners in the process of modernization of district heating networks – in Polish conditions there is a large share of land to which distributors do not have legal title.

Upgraded or new district heating networks are metered in a completely different way than existing ones. Smart metering of the network also has a significant impact on the spread and delivery of heat to consumers. Thanks to "smart metering", district heating networks can be treated as heat accumulators of several hours and reduce the operation of peak sources, which has a significant impact on heat prices for end users. The analysis assumed that the reduction in peak source operation at times of lowest temperatures, due to smart network metering, would be about 5%. Digitization of the district heating sector, mainly on the network side, is an integral part of its transformation.

5.2.2.Conditions for consumer systems

The most difficult to estimate the necessary investment is the area of modernization of consumer systems in buildings, which includes the modernization, installation or replacement of heat distribution substations and the modernization of the building service systems, without which, it will not be possible to carry out an effective transformation of the district heating sector. The extent of capital expenditures to be determined in this area is all the more difficult because the technical condition of buildings in Poland and building service systems varies, in addition, in some buildings heat is supplied from group heat distribution substations. It has been assumed that the capital expenditures necessary to be incurred for the modernization of network heat receiving facilities will amount to 1.4 times the expenditures necessary for the modernization of transmission and distribution infrastructure. The size of these expenditures will thus amount to PLN 106-140 billion.

59, 60 PTEZ's own study

6. Summary and recommendations

- In Poland, metropolitan areas are heated and supplied with heat for domestic hot water by district heating systems with sufficiently high generating capacities. The market for district heating systems in Poland is, in principle, the largest in the EU, which is mainly due to climatic conditions in correlation with high urban density, a high urbanization rate. Poland's population size, moreover, is one of the largest among EU countries.

- In recent years, intensive investment processes have been initiated in the district heating sector in Poland. Along with efforts to reduce the carbon performance of heat generation, work is being undertaken to build hybrid systems in which central generating units will be supplemented by renewable sources of heat generation. According to the climate and energy policy goal, district heating systems will achieve climate neutrality in 2050.

- EU energy and climate policy regulations will have a particularly significant impact on the further development of system-based district heating in Poland. Given the above, it should be pointed out that it will be necessary to build new zero- or low-carbon generation sources, especially using renewable energy sources in order to achieve the goal of climate neutrality. In this context, the most important are the provisions in the "Fit for 55" legislative package proposed by the European Commission and – for the most part – already agreed by the European Parliament and the Council.

- This report attempts to determine the costs of decarbonizing the district heating sector in Poland based on the settlements achieved and to identify key technologies that will enable the transition process.

- The analysis was carried out for characteristic heat markets in Poland, classified by contracted capacity. The model is based on detailed macroeconomic, market and technology assumptions for reference heat markets for the period 2023-2050. Four technology options were proposed for each market to meet the definition of an efficient district heating and cooling system. The developed model in each year recalculates the most cost-effective heat sources, taking into account not only the fulfillment of the requirements

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of an efficient district heating system, but also the variable costs of production, and – for each year – arranges the stack of generating units writing them into the demand resulting from the heat profile for a given variant of the district heating system. This means that the heat production of each unit is based on the demand of a given market and the margin situation in a given year. The generating units with the lowest variable cost operate at the base of the district heating system.

- The analysis also takes into account scenarios for reducing heat demand in district heating systems, resulting mainly from thermal rehabilitation of buildings.

- Meeting the requirements of the EU's "Fit for 55" package will require, in Poland's case, depending on the scenario, expenditures of:
  - from PLN 94 billion to PLN 178 billion – expenditures for generation infrastructure,
  - from PLN 76 billion to PLN 100 billion – expenditures for transmission and distribution infrastructure,
  - from PLN 106 billion to PLN 140 billion – expenditures for modernization of heat distribution substations.

  that is, in total – from PLN 276 billion to PLN 418 billion for the decarbonization of the district heating sector.

  It is important to point out the likelihood of a non-inflationary increase in capital expenditures due to: the need to modernize the entire segment at the same time (the opening of a large work site), the saturation of the Contractors' market or, for example, the interruption of the supply chain due to the geopolitical situation. These aspects are important given the assumed schedule and the need to meet further milestones for the definition of an efficient district heating and cooling system.

- Although outside the scope of this report, an important aspect of financing the transformation, beyond ensuring its availability, is the maximum levels of intensity of state aid, as defined at the level of EU legislation[61], which, as amended in March 2023, limits the volumes of investment project financing from aid funds. They amount, depending on the type of project, to only 30 to 45% of eligible costs. This means that a significant portion of the cost of decarbonization will have to be borne by end users.

- The report analyzes the most important technologies and fuels that can be used to decarbonize the district heating sector. These include:
  - gas sources,
  - biomass sources,
  - geothermal sources,
  - large-scale heat pumps,
  - electrode boilers powered by electricity from RES.

- In the future, cogeneration units could also be fueled by green hydrogen or biomethane, but this still requires the development of a market for these fuels to ensure their actual supply, as well as adequate transmission and distribution infrastructure. The use of waste heat similarly can be one means for transforming the sector, but its availability varies strongly from location to location. An important technology in the transformation process, which will be worth developing further, is heat storage technology, which brings tangible benefits, including improved flexibility in the operation of generating units.

- There is no universal energy mix or way to transform district heating systems. The larger the system, the smaller the range of technological solutions possible. Key in this regard is planning at the local level and taking into account considerations related to the availability of individual energy carriers.

- The new ambitious trajectory of decarbonization of district heating will be a cost-intensive process under Polish conditions, requiring fundamental changes in terms of, among other things, adapting consumer installations to lower network temperatures, a prerequisite for integrating higher volumes of low-temperature heat from renewable energy sources. The relationships between the impacts of the directives analyzed confirm that effective reduction of the carbon performance of system heat generation in Poland, although already underway, will require the involvement of all key stakeholders over the long term.

- Taking into account the requirement to transpose EU regulations into the national legal order, the following section contains recommendations relating to the most important aspects of the directives under consideration in areas relevant to the district heating sector in Poland, the directional application of which will affect the efficiency and final cost of the transformation process.

- The key conclusion of the analyses remains the legitimacy of building gas-fired cogeneration units, which are stable sources that secure the supply of heat and electricity to end users. In addition, by 2040 they achieve margins that allow investors to cover fixed and capital costs assuming support for electricity from high-efficiency cogeneration.

- Given that cogeneration sources also have a significant impact on the country's broader energy security due to the production of electricity in cogeneration, there should be an additional element of incentives for investors to choose investments in this type of source over district heating sources. Otherwise, much of the fully available capacity will have to be rebuilt on the side of the National Power System, leading to cost inefficiencies in the electricity sector.

61 Commission Regulation (EU) No. 651/2014 of June 17, 2014 declaring certain types of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty

6.1. Energy Efficiency Directive (EED)

The most important elements of the EED and its transposition into national law relate to the definition of an efficient district heating and cooling system and the inclusion of a new criterion for direct carbon dioxide emissions for high-efficiency cogeneration units, both new and retrofitted, as well as the existing ones.

REVIEWED ITEM	ISSUE	RECOMMENDATION ON THE DIRECTION OF IMPLEMENTATION IN NATIONAL LAW
Article 24 section 1 point 1a	Determining the criteria within the definition of an efficient district heating system that will apply in each time frame, as well as an indicating the possibility for member states to apply alternative criteria for recognizing a system as efficient, based on the maximum greenhouse gas emission rate per unit of heat supplied to consumers.	Making changes to transpose the revised definition of an efficient district heating system, subject to the non-application of alternative ones. Given the specifics of Polish district heating systems, the alternative methodology is far less favorable. At the same time, it is necessary to clarify the provisions in such a way as to avoid ambiguities and doubts of interpretation, particularly with regard to the criteria, applicable from 2035 and from 2040, and relating to cases where there is a combination of different types of sources or technologies in the system.
Article 24 section 2	Introducing an obligation that, in the case of a newly built district heating system or a significant upgrade of generating units supplying existing systems, the criteria for an efficient system (in effect at the start of system operation or continued operation after the upgrade) must be met, and there must be no increase in the use of fossil fuels, other than natural gas, compared to the three-year average before the upgrade; for new units, it has been indicated that they must not use fossil fuels except natural gas until 2030.	Adopting legislation that will govern the time horizon for the use of natural gas in new units supplying district heating systems in a manner that is not open to interpretation so as to provide legal certainty with regard to the possibility of building or significantly upgrading such sources until 2030 and operating gas-fired generating units thereafter.
Article 24 section 3	Introducing an obligation, imposed on operators/owners of existing district heating systems (with a capacity of more than 5 MW_t) that do not meet the criteria for an efficient system to prepare a plan every five years, starting January 1, 2025, to improve the efficiency of primary energy use, reduce transmission losses and increase the share of heat supply from renewable sources, and to include measures for these	Introducing regulations specifying the detailed content, status and method of adopting the plan, as well as governing the form and principles of monitoring the activities included in the document in question; the regulations should not include sanctions for the operator in the event that projects included in the plan are not implemented or there are delays in this regard so as to prevent overburdening of district heating network operators and generators

	systems to achieve efficient status; such a plan is to be adopted by the competent authority.	in these systems. Given the need to prepare the plan referred to in Annex III, it is further advisable to minimize the administrative burden of preparing the plans required by the regulations toward the creation of as single a document as possible to be used for reporting under the directive.
Annex III	Introducing a derogation for existing cogeneration units, until January 1, 2034, in terms of not having to verify the direct carbon emissions criterion to meet the criterion of a high-efficiency cogeneration unit, provided that the unit's emission reduction plan is submitted.	Introducing a legal framework for: the procedure for the submission of an emission reduction plan by a generator in a unit that seeks a derogation; the scope of the plan; the possibility of modifying it; and the rules for monitoring and reporting – taking into account the need to minimize the administrative burden on companies for the development and implementation of the aforementioned document.

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6.2. Energy Performance of Buildings Directive (EPBD)

Given the unfinished works on the final form of the directive, it is crucial to continue efforts to develop solutions to connect new facilities to all district heating systems with the efficient system status (according to Article 24 of the EED). At the very least, it would be desirable to retain the amendment, introduced in the European Parliament's position, according to which, in cases where, due to the nature of the building or the lack of access to renewable energy from district heating systems, it would not be technically or economically feasible to fully meet the building's RES power requirements, the remainder or all of the total annual primary energy consumption can also come from "any" efficient district heating and cooling system. The most optimal solution from the point of view of regulatory stability would be to maintain the proposal contained in the Council's general approach, according to which energy from efficient district heating and cooling systems in accordance with the EED is included as one of the possible sources for meeting the primary energy needs of new zero-emission buildings. Moreover, it is crucial that – with regard to issues concerning the pace of decarbonization of the heating sector – one should strive to take into account the conditions (organizational, technical, financial) that exist in individual member states.

6.3. Renewable Energy Directive (RED)

The most important elements of the RED directive and its transposition into national law relate to the implementation of solutions allowing electricity from RES to count towards district heating and cooling targets, new sector targets, stricter requirements for forest biomass, and regulations related to access to district heating systems.

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REVIEWED ITEM	ISSUE	RECOMMENDATION ON THE DIRECTION OF IMPLEMENTATION IN NATIONAL LAW
Article 3	Making the cascading principle mandatory for forest biomass. These rules are to be taken into account when designing support systems, in order to avoid potential distortions in the materials market. Member states may use the derogation if it is related to ensuring energy security or the characteristics of the local market for the use of forest biomass that does not meet the requirements for its reuse or biomass from forestry-related activities.	Introducing regulations that implement the cascading principle with the widest possible use of permissible derogations related to ensuring energy security, which will minimize the negative impact of the new regulations on the supply of biomass on local markets.
Article 15a	A non-binding target at the member state level for the share of energy from renewable sources of 49% in the total final energy consumption in the buildings sector by 2030.	Introducing provisions in national legislation to meet the non-binding target for buildings by connecting them to efficient district heating and cooling systems.
Article 19	Introducing an expanded system of guarantees of origin to provide better information to consumers.	Introducing in national legislation the possibility of an equivalent exchange of guarantees of origin for electricity for guarantees of origin for heat generated using that electricity.
Article 23 section 1 and 4 and Annex 1a	Introducing nationally binding overall targets for renewable heat and cooling are 0.8 percentage points in the 2021–2025 period and 1.1 percentage points in the 2026–2030 period, with non-binding additional targets for member countries also agreed. For Poland, the target is set at 0.8 percentage points in the 2021–2025 period and 0.5 percentage points in the 2026–2030 period.	It is recommended that the implementation of the RES target in the district heating sector be done to the greatest extent possible through the implementation of measures in the form of incentive mechanisms instead of instruments that have a negative impact on the system-based district heating sector, such as an absolute obligation to connect heat sources that generate energy from renewable sources.

REVIEWED ITEM	ISSUE	RECOMMENDATION ON THE DIRECTION OF IMPLEMENTATION IN NATIONAL LAW
Article 24 section 4	Introducing an indicative target of an average increase in the share of energy from renewable sources of 2.2 percentage points over the period 2021–2030.	It is recommended that there should be no obligation to achieve the corresponding annual incremental share of renewable energy – each district heating system is specific, and it is reasonable to leave the pace of investment in new renewable energy plants free allowing, for example, the construction of one large plant that does not fit into the annual incremental trajectory.
Article 24 section 4a	Introducing the possibility of counting electricity from renewable energy sources for district heating targets and reporting by member states using this mechanism, energy volume data as part of integrated national energy and climate plans.	Introducing national legislation to allow electricity generated from renewable sources to be counted for district heating purposes in a way that ensures that all electricity will be counted when there is a direct connection of a RES plant generating electricity or, in the case of connection of a heat source to the power grid, when the generator documents the volume in question, e.g. by means of a PPA. In the absence of a PPA, heat would qualify equivalently to the share of renewable energy in the electricity mix.
Article 24 sections 4b–8	Implementing plans related to the development of district heating systems and sector integration.	Including heat generators in the preparation processes of any planning documents. The Polish legal system does not provide for a district heating system operator, but a district heating network operator and a generator separately, which needs to be systematized.
Article 29 section 1	Reducing the power threshold of biomass plants where the fuel burned must meet sustainability criteria up to 7.5 MW_t.	Maximizing opportunities for compliance through, for example, national certification and conduct a broad campaign among biomass suppliers about the need for certification.

Article 29 section 15

By December 31, 2030 at the latest, energy from biomass fuels may be counted towards the renewable energy share targets if the support has been provided before the revised directive entered into force, and the support ensures that it has been provided in the form of long-term support, for which a fixed amount has been set at the beginning of the support period and a mechanism has been put in place to ensure that there has been no over-supply.

Adjusting the support mechanisms under the auction system and the support system for electricity from high-efficiency cogeneration to meet the requirements for their continuation. In addition, it will be equally important to guarantee legal certainty for support that has been granted previously and the period of support extends beyond 2030.

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6.4. EU Emissions Trading System Directive (EU ETS)

The most important elements of the EU ETS Directive and its transposition into national law relate to the issues of free allocation of greenhouse gas emission allowances, financing of investments under the Modernization Fund, the new system for buildings and road transport, and horizontal areas related to the future form of the EU ETS operation.

REVIEWED ITEM	ISSUE	RECOMMENDATION ON THE DIRECTION OF IMPLEMENTATION IN NATIONAL LAW
Article 10a section 1	Introducing a condition that 20% of the free allocation to plants will be subject to the implementation of the recommendations of the energy efficiency audit unless the payback period for the relevant investments is longer than three years or the costs of these investments are disproportionate; the number of free allocations is not reduced if the operator demonstrates that it has implemented other measures that have provided greenhouse gas emission reductions equivalent to those recommended for the plant in the audit report.	Adopting national legislation providing as much flexibility as possible with regard to cases in which it will be permissible not to implement the results of an energy efficiency audit, with no consequences for the amount of free allocation.


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Article 10b section 4	Introducing a provision that provides for the possibility of allocating an additional pool of free allowances to system-based district heating of 30% provided that investments corresponding to the value of this additional free allocation are made in order to significantly reduce emissions before 2030, in accordance with climate neutrality plans; these plans are to be prepared by system operators by May 1, 2024, and will specify, among other things, measures and investments for achieving climate neutrality by 2050.	Adopting national legislation clarifying the operation of the mechanism for granting an additional pool of free allowances to the system-based district heating sector, in particular governing (with an appropriate margin of flexibility) the issue of how to select, monitor and account for investments, the performance of which will be a condition for obtaining the allocation of this additional pool, and specifying the detailed scope, nature and manner of adoption of climate neutrality plans. It is desirable to simplify as much as possible and minimize the burden on plant operators associated with the preparation of all strategic documents on the grounds of various directives, including those arising from the EED, towards the creation of a single document.
Article 10d section 1	Introducing a ban on support from the Modernization Fund for fossil fuel-based generation plant projects except for natural gas, with the stipulation that, in the case of this fuel, it will be possible to use revenues from allowances for gas investment projects when such activities qualify as environmentally sustainable and are justified on energy security grounds, and with the stipulation that emission allowances are auctioned by the end of 2027.	Implementing provisions to enable the continuation of support from the Modernization Fund for high-efficiency natural gas cogeneration projects, in particular, not to impose additional requirements for association with the provisions relating to technical eligibility criteria for taxonomy, and applying the premise on energy security as flexibly as possible; it would also be important to guarantee legal certainty with regard to the investment support that, based on existing regulations, has been granted to high-efficiency natural gas cogeneration projects from the Modernization Fund (i.e. to keep the terms and conditions of the subsidy unchanged).
Article 30 section 4a letter b	Introducing a provision requiring the European Commission to submit a report (potentially with a legislative proposal) by July 31, 2026, on the feasibility of lowering, starting in 2031, the threshold of total rated thermal power input, above which a plant would be eligible to participate in the EU ETS.	Continuing an active opposition to the idea of lowering the threshold, as such a solution would significantly increase the financial burden on operators of plants that are not currently covered by the system, and in light of the uncertainties surrounding the operation of the new system for buildings and road transport.

Article 30 section 4c	Introducing a provision requiring the European Commission to present an assessment of the feasibility of including municipal waste incineration plants in the EU ETS by July 31, 2026, including with a view to their inclusion from 2028, with the possibility of a derogation by the end of 2030.	Continuing an active opposition to the inclusion of municipal waste incineration plants (with a rated thermal capacity of more than 20 MW_t) in the EU ETS, as such a solution may significantly worsen the operating conditions of these plants, which will consequently negatively affect investment plans for the construction of such plants.
Chapter IVA	Introducing legislation on the rules of the EU ETS, which will cover the construction and transportation sectors. Activities relating to the scope of Chapter IVA include allowing the consumption of fuels used for combustion in the construction and road transport sectors, as well as additional sectors excluding, among others, the activities listed in Annex I of the directive.	Clarifying in national legislation the issue of the scope of the new system, in particular, precisely defining the group of entities directly covered by the obligation to participate in the system, i.e. entities that allow consumption of fuels used for combustion in the construction and road transport sectors, subject to the need to adopt solutions that will reduce the burden of the establishment of this system to the extent possible.

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