Comprehensive assessment of the potential for efficient heating and cooling in Poland

Ministry
of Climate and Environment

Table of contents

1. Introduction

Article 14 of Directive 2012/27/EU on energy efficiency (EED) requires Member States to carry out and notify to the Commission a comprehensive assessment of the energy efficiency of heating and cooling systems. The comprehensive assessment is to contain the information set out in Annex VIII to the Directive, which is to make up an overview of the following elements:

- an assessment of the amount of useful energy (UE) and quantification of final energy consumption (FEC) by sector;
- the estimated and identified current heating and cooling supplied to sectors of final consumption, with breakdowns by technologies and as to whether the energy was derived from fossil or renewable sources;
- the identification of potential supply from installations that generate waste heat or cold;
- reported shares of energy from renewable sources and from waste heat or cold in district heating and cooling FEC over the past 5 years;
- forecast trends in demand for heating and cooling for the next 30 years; and
- a map of the national territory showing energy-dense areas, heat and cold supply points identified and district heating transmission installations, both existing and planned.

To give a general overview of policy on heating and cooling, the assessment must include:

- a description of the role of efficient heating and cooling in long-term greenhouse gas (GHG) emission reductions; and
- a general overview of existing policies and measures on heating and cooling, as reported in accordance with the Governance Regulation.

In order to analyse the economic potential for efficiency in heating and cooling, the steps leading to a complete assessment must include:

- the identification of suitable technologies for supplying low-carbon and energy-efficient heat and cold on the national territory using a cost-benefit analysis (CBA);
- a baseline and alternative scenarios for a well-defined geographical area;
- financial and economic analyses (the latter taking into account external costs);
- a sensitivity analysis; and
- a presentation of the method used and assumptions made.

This Report has been prepared on the basis of the results of the analysis entitled ‘Przygotowanie wybranych analiz, prognoz i opracowań na potrzeby aktualizacji dokumentu pn. “Kompleksowa ocena potencjału efektywności w zakresie ogrzewania i chłodzenia” zgodnie z zapisami art. 14 dyrektywy 2012/27/UE’ (Preparation of selected analyses, forecasts and studies for the update of the ‘Comprehensive assessment of the potential for efficient heating and cooling’ as per Article 14 of Directive 2012/27/EU’), prepared by Audytel SA at the request of the Minister for Climate and Environment.

The preparation of this Report involved a review of local (municipal and district) policies for the purpose of compiling an overview of heating and cooling demand. This was followed by cost-benefit analyses, the starting point for which was the elements of the national heating and cooling system, i.e. an overview of consumers, their consumption and demand, as well as existing and potential energy supply sources. The data compiled as part of the overview were also used to produce heat and cold maps. The last section contains an analysis of the potential for using waste heat sources.

2. Limitations

The quality and results of such an assessment are entirely dependent on the level of detail and consistency of available data sources. In order to complete the work, municipalities throughout the country were surveyed. For this purpose use was made of an IT tool, i.e. a data collection system, by means of which 700 questionnaires, i.e. for nearly 30% of the approximately 2500 local government units, were collected. Some of the surveys that contained complete data were used to prepare an overview of demand for energy, e.g. as broken down by the area of residential, industrial, service and public building stock. Some of the existing plans and strategies for local government units were obtained from the municipalities themselves, while others were retrieved from the unit's publicly available websites and from the Public Information Bulletin (Biuletyn Informacji Publicznej). Subsequently, they were analysed in order for the necessary data to be obtained.

The results of the survey and of the overview of local policies carried out by the implementation team identified a number of data sourcing limitations and data gaps, e.g. lack of information on non-residential building stock, no disaggregated data (aggregation of demand and area for various types of building stock, e.g. service, industry buildings), incorrect descriptions in the plans and local policies or misapplied terms (e.g. useful v. final energy, demand v. consumption). Other common limitations included incomplete municipality's energy balances, no breakdown of consumption by fuels, lack of analyses related to heat generation plants or no information on source data. Many of the renewable energy sources identified were accounted for only in descriptive form, with no data on their estimated capacity, and there were only few cases where the calculations were detailed enough for the data to be used. Similarly, few units have information about the potential for generation of waste heat or its reported share.

In addition, the documents, plans, spatial development guidelines and local strategies of different territorial units were compiled for different timespans. Some of the provided information is partly out of date.

3. Overview of heating and cooling and forecast heating and cooling demand

3.1. Data sources

In order to prepare a national overview of heating and cooling, the division of the country into districts was used and a uniform methodology based on available input data was employed. The analyses were carried out for Poland's major cities and districts (powiaty), in particular for:

- Białystok
- Bydgoszcz
- Gdańsk
- Gorzów Wielkopolski
- Katowice

- Kielce
- Kraków
- Lublin
- Łódź
- Olsztyn
- Opole
- Poznań
- Rzeszów
- Szczecin
- Toruń
- Warsaw
- Wrocław
- Zielona Góra

3.2. Input data used in the analyses

In keeping with Commission Recommendation (EU) 2019/1659, a breakdown into residential, service, industry and other sectors, including public buildings, was adopted.

The calculations were based on data obtained from the following sources:

- Statistics Poland (Główny Urząd Statystyczny) for: population size, areas of dwellings, historical structure of building stock;
- 'Draft assumptions for heat, electricity and gas fuel plans' (Projekt założeń do planów zaopatrzenia w ciepło, energię elektryczną i paliwa gazowe) of the individual units for: the district heating plants, equipment, efficiency, heat production, heat sales, fuel consumption, sales structure, municipal building stock energy renovation status, district heating networks, network structure, transmission efficiency, local energy sources, equipment, consumption of fuels;
- Krajowy Ośrodek Bilansowania i Zarządzania Emisjami (KOBIZE) for: characteristics of district heating plants, capacity, equipment;
- Spatial development guidelines (Studium uwarunkowań i kierunki zagospodarowania przestrzennego) for: the number and sizes of areas and buildings as per the individual types of building stock: residential, public, commercial, service and industrial buildings, the age structure of building stock;
- Low-carbon economy plan (Plan gospodarki niskoemisyjnej) for: the district heating plants, fuel structure and consumption, existing building stock energy renovation status and plans, existing air pollution situation and planned abatement actions, and list of local boiler plants (kotłownie lokalne);
- Other sources – city development strategy (Strategia rozwoju miasta), data and information from city administrations, energy companies in individual cities, documents provided by the city administrations (for Warsaw – Energy Transition in Warsaw/Transformacja energetyczna Warszawy – 2021), energy companies' development plans.

A detailed list of the data sources used for individual cities is presented in Annex 1.

3.3. Description of the methodology employed

The steps followed to compile the presented data were as follows:

1. Obtaining relevant data from the sources referred to in section 3.1.1.
2. Validation and assessment of the data for quality and completeness. In particular, as regards the following:
    1. Final and useful energy consumption;
    2. Breakdown and specification of consumption by energy products, the fuel mix;
    3. Determination of electricity and heat consumption areas;
    4. Breakdown of demand into the residential, public (other), industry, and service building segments;
    5. Collecting information about the population size, number of dwellings, structure of the building stock (single-family v. multi-family buildings), total surface area of dwellings;
    6. Determination of the surface area corresponding to industry, service and other (public) building stock.
3. Depending on the quality of the data: (1) use was made of validated data, or (2) estimates were calculated, or (3) the data collected were supplemented.

Information on the age structure of building stock was used to determine the heating demand. The identified age structure of the residential building stock in towns and cities is crucial due to differences in energy demand indicators for space heating. In the analyses, use was made of indicators adjusted to the different age groups of individual types of buildings.

The estimated energy renovation status of buildings was matched to the age structure of the building stock, based on which the demand for useful energy was estimated. The next step involved taking account of the efficiency of the heating installation along with the age of the building before and after energy renovation. Demand for final heat at the level of the local administrative unit was derived from the above analyses.

3.4. Compilation of heat demand analyses for individual types of building

1. Once heat demand is determined, the thermal power demand, i.e. the utilisation of thermal power over time, is identified. The calculation is based on a town or city's known heat and power demand as a quotient of these quantities.
2. Once the territorial unit's heat and power demand is known, its coverage across a town or city is split between the district heating network (DHN), local boiler plants, and local (individual) heat energy sources.

3. The thermal energy and power supplied to heat consumers within a territorial unit off-site corresponds to the thermal energy and power supplied to these consumers by the district heating system.
4. The thermal energy and power generated for heat consumers in a territorial unit on-site is equal to the difference between the total demand for thermal energy and power from consumers in the territorial unit and the thermal energy and power supplied off-site.

Based on data from heat, electricity and gas fuel supply plans (plany zaopatrzenia w ciepło, energię elektryczną i paliwa gazowe), the source capacity in the district heating network is determined. Source capacity is broken down into:

1. cogeneration,
2. conventional district heating plants (heat-only boilers),
3. RES district heating plants (heat-only boilers)

The amount of energy generated by local boiler plants was calculated as the difference between demand for capacity and the capacity of centralised sources, which yielded the aggregate capacity of local sources. Information on the fuel mix of local sources is mainly derived from heat, electricity and gas fuel supply plans. On this basis, the share of fuels for local boiler plants is estimated.

The purpose of all the above analyses is to arrive at the final fuel mix.

3.5. Cooling supply analysis

1. The city's climate zone is identified for the winter and summer seasons.
2. The following are attributed to the calculations in correspondence to the zone:
    a) The average temperatures in the heating season,
    b) The length of the heating season,
    c) The length of the cooling season,
    d) The design temperature for individual years,
    e) The number of hours on cooling days.
3. The other values are calculated in the following steps:
    a) The indicators for the heating period are determined,
    b) The indicators for the cooling period are determined,
    c) The ratios of the indicators are established for both seasons,
    d) The ratio of cooling demand indicators is transferred from the heating demand, which is known.
4. Based on the indicators of the demand of consumers for cooling calculated for the territorial unit and on the cooled area determined for the individual groups of consumers, the cooling demand for each group of consumers is calculated as the product of these two values, i.e. the indicator and the cooling area.

5. Knowing the cooling efficiency of the cooling installation, which is the quotient of the useful energy – cooling energy and final energy – supplied to the cooling installation (electricity) and which is greater than one for cooling installations, the demand for electricity needed to satisfy the cooling needs of the individual consumer groups is calculated.

   In accordance with Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, final energy consumption means all energy supplied to industry, transport, households, services and agriculture. It excludes deliveries to the energy transformation sector and the energy industries themselves.

   In accordance with Commission Recommendation (EU) 2019/1659 of 25 September 2019 on the content of the comprehensive assessment of the potential for efficient heating and cooling, pursuant to Article 14 of Directive 2012/27/EU, useful energy means all the energy required by the end-users in the form of heat and cold after all the steps of energy transition have taken place in the heating and cooling equipment.

6. The current cooling demand coverage ratio was determined.

Summary of forecast analysis:

Based on the source data collected, changes over time periods of +5/10/15/20/25/30 years were forecast. The forecasting was completed through the extrapolation of the results obtained for 2020 on the basis of 20-year historical data on changes in the area of individual types of building stock, taking into account demographic indicators and population density[1].

[1] For residential buildings.

4. Reporting current heating and cooling demand and forecast heating and cooling demand

The data presented in sections 4.1-4.35 were sourced from the analysis entitled ‘Przygotowanie wybranych analiz, prognoz i opracowań na potrzeby aktualizacji dokumentu pn. “Kompleksowa ocena potencjału efektywności w zakresie ogrzewania i chłodzenia” zgodnie z zapisami art. 14 dyrektywy 2012/27/UE’, prepared by Audytel SA at the request of the Minister for Climate and Environment.

4.1. Wrocław

Table 1. Heating and cooling demand and forecast heating and cooling demand in Wrocław

		Wrocław City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	2 830.916						
	Service sector	GWh/a	406.944						
	Industry sector	GWh/a	432.863						
	Other sectors	GWh/a	392.184						
Cooling demand, **final energy**	Residential sector	GWh/a	4.975						
	Service sector	GWh/a	0.715						
	Industry sector	GWh/a	0.761						
	Other sectors	GWh/a	0.689						
Heating demand, **useful** energy	Residential sector	GWh/a	2 510.057	2 484.956	2 460.107	2 435.506	2 411.151	2 387.039	2 363.169
	Service sector	GWh/a	312.634	315.760	318.917	322.107	325.328	328.581	331.867
	Industry sector	GWh/a	332.546	329.220	325.928	322.669	319.442	316.248	313.085
	Other sectors	GWh/a	177.586	175.811	174.052	172.312	170.589	168.883	167.194
Cooling demand, **useful** energy	Residential sector	GWh/a	14.926	16.419	18.061	19.867	21.854	24.039	26.443
	Service sector	GWh/a	2.146	2.360	2.596	2.856	3.141	3.456	3.801
	Industry sector	GWh/a	2.282	2.511	2.762	3.038	3.342	3.676	4.043
	Other sectors	GWh/a	2.068	2.275	2.502	2.752	3.028	3.330	3.663

4.2. Dolnośląskie Province

Table 2. Heating and cooling demand and forecast heating and cooling demand in the Dolnośląskie Province

		DOLNOŚLĄSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	15 067.934						
	Service sector	GWh/a	599.099						
	Industry sector	GWh/a	533.390						
	Other sectors	GWh/a	457.751						
Cooling demand, **final energy**	Residential sector	GWh/a	17.340						
	Service sector	GWh/a	4.167						
	Industry sector	GWh/a	1.212						
	Other sectors	GWh/a	1.179						
Heating demand, **useful** energy	Residential sector	GWh/a	13 022.656	12 664.707	12 308.207	11 951.956	11 595.950	11 240.188	10 884.667
	Service sector	GWh/a	485.573	491.747	497.074	504.602	513.609	525.540	540.396
	Industry sector	GWh/a	423.020	421.776	421.607	424.592	429.693	438.988	452.480
	Other sectors	GWh/a	236.597	236.310	236.042	237.280	239.528	243.780	250.034
Cooling demand, **useful** energy	Residential sector	GWh/a	52.021	69.999	86.223	100.700	113.447	124.483	133.827
	Service sector	GWh/a	12.501	13.227	13.931	14.807	15.824	17.090	18.626
	Industry sector	GWh/a	3.636	4.068	4.551	5.135	5.816	6.660	7.694
	Other sectors	GWh/a	3.451	3.744	4.091	4.505	4.866	5.553	6.233

4.3. Bydgoszcz

Table 3. Heating and cooling demand and forecast heating and cooling demand in Bydgoszcz

		Bydgoszcz City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	1 996.770						
	Service sector	GWh/a	137.760						
	Industry sector	GWh/a	278.230						
	Other sectors	GWh/a	151.470						
Cooling demand, **final energy**	Residential sector	GWh/a	8.630						
	Service sector	GWh/a	0.600						
	Industry sector	GWh/a	1.200						
	Other sectors	GWh/a	0.650						
Heating demand, **useful** energy	Residential sector	GWh/a	1 598.650	1 582.664	1 566.837	1 551.168	1 535.657	1 520.300	1 505.097
	Service sector	GWh/a	109.920	111.019	112.129	113.251	114.383	115.527	116.682
	Industry sector	GWh/a	222.100	219.879	217.680	215.503	213.348	211.215	209.103
	Other sectors	GWh/a	120.430	119.226	118.033	116.853	115.685	114.528	113.382
Cooling demand, **useful** energy	Residential sector	GWh/a	8.630	9.493	10.442	11.487	12.635	13.899	15.289
	Service sector	GWh/a	0.600	0.660	0.726	0.799	0.878	0.966	1.063
	Industry sector	GWh/a	1.200	1.320	1.452	1.597	1.757	1.933	2.126
	Other sectors	GWh/a	0.650	0.715	0.787	0.865	0.952	1.047	1.152

4.4. Toruń

Table 4. Heating and cooling demand and forecast heating and cooling demand in Toruń

		Toruń City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	1 134.223						
	Service sector	GWh/a	73.391						
	Industry sector	GWh/a	48.454						
	Other sectors	GWh/a	113.897						
Cooling demand, **final energy**	Residential sector	GWh/a	1.739						
	Service sector	GWh/a	0.113						
	Industry sector	GWh/a	0.074						
	Other sectors	GWh/a	0.175						
Heating demand, **useful** energy	Residential sector	GWh/a	912.317	903.193	894.162	885.220	876.368	867.604	858.928
	Service sector	GWh/a	58.613	59.199	59.791	60.389	60.993	61.603	62.219
	Industry sector	GWh/a	38.698	38.311	37.928	37.548	37.173	36.801	36.433
	Other sectors	GWh/a	90.964	90.054	89.153	88.262	87.379	86.505	85.640
Cooling demand, **useful** energy	Residential sector	GWh/a	5.217	5.738	6.312	6.943	7.638	8.401	9.242
	Service sector	GWh/a	0.338	0.371	0.408	0.449	0.494	0.544	0.598
	Industry sector	GWh/a	0.223	0.245	0.270	0.297	0.326	0.359	0.395
	Other sectors	GWh/a	0.524	0.576	0.634	0.697	0.767	0.844	0.928

4.5. Kujawsko-Pomorskie Province

Table 5. Heating and cooling demand and forecast heating and cooling demand in the Kujawsko-Pomorskie Province

		KUJAWSKO-POMORSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	10 476.905						
	Service sector	GWh/a	300.805						
	Industry sector	GWh/a	359.273						
	Other sectors	GWh/a	300.874						
Cooling demand, **final energy**	Residential sector	GWh/a	18.505						
	Service sector	GWh/a	2.333						
	Industry sector	GWh/a	1.422						
	Other sectors	GWh/a	1.121						
Heating demand, **useful** energy	Residential sector	GWh/a	8 822.701	8 598.279	8 374.823	8 151.617	7 928.657	7 705.940	7 483.464
	Service sector	GWh/a	249.222	252.380	255.130	258.946	263.477	269.423	276.784
	Industry sector	GWh/a	290.128	288.110	286.412	285.625	285.452	286.484	288.721
	Other sectors	GWh/a	243.350	242.090	240.850	240.486	240.711	242.094	244.636
Cooling demand, **useful** energy	Residential sector	GWh/a	38.256	50.395	61.435	71.385	80.261	88.080	94.860
	Service sector	GWh/a	5.798	6.135	6.460	6.868	7.343	7.939	8.663
	Industry sector	GWh/a	1.865	2.072	2.302	2.569	2.873	3.234	3.660
	Other sectors	GWh/a	2.014	2.181	2.376	2.611	2.812	3.213	3.608

4.6. Lublin

Table 6. Heating and cooling demand and forecast heating and cooling demand in Lublin

		Lublin City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	2 523.709						
	Service sector	GWh/a	182.972						
	Industry sector	GWh/a	367.836						
	Other sectors	GWh/a	328.691						
Cooling demand, **final energy**	Residential sector	GWh/a	13.354						
	Service sector	GWh/a	0.968						
	Industry sector	GWh/a	1.946						
	Other sectors	GWh/a	1.739						
Heating demand, **useful** energy	Residential sector	GWh/a	1 888.936	1 870.047	1 851.346	1 832.833	1 814.504	1 796.359	1 778.396
	Service sector	GWh/a	148.003	149.483	150.978	152.488	154.012	155.553	157.108
	Industry sector	GWh/a	281.060	278.250	275.467	272.712	269.985	267.285	264.613
	Other sectors	GWh/a	248.464	245.979	243.519	241.084	238.673	236.286	233.924
Cooling demand, **useful** energy	Residential sector	GWh/a	13.354	14.689	16.158	17.774	19.552	21.507	23.657
	Service sector	GWh/a	0.968	1.065	1.172	1.289	1.418	1.559	1.715
	Industry sector	GWh/a	1.946	2.141	2.355	2.591	2.850	3.135	3.448
	Other sectors	GWh/a	1.739	1.913	2.104	2.315	2.546	2.801	3.081

4.7. Lubelskie Province

Table 7. Heating and cooling demand and forecast heating and cooling demand in the Lubelskie Province

		LUBELSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	11 837.120						
	Service sector	GWh/a	302.142						
	Industry sector	GWh/a	389.997						
	Other sectors	GWh/a	379.854						
Cooling demand, **final energy**	Residential sector	GWh/a	25.411						
	Service sector	GWh/a	3.076						
	Industry sector	GWh/a	2.044						
	Other sectors	GWh/a	2.140						
Heating demand, **useful** energy	Residential sector	GWh/a	9 886.324	9 611.209	9 337.341	9 063.659	8 790.163	8 516.851	8 243.719
	Service sector	GWh/a	255.255	258.829	261.814	266.304	271.804	279.305	288.809
	Industry sector	GWh/a	301.005	298.695	296.663	295.409	294.682	294.984	296.312
	Other sectors	GWh/a	294.510	293.352	292.219	292.437	293.565	296.485	301.199
Cooling demand, **useful** energy	Residential sector	GWh/a	49.526	66.456	81.691	95.240	107.115	117.334	125.913
	Service sector	GWh/a	7.292	7.714	8.115	8.629	9.231	9.996	10.936
	Industry sector	GWh/a	2.240	2.480	2.745	3.050	3.395	3.797	4.265
	Other sectors	GWh/a	2.873	3.115	3.404	3.756	4.052	4.658	5.251

Source: own study

4.8. Gorzów Wielkopolski

Table 8. Heating and cooling demand and forecast heating and cooling demand in Gorzów Wielkopolski

		Gorzów Wielkopolski City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	544.943						
	Service sector	GWh/a	74.973						
	Industry sector	GWh/a	204.435						
	Other sectors	GWh/a	28.572						
Cooling demand, **final energy**	Residential sector	GWh/a	1.093						
	Service sector	GWh/a	0.150						
	Industry sector	GWh/a	0.410						
	Other sectors	GWh/a	0.057						
Heating demand, **useful** energy	Residential sector	GWh/a	438.088	451.084	464.080	464.897	465.714	466.531	467.348
	Service sector	GWh/a	63.193	66.560	69.927	70.296	70.664	71.033	71.402
	Industry sector	GWh/a	169.865	171.834	173.803	173.201	172.599	171.997	171.395
	Other sectors	GWh/a	23.808	24.157	24.507	24.499	24.491	24.483	24.476
Cooling demand, **useful** energy	Residential sector	GWh/a	3.278	5.048	6.819	7.024	7.228	7.432	7.636
	Service sector	GWh/a	0.451	0.723	0.995	1.038	1.081	1.124	1.167
	Industry sector	GWh/a	1.230	1.867	2.504	2.578	2.652	2.726	2.801
	Other sectors	GWh/a	0.172	0.262	0.352	0.364	0.376	0.388	0.400

4.9. Zielona Góra

Table 9. Heating and cooling demand and forecast heating and cooling demand in Zielona Góra

		Zielona Góra City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	621.392						
	Service sector	GWh/a	54.406						
	Industry sector	GWh/a	85.385						
	Other sectors	GWh/a	86.709						
Cooling demand, **final energy**	Residential sector	GWh/a	1.348						
	Service sector	GWh/a	0.118						
	Industry sector	GWh/a	0.185						
	Other sectors	GWh/a	0.188						
Heating demand, **useful** energy	Residential sector	GWh/a	524.383	533.508	542.633	551.758	560.883	570.008	579.133
	Service sector	GWh/a	41.831	41.228	40.625	40.023	39.420	38.818	38.215
	Industry sector	GWh/a	63.924	62.363	60.802	59.240	57.679	56.118	54.556
	Other sectors	GWh/a	64.990	63.697	62.403	61.110	59.816	58.523	57.230
Cooling demand, **useful** energy	Residential sector	GWh/a	4.044	4.984	5.925	6.861	7.797	8.733	9.669
	Service sector	GWh/a	0.354	0.415	0.475	0.516	0.557	0.597	0.638
	Industry sector	GWh/a	0.556	0.641	0.727	0.773	0.819	0.865	0.911
	Other sectors	GWh/a	0.564	0.654	0.744	0.797	0.850	0.903	0.955

4.10. Lubuskie Province

Table 10. Heating and cooling demand and forecast heating and cooling demand in the Lubelskie Province

		LUBELSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	11 837.120						
	Service sector	GWh/a	302.142						
	Industry sector	GWh/a	389.997						
	Other sectors	GWh/a	379.854						
Cooling demand, **final energy**	Residential sector	GWh/a	25.411						
	Service sector	GWh/a	3.076						
	Industry sector	GWh/a	2.044						
	Other sectors	GWh/a	2.140						
Heating demand, **useful** energy	Residential sector	GWh/a	9 886.324	9 611.209	9 337.341	9 063.659	8 790.163	8 516.851	8 243.719
	Service sector	GWh/a	255.255	258.829	261.814	266.304	271.804	279.305	288.809
	Industry sector	GWh/a	301.005	298.695	296.663	295.409	294.682	294.984	296.312
	Other sectors	GWh/a	294.510	293.352	292.219	292.437	293.565	296.485	301.199
Cooling demand, **useful** energy	Residential sector	GWh/a	49.526	66.456	81.691	95.240	107.115	117.334	125.913
	Service sector	GWh/a	7.292	7.714	8.115	8.629	9.231	9.996	10.936
	Industry sector	GWh/a	2.240	2.480	2.745	3.050	3.395	3.797	4.265
	Other sectors	GWh/a	2.873	3.115	3.404	3.756	4.052	4.658	5.251

4.11. Łódź

Table 11. Heating and cooling demand and forecast heating and cooling demand in Łódź

		Łódź City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	4 948.897						
	Service sector	GWh/a	404.540						
	Industry sector	GWh/a	158.787						
	Other sectors	GWh/a	384.642						
Cooling demand, **final energy**	Residential sector	GWh/a	9.885						
	Service sector	GWh/a	0.808						
	Industry sector	GWh/a	0.317						
	Other sectors	GWh/a	0.768						
Heating demand, **useful** energy	Residential sector	GWh/a	3 759.202	3 721.610	3 684.394	3 647.550	3 611.075	3 574.964	3 539.214
	Service sector	GWh/a	323.382	326.616	329.882	333.181	336.513	339.878	343.277
	Industry sector	GWh/a	126.967	125.697	124.440	123.196	121.964	120.744	119.537
	Other sectors	GWh/a	309.858	306.760	303.692	300.655	297.649	294.672	291.725
Cooling demand, **useful** energy	Residential sector	GWh/a	29.655	32.620	35.882	39.470	43.417	47.759	52.535
	Service sector	GWh/a	2.424	2.666	2.933	3.226	3.549	3.904	4.294
	Industry sector	GWh/a	0.951	1.047	1.151	1.266	1.393	1.532	1.686
	Other sectors	GWh/a	2.305	2.535	2.789	3.068	3.375	3.712	4.083

4.12. Łódzkie Province

Table 12. Heating and cooling demand and forecast heating and cooling demand in the Łódzkie Province

		ŁÓDZKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	14 296.964						
	Service sector	GWh/a	531.306						
	Industry sector	GWh/a	220.291						
	Other sectors	GWh/a	431.613						
Cooling demand, **final energy**	Residential sector	GWh/a	21.624						
	Service sector	GWh/a	3.082						
	Industry sector	GWh/a	0.593						
	Other sectors	GWh/a	1.196						
Heating demand, **useful** energy	Residential sector	GWh/a	11 789.071	11 496.228	11 204.747	10 913.637	10 622.896	10 332.520	10 042.505
	Service sector	GWh/a	437.472	442.794	447.548	453.821	461.118	470.432	481.762
	Industry sector	GWh/a	182.321	182.277	182.859	185.292	188.963	195.099	203.698
	Other sectors	GWh/a	352.132	350.302	348.503	348.004	348.380	350.478	354.297
Cooling demand, **useful** energy	Residential sector	GWh/a	64.871	83.128	99.902	115.219	129.111	141.612	152.764
	Service sector	GWh/a	9.247	9.832	10.410	11.118	11.933	12.933	14.131
	Industry sector	GWh/a	1.778	1.997	2.242	2.541	2.894	3.337	3.885
	Other sectors	GWh/a	3.515	3.818	4.164	4.583	4.943	5.647	6.338

4.13. Kraków

Table 13. Heating and cooling demand and forecast heating and cooling demand in Kraków

		Kraków City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	4 061.697						
	Service sector	GWh/a	444.484						
	Industry sector	GWh/a	278.508						
	Other sectors	GWh/a	570.864						
Cooling demand, **final energy**	Residential sector	GWh/a	7.571						
	Service sector	GWh/a	0.829						
	Industry sector	GWh/a	0.519						
	Other sectors	GWh/a	1.064						
Heating demand, **useful** energy	Residential sector	GWh/a	3 458.530	3 423.944	3 389.705	3 355.808	3 322.250	3 289.027	3 256.137
	Service sector	GWh/a	379.890	383.688	387.525	391.401	395.315	399.268	403.260
	Industry sector	GWh/a	238.034	235.653	233.297	230.964	228.654	226.368	224.104
	Other sectors	GWh/a	487.903	483.024	478.194	473.412	468.678	463.991	459.351
Cooling demand, **useful** energy	Residential sector	GWh/a	22.713	24.984	27.483	30.231	33.254	36.580	40.238
	Service sector	GWh/a	2.486	2.734	3.008	3.308	3.639	4.003	4.403
	Industry sector	GWh/a	1.557	1.713	1.884	2.073	2.280	2.508	2.759
	Other sectors	GWh/a	3.192	3.512	3.863	4.249	4.674	5.141	5.655

4.14. Małopolskie Province

Table 14. Heating and cooling demand and forecast heating and cooling demand in the Małopolskie Province

		MAŁOPOLSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	16 555.296						
	Service sector	GWh/a	694.495						
	Industry sector	GWh/a	334.938						
	Other sectors	GWh/a	665.692						
Cooling demand, **final energy**	Residential sector	GWh/a	23.727						
	Service sector	GWh/a	5.228						
	Industry sector	GWh/a	0.769						
	Other sectors	GWh/a	1.691						
Heating demand, **useful** energy	Residential sector	GWh/a	14 211.640	13 844.400	13 479.295	13 114.532	12 750.108	12 386.019	12 022.263
	Service sector	GWh/a	604.899	613.079	620.035	630.148	642.379	658.808	679.435
	Industry sector	GWh/a	288.821	287.756	287.373	288.987	291.940	297.547	305.808
	Other sectors	GWh/a	573.248	570.886	568.573	568.825	570.803	576.184	584.968
Cooling demand, **useful** energy	Residential sector	GWh/a	71.181	94.378	115.450	134.408	151.278	166.087	178.866
	Service sector	GWh/a	15.684	16.610	17.498	18.624	19.941	21.602	23.635
	Industry sector	GWh/a	2.308	2.580	2.884	3.252	3.684	4.219	4.874
	Other sectors	GWh/a	4.957	5.392	5.924	6.562	7.115	8.189	9.253

4.15. Warsaw

Table 15. Heating and cooling demand and forecast heating and cooling demand in Warsaw

		Warsaw Capital City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	9 317.785						
	Service sector	GWh/a	1 597.162						
	Industry sector	GWh/a	229.577						
	Other sectors	GWh/a	1 442.402						
Cooling demand, **final energy**	Residential sector	GWh/a	23.113						
	Service sector	GWh/a	3.962						
	Industry sector	GWh/a	0.569						
	Other sectors	GWh/a	3.578						
Heating demand, **useful** energy	Residential sector	GWh/a	5 869.364	5 810.670	5 752.563	5 695.038	5 638.087	5 581.706	5 525.889
	Service sector	GWh/a	1 144.967	1 156.417	1 167.981	1 179.661	1 191.458	1 203.372	1 215.406
	Industry sector	GWh/a	162.632	161.005	159.395	157.801	156.223	154.661	153.114
	Other sectors	GWh/a	975.295	965.542	955.887	946.328	936.865	927.496	918.221
Cooling demand, **useful** energy	Residential sector	GWh/a	69.338	76.272	83.899	92.289	101.518	111.670	122.837
	Service sector	GWh/a	11.885	13.074	14.381	15.819	17.401	19.141	21.055
	Industry sector	GWh/a	1.708	1.879	2.067	2.274	2.501	2.751	3.027
	Other sectors	GWh/a	10.734	11.807	12.988	14.286	15.715	17.287	19.015

4.16. Mazowieckie Province

Table 16. Heating and cooling demand and forecast heating and cooling demand in the Mazowieckie Province

		MAZOWIECKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	27 077.309						
	Service sector	GWh/a	1 937.947						
	Industry sector	GWh/a	307.632						
	Other sectors	GWh/a	1 585.201						
Cooling demand, **final energy**	Residential sector	GWh/a	45.270						
	Service sector	GWh/a	9.986						
	Industry sector	GWh/a	0.913						
	Other sectors	GWh/a	4.597						
Heating demand, **useful** energy	Residential sector	GWh/a	21 178.978	20 656.860	20 138.446	19 620.612	19 103.354	18 586.665	18 070.540
	Service sector	GWh/a	1 451.674	1 468.956	1 484.672	1 504.656	1 527.526	1 556.049	1 590.228
	Industry sector	GWh/a	232.881	232.826	233.572	236.691	241.398	249.262	260.284
	Other sectors	GWh/a	1 103.815	1 097.803	1 091.890	1 089.814	1 090.328	1 095.926	1 106.606
Cooling demand, **useful** energy	Residential sector	GWh/a	135.809	171.791	205.304	236.398	265.149	291.641	315.967
	Service sector	GWh/a	29.957	32.064	34.207	36.763	39.676	43.165	47.277
	Industry sector	GWh/a	2.740	3.066	3.429	3.867	4.378	5.009	5.781
	Other sectors	GWh/a	13.626	14.865	16.312	17.984	19.602	22.075	24.621

4.17. Opole

Table 17. Heating and cooling demand and forecast heating and cooling demand in Opole

		Opole City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	690.659						
	Service sector	GWh/a	21.282						
	Industry sector	GWh/a	110.688						
	Other sectors	GWh/a	120.843						
Cooling demand, **final energy**	Residential sector	GWh/a	0.733						
	Service sector	GWh/a	0.023						
	Industry sector	GWh/a	0.117						
	Other sectors	GWh/a	0.128						
Heating demand, **useful** energy	Residential sector	GWh/a	550.130	544.629	539.182	533.791	528.453	523.168	517.936
	Service sector	GWh/a	16.455	16.620	16.786	16.954	17.123	17.295	17.468
	Industry sector	GWh/a	86.444	85.580	84.724	83.877	83.038	82.207	81.385
	Other sectors	GWh/a	88.620	87.734	86.856	85.988	85.128	84.277	83.434
Cooling demand, **useful** energy	Residential sector	GWh/a	2.198	2.417	2.659	2.925	3.218	3.539	3.893
	Service sector	GWh/a	0.068	0.074	0.082	0.090	0.099	0.109	0.120
	Industry sector	GWh/a	0.352	0.387	0.426	0.469	0.516	0.567	0.624
	Other sectors	GWh/a	0.385	0.423	0.465	0.512	0.563	0.619	0.681

4.18. Opolskie Province

Table 18. Heating and cooling demand and forecast heating and cooling demand in the Opolskie Province

		OPOLSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	5 780.317						
	Service sector	GWh/a	73.020						
	Industry sector	GWh/a	135.081						
	Other sectors	GWh/a	138.900						
Cooling demand, **final energy**	Residential sector	GWh/a	6.147						
	Service sector	GWh/a	0.947						
	Industry sector	GWh/a	0.226						
	Other sectors	GWh/a	0.249						
Heating demand, **useful** energy	Residential sector	GWh/a	4 911.598	4 763.092	4 614.922	4 466.807	4 318.746	4 170.739	4 022.784
	Service sector	GWh/a	63.019	64.116	64.947	66.442	68.383	71.210	74.924
	Industry sector	GWh/a	108.398	108.088	108.064	108.880	110.259	112.755	116.368
	Other sectors	GWh/a	104.872	104.381	103.898	103.820	104.014	104.743	106.008
Cooling demand, **useful** energy	Residential sector	GWh/a	18.441	25.736	32.199	37.829	42.631	46.606	49.757
	Service sector	GWh/a	2.840	2.991	3.129	3.313	3.533	3.821	4.183
	Industry sector	GWh/a	0.679	0.765	0.861	0.981	1.124	1.306	1.536
	Other sectors	GWh/a	0.721	0.787	0.862	0.954	1.029	1.189	1.344

4.19. Rzeszów

Table 19. Heating and cooling demand and forecast heating and cooling demand in Rzeszów

		Rzeszów City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	661.032						
	Service sector	GWh/a	135.924						
	Industry sector	GWh/a	97.220						
	Other sectors	GWh/a	142.829						
Cooling demand, **final energy**	Residential sector	GWh/a	5.435						
	Service sector	GWh/a	1.118						
	Industry sector	GWh/a	0.799						
	Other sectors	GWh/a	1.174						
Heating demand, **useful** energy	Residential sector	GWh/a	569.880	564.181	558.539	552.954	547.424	541.950	536.531
	Service sector	GWh/a	118.595	119.781	120.979	122.189	123.411	124.645	125.892
	Industry sector	GWh/a	84.189	83.347	82.513	81.688	80.871	80.063	79.262
	Other sectors	GWh/a	124.380	123.136	121.905	120.686	119.479	118.284	117.101
Cooling demand, **useful** energy	Residential sector	GWh/a	5.435	5.979	6.576	7.234	7.957	8.753	9.628
	Service sector	GWh/a	1.118	1.229	1.352	1.487	1.636	1.800	1.980
	Industry sector	GWh/a	0.799	0.879	0.967	1.064	1.170	1.287	1.416
	Other sectors	GWh/a	1.174	1.292	1.421	1.563	1.719	1.891	2.080

4.20. Podkarpackie Province

Table 20. Heating and cooling demand and forecast heating and cooling demand in the Podkarpackie Province

		PODKARPACKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	10 028.459						
	Service sector	GWh/a	288.825						
	Industry sector	GWh/a	140.497						
	Other sectors	GWh/a	220.295						
Cooling demand, **final energy**	Residential sector	GWh/a	17.648						
	Service sector	GWh/a	3.829						
	Industry sector	GWh/a	0.992						
	Other sectors	GWh/a	1.739						
Heating demand, **useful** energy	Residential sector	GWh/a	8 617.286	8 356.675	8 097.045	7 837.472	7 577.955	7 318.493	7 059.085
	Service sector	GWh/a	256.206	259.938	262.948	267.782	273.836	282.319	293.230
	Industry sector	GWh/a	123.138	123.368	124.144	126.536	130.009	135.634	143.413
	Other sectors	GWh/a	194.100	194.785	195.482	198.121	202.058	208.580	217.685
Cooling demand, **useful** energy	Residential sector	GWh/a	42.074	58.382	72.918	85.682	96.680	105.918	113.404
	Service sector	GWh/a	9.252	9.774	10.269	10.901	11.640	12.576	13.725
	Industry sector	GWh/a	1.378	1.549	1.741	1.981	2.266	2.630	3.085
	Other sectors	GWh/a	2.778	2.986	3.263	3.613	3.870	4.547	5.188

4.21. Białystok

Table 21. Heating and cooling demand and forecast heating and cooling demand in Białystok

		Białystok City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	1 763.210						
	Service sector	GWh/a	141.230						
	Industry sector	GWh/a	152.250						
	Other sectors	GWh/a	344.910						
Cooling demand, **final energy**	Residential sector	GWh/a	2.210						
	Service sector	GWh/a	0.180						
	Industry sector	GWh/a	0.190						
	Other sectors	GWh/a	0.430						
Heating demand, **useful** energy	Residential sector	GWh/a	1 350.580	1 350.920	1 351.260	1 341.083	1 330.905	1 320.728	1 310.550
	Service sector	GWh/a	111.370	111.555	111.740	111.135	110.530	109.925	109.320
	Industry sector	GWh/a	119.700	119.880	120.060	119.380	118.700	118.020	117.340
	Other sectors	GWh/a	271.470	271.795	272.120	270.338	268.555	266.773	264.990
Cooling demand, **useful** energy	Residential sector	GWh/a	6.620	9.140	11.660	14.705	17.750	20.795	23.840
	Service sector	GWh/a	0.530	0.735	0.940	1.190	1.440	1.690	1.940
	Industry sector	GWh/a	0.570	0.790	1.010	1.280	1.550	1.820	2.090
	Other sectors	GWh/a	1.290	1.790	2.290	2.895	3.500	4.105	4.710

4.22. Podlaskie Province

Table 22. Heating and cooling demand and forecast heating and cooling demand in the Podlaskie Province

		PODLASKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	6 580.203						
	Service sector	GWh/a	221.599						
	Industry sector	GWh/a	190.519						
	Other sectors	GWh/a	368.547						
Cooling demand, **final energy**	Residential sector	GWh/a	7.252						
	Service sector	GWh/a	1.453						
	Industry sector	GWh/a	0.341						
	Other sectors	GWh/a	0.618						
Heating demand, **useful** energy	Residential sector	GWh/a	5 491.794	5 361.420	5 231.724	5 091.510	4 951.296	4 811.083	4 670.869
	Service sector	GWh/a	183.702	185.061	186.082	187.149	188.773	191.512	195.366
	Industry sector	GWh/a	154.142	154.924	156.007	157.133	158.861	161.794	165.930
	Other sectors	GWh/a	292.744	293.681	294.618	294.060	293.910	294.577	296.060
Cooling demand, **useful** energy	Residential sector	GWh/a	21.747	30.839	39.175	47.275	54.615	61.196	67.016
	Service sector	GWh/a	4.348	4.736	5.109	5.578	6.086	6.669	7.333
	Industry sector	GWh/a	1.024	1.310	1.603	1.965	2.345	2.759	3.212
	Other sectors	GWh/a	1.825	2.354	2.894	3.560	4.189	4.950	5.691

4.23. Gdańsk

Table 23. Heating and cooling demand and forecast heating and cooling demand in Gdańsk

		Gdańsk City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	3 020.969						
	Service sector	GWh/a	415.180						
	Industry sector	GWh/a	279.396						
	Other sectors	GWh/a	451.785						
Cooling demand, **final energy**	Residential sector	GWh/a	4.636						
	Service sector	GWh/a	0.637						
	Industry sector	GWh/a	0.429						
	Other sectors	GWh/a	0.693						
Heating demand, **useful** energy	Residential sector	GWh/a	2 329.770	2 306.473	2 283.408	2 260.574	2 237.968	2 215.588	2 193.433
	Service sector	GWh/a	318.540	321.725	324.942	328.192	331.474	334.788	338.136
	Industry sector	GWh/a	214.210	212.068	209.947	207.848	205.769	203.712	201.675
	Other sectors	GWh/a	345.063	341.612	338.196	334.814	331.466	328.151	324.870
Cooling demand, **useful** energy	Residential sector	GWh/a	13.907	15.298	16.828	18.511	20.362	22.398	24.638
	Service sector	GWh/a	1.911	2.102	2.313	2.544	2.798	3.078	3.386
	Industry sector	GWh/a	1.286	1.415	1.556	1.712	1.883	2.071	2.279
	Other sectors	GWh/a	2.080	2.288	2.517	2.768	3.045	3.350	3.685

4.24. Pomorskie Province

Table 24. Heating and cooling demand and forecast heating and cooling demand in the Pomorskie Province

		POMORSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	11 636.119						
	Service sector	GWh/a	602.537						
	Industry sector	GWh/a	324.523						
	Other sectors	GWh/a	513.758						
Cooling demand, **final energy**	Residential sector	GWh/a	11.813						
	Service sector	GWh/a	3.465						
	Industry sector	GWh/a	0.608						
	Other sectors	GWh/a	1.070						
Heating demand, **useful** energy	Residential sector	GWh/a	9 752.006	9 503.150	9 255.775	9 008.630	8 761.713	8 515.023	8 268.556
	Service sector	GWh/a	487.161	493.364	498.730	506.276	515.287	527.195	542.000
	Industry sector	GWh/a	254.824	253.667	253.024	253.879	255.741	259.593	265.436
	Other sectors	GWh/a	400.839	399.001	397.197	397.041	397.993	401.129	406.448
Cooling demand, **useful** energy	Residential sector	GWh/a	35.439	46.525	56.682	65.921	74.257	81.705	88.286
	Service sector	GWh/a	10.395	11.010	11.606	12.350	13.212	14.287	15.590
	Industry sector	GWh/a	1.823	2.033	2.267	2.548	2.873	3.271	3.752
	Other sectors	GWh/a	3.149	3.418	3.744	4.133	4.479	5.114	5.748

4.25. Katowice

Table 25. Heating and cooling demand and forecast heating and cooling demand in Katowice

		Katowice City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	2 288.316						
	Service sector	GWh/a	485.937						
	Industry sector	GWh/a	603.385						
	Other sectors	GWh/a	198.469						
Cooling demand, **final energy**	Residential sector	GWh/a	5.506						
	Service sector	GWh/a	1.169						
	Industry sector	GWh/a	1.452						
	Other sectors	GWh/a	0.478						
Heating demand, **useful** energy	Residential sector	GWh/a	1 775.577	1 757.822	1 740.243	1 722.841	1 705.613	1 688.556	1 671.671
	Service sector	GWh/a	400.783	404.791	408.839	412.927	417.057	421.227	425.439
	Industry sector	GWh/a	464.077	459.436	454.842	450.293	445.791	441.333	436.919
	Other sectors	GWh/a	163.690	162.053	160.432	158.828	157.239	155.667	154.110
Cooling demand, **useful** energy	Residential sector	GWh/a	16.518	18.170	19.987	21.986	24.184	26.603	29.263
	Service sector	GWh/a	3.508	3.858	4.244	4.669	5.136	5.649	6.214
	Industry sector	GWh/a	4.356	4.791	5.270	5.797	6.377	7.015	7.716
	Other sectors	GWh/a	1.433	1.576	1.733	1.907	2.098	2.307	2.538

4.26. Śląskie Province

Table 26. Heating and cooling demand and forecast heating and cooling demand in the Śląskie Province

		ŚLĄSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	26 005.787						
	Service sector	GWh/a	842.244						
	Industry sector	GWh/a	717.073						
	Other sectors	GWh/a	303.789						
Cooling demand, **final energy**	Residential sector	GWh/a	27.796						
	Service sector	GWh/a	7.529						
	Industry sector	GWh/a	1.959						
	Other sectors	GWh/a	1.239						
Heating demand, **useful** energy	Residential sector	GWh/a	22 125.704	21 452.231	20 780.772	20 109.488	19 438.378	18 767.441	18 096.674
	Service sector	GWh/a	721.459	730.791	738.629	750.297	764.533	783.864	808.290
	Industry sector	GWh/a	566.396	563.948	562.642	564.671	568.937	577.634	590.760
	Other sectors	GWh/a	258.478	259.782	261.103	265.382	271.637	281.831	295.962
Cooling demand, **useful** energy	Residential sector	GWh/a	83.388	115.025	143.308	168.245	189.855	208.157	223.173
	Service sector	GWh/a	22.587	23.861	25.092	26.623	28.394	30.596	33.264
	Industry sector	GWh/a	5.877	6.540	7.274	8.136	9.125	10.309	11.721
	Other sectors	GWh/a	3.572	3.860	4.215	4.667	4.999	5.886	6.736

4.27. Kielce

Table 27. Heating and cooling demand and forecast heating and cooling demand in Kielce

		Kielce City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	856.623						
	Service sector	GWh/a	90.706						
	Industry sector	GWh/a	304.854						
	Other sectors	GWh/a	69.136						
Cooling demand, **final energy**	Residential sector	GWh/a	3.830						
	Service sector	GWh/a	0.406						
	Industry sector	GWh/a	1.363						
	Other sectors	GWh/a	0.309						
Heating demand, **useful** energy	Residential sector	GWh/a	670.656	663.950	657.310	650.737	644.230	637.787	631.410
	Service sector	GWh/a	70.994	71.704	72.421	73.145	73.876	74.615	75.361
	Industry sector	GWh/a	238.948	236.559	234.193	231.851	229.533	227.238	224.965
	Other sectors	GWh/a	54.164	53.622	53.086	52.555	52.030	51.509	50.994
Cooling demand, **useful** energy	Residential sector	GWh/a	3.830	4.213	4.634	5.098	5.608	6.168	6.785
	Service sector	GWh/a	0.406	0.446	0.491	0.540	0.594	0.653	0.718
	Industry sector	GWh/a	1.363	1.499	1.649	1.814	1.996	2.195	2.415
	Other sectors	GWh/a	0.309	0.340	0.374	0.411	0.453	0.498	0.548

4.28. Świętokrzyskie Province

Table 28. Heating and cooling demand and forecast heating and cooling demand in the Świętokrzyskie Province

		ŚWIĘTOKRZYSKIE	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	6 094.243						
	Service sector	GWh/a	159.994						
	Industry sector	GWh/a	320.688						
	Other sectors	GWh/a	104.533						
Cooling demand, **final energy**	Residential sector	GWh/a	11.078						
	Service sector	GWh/a	1.642						
	Industry sector	GWh/a	1.434						
	Other sectors	GWh/a	0.587						
Heating demand, **useful** energy	Residential sector	GWh/a	5 164.557	5 012.779	4 861.506	4 710.299	4 559.158	4 408.082	4 257.071
	Service sector	GWh/a	133.353	135.363	137.005	139.580	142.780	147.221	152.903
	Industry sector	GWh/a	253.199	251.117	249.213	247.794	246.706	246.256	246.444
	Other sectors	GWh/a	86.021	86.382	86.749	88.025	89.909	93.002	97.306
Cooling demand, **useful** energy	Residential sector	GWh/a	25.573	35.276	43.910	51.478	57.983	63.429	67.822
	Service sector	GWh/a	4.116	4.352	4.573	4.863	5.206	5.648	6.197
	Industry sector	GWh/a	1.575	1.743	1.929	2.140	2.379	2.655	2.974
	Other sectors	GWh/a	1.091	1.172	1.275	1.410	1.496	1.783	2.048

4.29. Olsztyn

Table 29. Heating and cooling demand and forecast heating and cooling demand in Olsztyn

		Olsztyn City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	601.426						
	Service sector	GWh/a	68.565						
	Industry sector	GWh/a	465.831						
	Other sectors	GWh/a	113.116						
Cooling demand, **final energy**	Residential sector	GWh/a	0.903						
	Service sector	GWh/a	0.103						
	Industry sector	GWh/a	0.699						
	Other sectors	GWh/a	0.170						
Heating demand, **useful** energy	Residential sector	GWh/a	497.680	504.529	511.377	518.328	525.279	532.230	539.180
	Service sector	GWh/a	57.872	59.501	61.130	62.683	64.236	65.788	67.341
	Industry sector	GWh/a	387.058	393.497	399.936	405.920	411.904	417.887	423.871
	Other sectors	GWh/a	93.724	95.377	97.030	98.380	99.729	101.078	102.427
Cooling demand, **useful** energy	Residential sector	GWh/a	2.708	3.532	4.356	4.966	5.577	6.188	6.799
	Service sector	GWh/a	0.309	0.411	0.513	0.597	0.681	0.765	0.849
	Industry sector	GWh/a	2.097	2.747	3.396	3.883	4.370	4.858	5.345
	Other sectors	GWh/a	0.509	0.667	0.825	0.942	1.058	1.175	1.292

4.30. Warmińsko-Mazurskie Province

Table 30. Heating and cooling demand and forecast heating and cooling demand in the Warmińsko-Mazurskie Province

WARMIŃSKO-MAZURSKIE	2020	2025	2030	2035	2040	2045	2050

Heating demand, **final** energy	Residential sector	GWh/a	6 722.198						
	Service sector	GWh/a	169.878						
	Industry sector	GWh/a	497.867						
	Other sectors	GWh/a	152.428						
Cooling demand, **final energy**	Residential sector	GWh/a	6.588						
	Service sector	GWh/a	1.799						
	Industry sector	GWh/a	0.833						
	Other sectors	GWh/a	0.470						
Heating demand, **useful** energy	Residential sector	GWh/a	5 754.825	5 594.321	5 434.457	5 274.695	5 114.933	4 955.172	4 795.410
	Service sector	GWh/a	149.053	152.377	155.212	159.178	163.947	170.325	178.311
	Industry sector	GWh/a	415.891	423.001	430.447	438.443	447.110	457.119	468.470
	Other sectors	GWh/a	129.105	131.690	134.275	137.489	141.324	146.402	152.723
Cooling demand, **useful** energy	Residential sector	GWh/a	19.763	28.182	35.718	42.155	47.707	52.372	56.151
	Service sector	GWh/a	5.398	5.757	6.093	6.488	6.942	7.511	8.204
	Industry sector	GWh/a	2.499	3.209	3.927	4.506	5.106	5.746	6.433
	Other sectors	GWh/a	1.362	1.569	1.794	2.007	2.167	2.521	2.848

4.31. Poznań

Table 31. Heating and cooling demand and forecast heating and cooling demand in Poznań

		Poznań City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	2 465.431						
	Service sector	GWh/a	628.849						
	Industry sector	GWh/a	466.184						
	Other sectors	GWh/a	480.073						
Cooling demand, **final energy**	Residential sector	GWh/a	6.938						
	Service sector	GWh/a	1.770						
	Industry sector	GWh/a	1.312						
	Other sectors	GWh/a	1.351						
Heating demand, **useful** energy	Residential sector	GWh/a	2 073.010	2 052.280	2 031.757	2 011.440	1 991.325	1 971.412	1 951.698
	Service sector	GWh/a	537.556	542.932	548.361	553.845	559.383	564.977	570.627
	Industry sector	GWh/a	398.546	394.560	390.615	386.709	382.842	379.013	375.223
	Other sectors	GWh/a	410.420	406.316	402.253	398.230	394.248	390.306	386.402
Cooling demand, **useful** energy	Residential sector	GWh/a	20.813	22.894	25.183	27.702	30.472	33.519	36.871
	Service sector	GWh/a	5.309	5.840	6.423	7.066	7.772	8.550	9.405
	Industry sector	GWh/a	3.935	4.329	4.762	5.238	5.762	6.338	6.972
	Other sectors	GWh/a	4.053	4.458	4.904	5.394	5.934	6.527	7.180

4.32. Wielkopolskie Province

Table 32. Heating and cooling demand and forecast heating and cooling demand in the Wielkopolskie Province

WIELKOPOLSKIE	2020	2025	2030	2035	2040	2045	2050

Heating demand, **final** energy	Residential sector	GWh/a	17 101.186						
	Service sector	GWh/a	920.914						
	Industry sector	GWh/a	592.885						
	Other sectors	GWh/a	573.784						
Cooling demand, **final energy**	Residential sector	GWh/a	23.530						
	Service sector	GWh/a	7.128						
	Industry sector	GWh/a	1.893						
	Other sectors	GWh/a	1.993						
Heating demand, **useful** energy	Residential sector	GWh/a	14 670.890	14 263.382	13 857.800	13 452.423	13 047.250	12 642.277	12 237.504
	Service sector	GWh/a	800.415	810.383	819.081	831.102	845.358	864.028	887.112
	Industry sector	GWh/a	512.577	511.175	511.106	514.952	521.421	533.097	549.979
	Other sectors	GWh/a	494.760	493.024	491.329	492.044	494.378	499.910	508.639
Cooling demand, **useful** energy	Residential sector	GWh/a	70.591	94.538	116.252	135.745	153.040	168.163	181.140
	Service sector	GWh/a	21.384	22.707	24.014	25.611	27.447	29.696	32.388
	Industry sector	GWh/a	5.679	6.335	7.065	7.934	8.940	10.166	11.648
	Other sectors	GWh/a	5.869	6.385	7.011	7.749	8.421	9.597	10.783

4.33. Szczecin

Table 33. Heating and cooling demand and forecast heating and cooling demand in Szczecin

		Szczecin City District	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	2 598.810						
	Service sector	GWh/a	165.422						
	Industry sector	GWh/a	55.074						
	Other sectors	GWh/a	223.347						
Cooling demand, **final energy**	Residential sector	GWh/a	3.722						
	Service sector	GWh/a	0.237						
	Industry sector	GWh/a	0.079						
	Other sectors	GWh/a	0.320						
Heating demand, **useful** energy	Residential sector	GWh/a	2 083.559	2 062.723	2 042.096	2 021.675	2 001.458	1 981.444	1 961.629
	Service sector	GWh/a	131.990	133.310	134.643	135.990	137.350	138.723	140.111
	Industry sector	GWh/a	43.963	43.524	43.088	42.658	42.231	41.809	41.391
	Other sectors	GWh/a	177.586	175.811	174.052	172.312	170.589	168.883	167.194
Cooling demand, **useful** energy	Residential sector	GWh/a	11.165	12.282	13.510	14.861	16.347	17.982	19.780
	Service sector	GWh/a	0.711	0.782	0.860	0.946	1.041	1.145	1.259
	Industry sector	GWh/a	0.237	0.260	0.286	0.315	0.346	0.381	0.419
	Other sectors	GWh/a	0.960	1.056	1.161	1.277	1.405	1.545	1.700

4.34. Zachodniopomorskie Province

Table 34. Heating and cooling demand and forecast heating and cooling demand in the Zachodniopomorskie Province

		ZACHODNIOPOMORSKIE	2020	2025	2030	2035	2040	2045	2050
	Residential sector	GWh/a	9 146.972						

Heating demand, **final** energy	Service sector	GWh/a	324.544						
	Industry sector	GWh/a	85.942						
	Other sectors	GWh/a	277.626						
Cooling demand, **final energy**	Residential sector	GWh/a	8.813						
	Service sector	GWh/a	2.470						
	Industry sector	GWh/a	0.187						
	Other sectors	GWh/a	0.621						
Heating demand, **useful** energy	Residential sector	GWh/a	7 708.818	7 510.049	7 312.082	7 114.321	6 916.764	6 719.410	6 522.255
	Service sector	GWh/a	275.200	279.199	282.439	287.599	294.045	303.046	314.605
	Industry sector	GWh/a	71.745	71.906	72.371	73.743	75.719	78.900	83.287
	Other sectors	GWh/a	226.438	225.737	225.054	225.464	226.608	229.203	233.249
Cooling demand, **useful** energy	Residential sector	GWh/a	26.439	34.380	41.642	48.237	54.175	59.471	64.139
	Service sector	GWh/a	7.409	7.818	8.205	8.702	9.285	10.031	10.951
	Industry sector	GWh/a	0.561	0.634	0.714	0.815	0.934	1.086	1.276
	Other sectors	GWh/a	1.801	1.958	2.140	2.357	2.543	2.907	3.266

4.35. Poland

Table 35. Heating and cooling demand and forecast heating and cooling demand in Poland

		POLAND	2020	2025	2030	2035	2040	2045	2050
Heating demand, **final** energy	Residential sector	GWh/a	200 115.303						
	Service sector	GWh/a	8 154.108						
	Industry sector	GWh/a	5 477.227						
	Other sectors	GWh/a	6 628.194						
Cooling demand, **final energy**	Residential sector	GWh/a	279.544						
	Service sector	GWh/a	59.391						
	Industry sector	GWh/a	16.184						
	Other sectors	GWh/a	21.009						
Heating demand, **useful** energy	Residential sector	GWh/a	167 971.670	163 449.360	158 946.767	154 425.476	149 906.176	145 389.792	140 876.295
	Service sector	GWh/a	6 708.532	6 796.967	6 873.383	6 977.052	7 101.608	7 267.527	7 474.811
	Industry sector	GWh/a	4 445.404	4 440.608	4 444.856	4 471.760	4 516.453	4 596.433	4 711.698
	Other sectors	GWh/a	5 114.246	5 102.496	5 091.123	5 102.316	5 130.518	5 192.367	5 287.859
Cooling demand, **useful** energy	Residential sector	GWh/a	776.123	1 034.834	1 269.698	1 479.602	1 666.066	1 829.378	1 969.933
	Service sector	GWh/a	171.980	182.842	193.435	206.232	220.990	239.232	261.222
	Industry sector	GWh/a	37.935	43.446	49.403	55.576	62.538	70.889	80.750
	Other sectors	GWh/a	54.040	59.279	65.394	72.535	78.786	90.323	101.725

5. Reporting current heating and cooling supply

The data presented in sections 5.1-5.35 were sourced from the analysis entitled 'Przygotowanie wybranych analiz, prognoz i opracowań na potrzeby aktualizacji dokumentu pn. "Kompleksowa ocena potencjału efektywności w zakresie ogrzewania i chłodzenia" zgodnie z zapisami art. 14 dyrektywy 2012/27/UE', prepared by Audytel SA at the request of the Minister for Climate and Environment.

5.1. Wrocław

Table 36. Heating and cooling supply in Wrocław

Energy provided on-site		Wrocław City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1 270.575
		High-efficiency cogeneration	GWh/a	47.595
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	2.293
		Other technologies	GWh/a	35.908
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	204.683
		High-efficiency cogeneration	GWh/a	2.036
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	331.599
		High-efficiency cogeneration	GWh/a	3.765
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	12.995
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	122.328
		High-efficiency cogeneration	GWh/a	17.996
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	20.641
		Other technologies	GWh/a	20.673

Off-site		Wrocław City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	687.937
		Other technologies	GWh/a	394.093
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	28.588
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	206.724
		Other technologies	GWh/a	118.424
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.591
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	76.241
		Other technologies	GWh/a	43.675
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.168
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	249.408
		Other technologies	GWh/a	142.877
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	10.364
		Other technologies	GWh/a	0.000

5.2. Dolnośląskie Province

Table 37. Heating and cooling supply in the Dolnośląskie Province

Energy provided on-site		DOLNOŚLĄSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	10.162
		Other technologies	GWh/a	11 152.051
		High-efficiency cogeneration	GWh/a	47.595
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	31.709
		Other technologies	GWh/a	1 570.792
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.762
		Other technologies	GWh/a	267.759
		High-efficiency cogeneration	GWh/a	2.036
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	125.178
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.414
		Other technologies	GWh/a	386.843
		High-efficiency cogeneration	GWh/a	3.765
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	12.995
		Heat pumps	GWh/a	1.357
		Other technologies	GWh/a	19.061
Other sectors	Fossil sources	Heat-only boilers	GWh/a	1.270
		Other technologies	GWh/a	159.553
		High-efficiency cogeneration	GWh/a	17.996
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	20.641
		Other technologies	GWh/a	22.613

Off-site		DOLNOŚLĄSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 451.460
		Other technologies	GWh/a	411.650
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	28.588
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	289.256
		Other technologies	GWh/a	119.741
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.591
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	134.359
		Other technologies	GWh/a	44.553
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.168
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	366.134
		Other technologies	GWh/a	145.071
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	10.364
		Other technologies	GWh/a	0.000

5.3. Bydgoszcz

Table 38. Heating and cooling supply in Bydgoszcz

Energy provided on-site		Bydgoszcz City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	78.790
		Other technologies	GWh/a	974.530
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.020
		Other technologies	GWh/a	46.550
Service sector	Fossil sources	Heat-only boilers	GWh/a	5.680
		Other technologies	GWh/a	70.230
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.220
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	11.400
		Other technologies	GWh/a	140.980
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1.080
		Heat pumps	GWh/a	0.090
		Other technologies	GWh/a	0.660
Other sectors	Fossil sources	Heat-only boilers	GWh/a	5.990
		Other technologies	GWh/a	74.140
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.210
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000

Energy provided off-site		Bydgoszcz City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	741.320
		Other technologies	GWh/a	83.150
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	72.590
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	51.140
		Other technologies	GWh/a	5.740
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	5.010
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	103.300
		Other technologies	GWh/a	11.590
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	10.110
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	56.230
		Other technologies	GWh/a	6.310
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	5.510
		Other technologies	GWh/a	0.000

5.4. Toruń

Table 39. Heating and cooling supply Toruń

Energy provided on-site		Toruń City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	526.932
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.047
		Other technologies	GWh/a	45.672
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	36.925
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	19.129
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.851
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	57.293
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.047

Off-site		Toruń City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	478.040
		Other technologies	GWh/a	81.514
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.556
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	31.011
		Other technologies	GWh/a	5.274
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.165
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	20.474
		Other technologies	GWh/a	3.482
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.109
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	48.127
		Other technologies	GWh/a	8.186
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.165
		Other technologies	GWh/a	0.000

5.5. Kujawsko-Pomorskie Province

Table 40. Heating and cooling supply in the Kujawsko-Pomorskie Province

Energy provided on-site		KUJAWSKO-POMORSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	78.790
		Other technologies	GWh/a	6 709.120
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	4.779
		Other technologies	GWh/a	1 151.437
Service sector	Fossil sources	Heat-only boilers	GWh/a	5.680
		Other technologies	GWh/a	142.302
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.220
		Other technologies	GWh/a	27.551
Industry sector	Fossil sources	Heat-only boilers	GWh/a	11.400
		Other technologies	GWh/a	177.199
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	5.931
		Heat pumps	GWh/a	0.090
		Other technologies	GWh/a	3.827
Other sectors	Fossil sources	Heat-only boilers	GWh/a	5.990
		Other technologies	GWh/a	147.139
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.210
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	2.020

Off-site		KUJAWSKO-POMORSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2 068.406
		Other technologies	GWh/a	419.720
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	75.146
		Other technologies	GWh/a	0.490
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	189.811
		Other technologies	GWh/a	47.031
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	5.175
		Other technologies	GWh/a	0.052
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	205.859
		Other technologies	GWh/a	43.823
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	10.219
		Other technologies	GWh/a	0.033
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	242.614
		Other technologies	GWh/a	57.932
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	5.675
		Other technologies	GWh/a	0.078

5.6. Lublin

Table 41. Heating and cooling supply in Lublin

Energy provided on-site		Lublin City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1 440.483
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	101.245
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	210.026
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	267.274
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.889
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	213.020
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	2.552

Off-site		Lublin City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	623.155
		Other technologies	GWh/a	172.412
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	84.891
		Other technologies	GWh/a	23.487
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	113.210
		Other technologies	GWh/a	31.323
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	87.133
		Other technologies	GWh/a	24.108
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.7. Lubelskie Province

Table 42. Heating and cooling supply in the Lubelskie Province

Energy provided on-site		LUBELSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	8 891.501
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	5.078
		Other technologies	GWh/a	1 314.704
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	274.569
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	14.982
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	280.826
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.889
		Heat pumps	GWh/a	0.140
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	238.446
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	13.429

Off-site		LUBELSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 267.012
		Other technologies	GWh/a	172.412
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	146.802
		Other technologies	GWh/a	23.487
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	152.573
		Other technologies	GWh/a	31.323
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	182.671
		Other technologies	GWh/a	24.108
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.8. Gorzów Wielkopolski

Table 43. Heating and cooling supply in Gorzów Wielkopolski

Energy provided on-site		Gorzów Wielkopolski City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	204.423
		Other technologies	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	18.420
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Heat-only boilers	GWh/a	46.282
		Other technologies	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	5.249
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	110.465
		Other technologies	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	14.031
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	16.789
		Other technologies	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.512
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000

Off-site		**Gorzów Wielkopolski City District**	**Unit**	**Value**
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	190.032
		Other technologies	GWh/a	100.526
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	25.729
		Other technologies	GWh/a	13.240
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	62.159
		Other technologies	GWh/a	31.986
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.638
		Other technologies	GWh/a	4.445
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.9. Zielona Góra

Table 44. Heating and cooling supply in Zielona Góra

Energy provided on-site		Zielona Góra City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	330.179
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	8.786
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	30.570
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	6.683
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	41.294
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	48.357
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.364

Off-site		Zielona Góra City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	173.850
		Other technologies	GWh/a	105.855
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	15.221
		Other technologies	GWh/a	9.268
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	23.888
		Other technologies	GWh/a	14.545
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	24.259
		Other technologies	GWh/a	14.771
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.10. Lubuskie Province

Table 45. Heating and cooling supply in the Lubuskie Province

Energy provided on-site		LUBUSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	269.337
		Other technologies	GWh/a	3 740.751
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	18.420
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	461.387
Service sector	Fossil sources	Heat-only boilers	GWh/a	51.996
		Other technologies	GWh/a	56.686
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	5.249
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	10.706
Industry sector	Fossil sources	Heat-only boilers	GWh/a	117.751
		Other technologies	GWh/a	26.169
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	14.031
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.497
		Other technologies	GWh/a	42.420
Other sectors	Fossil sources	Heat-only boilers	GWh/a	25.837
		Other technologies	GWh/a	70.262
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.512
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.364

Off-site		LUBUSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	514.770
		Other technologies	GWh/a	206.381
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	53.505
		Other technologies	GWh/a	22.508
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	94.244
		Other technologies	GWh/a	46.532
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	53.127
		Other technologies	GWh/a	19.216
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.11. Łódź

Table 46. Heating and cooling supply in Łódź

Energy provided on-site		**Łódź City District**	**Unit**	**Value**
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	2 682.806
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	57.049
		Other technologies	GWh/a	14.139
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	72.170
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	56.155
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	18.585
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	54.215
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	30.719
		Other technologies	GWh/a	20.224

Off-site		Łódź City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 118.848
		Other technologies	GWh/a	492.121
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	124.210
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	323.733
		Other technologies	GWh/a	142.393
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	35.939
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	107.635
		Other technologies	GWh/a	47.343
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	11.949
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	313.083
		Other technologies	GWh/a	137.708
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	34.757
		Other technologies	GWh/a	0.000

5.12. Łódzkie Province

Table 47. Heating and cooling supply in the Łódzkie Province

Energy provided on-site		ŁÓDZKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	184.576
		Other technologies	GWh/a	10 282.715
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	104.754
		Other technologies	GWh/a	928.394
Service sector	Fossil sources	Heat-only boilers	GWh/a	19.171
		Other technologies	GWh/a	72.170
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	190.093
Industry sector	Fossil sources	Heat-only boilers	GWh/a	17.087
		Other technologies	GWh/a	81.324
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	6.256
		Other technologies	GWh/a	18.585
Other sectors	Fossil sources	Heat-only boilers	GWh/a	28.960
		Other technologies	GWh/a	69.069
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	30.719
		Other technologies	GWh/a	31.024

Off-site		ŁÓDZKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 720.470
		Other technologies	GWh/a	492.121
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	124.210
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	385.601
		Other technologies	GWh/a	142.393
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	35.939
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	146.530
		Other technologies	GWh/a	47.343
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	11.949
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	406.795
		Other technologies	GWh/a	137.708
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	34.757
		Other technologies	GWh/a	0.000

5.13. Kraków

Table 48. Heating and cooling supply in Kraków

Energy provided on-site		**Kraków City District**	**Unit**	**Value**
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	2 223.178
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	66.498
		Other technologies	GWh/a	68.638
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	47.494
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	25.234
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	30.425
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	11.517
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	106.942
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	24.937
		Other technologies	GWh/a	12.002

Off-site		Kraków City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 148.989
		Other technologies	GWh/a	424.141
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	78.298
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	268.669
		Other technologies	GWh/a	99.177
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	18.308
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	171.491
		Other technologies	GWh/a	63.305
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	11.686
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	316.305
		Other technologies	GWh/a	116.762
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	21.555
		Other technologies	GWh/a	0.000

5.14. Małopolskie Province

Table 49. Heating and cooling supply in the Małopolskie Province

Energy provided on-site		MAŁOPOLSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	10.247
		Other technologies	GWh/a	11 996.912
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	77.493
		Other technologies	GWh/a	1 468.501
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.991
		Other technologies	GWh/a	47.494
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	338.605
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.527
		Other technologies	GWh/a	63.506
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.019
		Other technologies	GWh/a	11.607
Other sectors	Fossil sources	Heat-only boilers	GWh/a	1.526
		Other technologies	GWh/a	157.563
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	24.937
		Other technologies	GWh/a	32.352

Off-site		MAŁOPOLSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2 447.749
		Other technologies	GWh/a	424.141
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	78.298
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	418.865
		Other technologies	GWh/a	99.177
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	18.308
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	273.472
		Other technologies	GWh/a	63.305
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	11.686
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	527.737
		Other technologies	GWh/a	116.762
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	21.555
		Other technologies	GWh/a	0.000

5.15. Warsaw

Table 50. Heating and cooling supply in Warsaw

Energy provided on-site		Warsaw Capital City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	2 567.491
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	25.990
		Other technologies	GWh/a	0.385
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	372.067
		High-efficiency cogeneration	GWh/a	97.092
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	18.565
		Other technologies	GWh/a	36.829
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	63.267
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	343.395
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	47.109
		Other technologies	GWh/a	63.909

Off-site		Warsaw Capital City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3 804.575
		Other technologies	GWh/a	2 645.476
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	176.027
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	652.142
		Other technologies	GWh/a	453.461
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	30.173
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	93.739
		Other technologies	GWh/a	65.181
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.337
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	588.952
		Other technologies	GWh/a	409.522
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	27.249
		Other technologies	GWh/a	0.000

5.16. Mazowieckie Province

Table 51. Heating and cooling supply in the Mazowieckie Province

Energy provided on-site		MAZOWIECKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	9.429
		Other technologies	GWh/a	18 312.300
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	25.990
		Other technologies	GWh/a	614.519
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.890
		Other technologies	GWh/a	621.834
		High-efficiency cogeneration	GWh/a	97.092
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	18.565
		Other technologies	GWh/a	36.829
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.337
		Other technologies	GWh/a	118.455
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	1.381
		Other technologies	GWh/a	441.801
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	47.109
		Other technologies	GWh/a	63.909

Off-site		MAZOWIECKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	5 104.359
		Other technologies	GWh/a	2 736.844
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	176.027
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	801.189
		Other technologies	GWh/a	463.207
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	30.173
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	198.214
		Other technologies	GWh/a	71.272
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.337
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	796.069
		Other technologies	GWh/a	424.141
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	27.249
		Other technologies	GWh/a	0.000

5.17. Opole

Table 52. Heating and cooling supply in Opole

Energy provided on-site		Opole City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	357.753
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.408
		Other technologies	GWh/a	45.077
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1.655
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	33.815
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.054
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.090
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	7.237
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.611
		Other technologies	GWh/a	0.179

Off-site		Opole City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	52.158
		Other technologies	GWh/a	202.570
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.002
		Other technologies	GWh/a	22.269
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	30.744
		Other technologies	GWh/a	44.559
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	16.159
		Other technologies	GWh/a	123.130
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.18. Opolskie Province

Table 53. Heating and cooling supply in the Opolskie Province

Energy provided on-site		OPOLSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	6.411
		Other technologies	GWh/a	4 785.900
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	28.112
		Other technologies	GWh/a	395.278
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.481
		Other technologies	GWh/a	9.991
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	54.233
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.190
		Other technologies	GWh/a	48.756
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.054
		Heat pumps	GWh/a	0.101
		Other technologies	GWh/a	3.789
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.801
		Other technologies	GWh/a	17.241
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.611
		Other technologies	GWh/a	0.179

Off-site		OPOLSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	251.515
		Other technologies	GWh/a	280.409
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	21.351
		Other technologies	GWh/a	30.555
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	43.026
		Other technologies	GWh/a	49.739
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	45.938
		Other technologies	GWh/a	135.565
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.19. Rzeszów

Table 54. Heating and cooling supply in Rzeszów

Energy provided on-site		Rzeszów City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	267.734
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	14.470
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	70.009
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	44.175
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	70.009
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000

Off-site		**Rzeszów City District**	**Unit**	**Value**
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	157.950
		Other technologies	GWh/a	169.181
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	18.130
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	39.184
		Other technologies	GWh/a	41.970
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.498
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	24.724
		Other technologies	GWh/a	26.483
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.838
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	39.184
		Other technologies	GWh/a	41.970
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.498
		Other technologies	GWh/a	0.000

5.20. Podkarpackie Province

Table 55. Heating and cooling supply in the Podkarpackie Province

Energy provided on-site		PODKARPACKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	244.253
		Other technologies	GWh/a	6 669.670
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	11.085
		Other technologies	GWh/a	1 911.356
Service sector	Fossil sources	Heat-only boilers	GWh/a	20.166
		Other technologies	GWh/a	75.596
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	153.052
Industry sector	Fossil sources	Heat-only boilers	GWh/a	6.165
		Other technologies	GWh/a	69.569
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.123
		Other technologies	GWh/a	2.765
Other sectors	Fossil sources	Heat-only boilers	GWh/a	32.573
		Other technologies	GWh/a	112.850
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	13.050

Off-site		PODKARPACKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 026.402
		Other technologies	GWh/a	169.181
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	18.130
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	123.127
		Other technologies	GWh/a	41.970
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.498
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	78.047
		Other technologies	GWh/a	26.483
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.838
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	168.530
		Other technologies	GWh/a	41.970
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.498
		Other technologies	GWh/a	0.000

5.21. Białystok

Table 56. Heating and cooling supply in Białystok

Energy provided on-site		Białystok City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1 219.730
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Heat-only boilers	GWh/a	65.430
		Other technologies	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	49.030
		Other technologies	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	364.590
		Other technologies	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000

Off-site		Białystok City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	478.710
		Other technologies	GWh/a	205.620
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	107.150
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	43.290
		Other technologies	GWh/a	13.250
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	9.690
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	43.180
		Other technologies	GWh/a	49.380
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	9.670
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	101.550
		Other technologies	GWh/a	18.130
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	22.730
		Other technologies	GWh/a	0.000

5.22. Podlaskie Province

Table 57. Heating and cooling supply in the Podlaskie Province

Energy provided on-site		PODLASKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	4 295.128
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	1 174.704
Service sector	Fossil sources	Heat-only boilers	GWh/a	65.430
		Other technologies	GWh/a	30.608
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	37.455
Industry sector	Fossil sources	Heat-only boilers	GWh/a	49.030
		Other technologies	GWh/a	31.684
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.488
		Other technologies	GWh/a	1.545
Other sectors	Fossil sources	Heat-only boilers	GWh/a	364.590
		Other technologies	GWh/a	15.334
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	1.878

Off-site		PODLASKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 099.757
		Other technologies	GWh/a	211.303
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	107.150
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	98.041
		Other technologies	GWh/a	13.676
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	9.690
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	78.534
		Other technologies	GWh/a	49.664
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	9.670
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	188.213
		Other technologies	GWh/a	18.840
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	22.730
		Other technologies	GWh/a	0.000

5.23. Gdańsk

Table 58. Heating and cooling supply in Gdańsk

Energy provided on-site		Gdańsk City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1 930.216
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.346
		Other technologies	GWh/a	27.872
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	106.314
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	169.404
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	13.334
		Heat pumps	GWh/a	0.255
		Other technologies	GWh/a	14.654
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	89.425
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	2.792
		Other technologies	GWh/a	22.994

Off-site		Gdańsk City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	995.784
		Other technologies	GWh/a	57.402
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	279.590
		Other technologies	GWh/a	16.117
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	100.411
		Other technologies	GWh/a	5.788
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	339.095
		Other technologies	GWh/a	19.547
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.24. Pomorskie Province

Table 59. Heating and cooling supply in the Pomorskie Province

Energy provided on-site		POMORSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.995
		Other technologies	GWh/a	7 740.081
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	11.946
		Other technologies	GWh/a	849.583
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.106
		Other technologies	GWh/a	175.396
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	35.250
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.030
		Other technologies	GWh/a	187.351
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	13.334
		Heat pumps	GWh/a	0.332
		Other technologies	GWh/a	16.846
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.159
		Other technologies	GWh/a	104.581
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	2.792
		Other technologies	GWh/a	54.951

Off-site		POMORSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3 242.993
		Other technologies	GWh/a	57.402
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	549.093
		Other technologies	GWh/a	16.117
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	292.701
		Other technologies	GWh/a	5.788
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	704.794
		Other technologies	GWh/a	19.547
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	0.000

5.25. Katowice

Table 60. Heating and cooling supply in Katowice

Energy provided on-site		Katowice City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1 173.961
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	3.165
		Other technologies	GWh/a	160.763
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	201.266
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	1.055
		Other technologies	GWh/a	4.746
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	452.666
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.916
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	14.686
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	68.841
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	2.110
		Other technologies	GWh/a	9.641

Off-site		Katowice City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	841.207
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	15.580
		Other technologies	GWh/a	14.090
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	228.969
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.241
		Other technologies	GWh/a	3.835
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	150.919
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.795
		Other technologies	GWh/a	2.528
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Other technologies	GWh/a	93.516
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1.732
		Other technologies	GWh/a	1.566

5.26. Śląskie Province

Table 61. Heating and cooling supply in the Śląskie Province

Energy provided on-site		ŚLĄSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	5.638
		Other technologies	GWh/a	18 911.976
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	82.159
		Other technologies	GWh/a	1 088.459
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.601
		Other technologies	GWh/a	301.890
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	1.055
		Other technologies	GWh/a	11.693
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.158
		Other technologies	GWh/a	476.672
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.916
		Heat pumps	GWh/a	0.007
		Other technologies	GWh/a	24.334
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.902
		Other technologies	GWh/a	92.207
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	2.110
		Other technologies	GWh/a	13.475

Off-site		ŚLĄSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	6 217.405
		Other technologies	GWh/a	853.424
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	366.650
		Other technologies	GWh/a	14.090
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	821.412
		Other technologies	GWh/a	230.714
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	54.383
		Other technologies	GWh/a	3.835
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	625.980
		Other technologies	GWh/a	152.315
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	42.904
		Other technologies	GWh/a	2.528
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 041.451
		Other technologies	GWh/a	95.611
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	61.912
		Other technologies	GWh/a	1.566

5.27. Kielce

Table 62. Heating and cooling supply in Kielce

Energy provided on-site		Kielce City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	473.377
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	37.851
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	54.133
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	181.935
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	39.764
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	1.496

Off-site		Kielce City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	21.257
		Other technologies	GWh/a	299.087
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	25.051
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.251
		Other technologies	GWh/a	31.670
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.653
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	7.565
		Other technologies	GWh/a	106.439
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.915
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1.716
		Other technologies	GWh/a	24.139
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.022
		Other technologies	GWh/a	0.000

5.28. Świętokrzyskie Province

Table 63. Heating and cooling supply in the Świętokrzyskie Province

Energy provided on-site		ŚWIĘTOKRZYSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	18.460
		Other technologies	GWh/a	5 049.927
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	103.273
Service sector	Fossil sources	Heat-only boilers	GWh/a	1.384
		Other technologies	GWh/a	94.668
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.911
Industry sector	Fossil sources	Heat-only boilers	GWh/a	1.570
		Other technologies	GWh/a	190.463
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	2.307
		Other technologies	GWh/a	58.848
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	1.496

Off-site		ŚWIĘTOKRZYSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	598.444
		Other technologies	GWh/a	299.087
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	25.051
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	60.981
		Other technologies	GWh/a	31.670
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.653
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	44.551
		Other technologies	GWh/a	106.439
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.915
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	90.931
		Other technologies	GWh/a	24.139
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	2.022
		Other technologies	GWh/a	0.000

5.29. Olsztyn

Table 64. Heating and cooling supply in Olsztyn

Energy provided on-site		Olsztyn City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	312.611
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	7.829
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.700
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	14.600
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	122.316
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	7.231
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	40.837
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	55.460
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	18.790
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000

Off-site		Olsztyn City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	88.624
		Other technologies	GWh/a	253.648
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	27.667
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.625
		Other technologies	GWh/a	33.586
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.658
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	21.920
		High-efficiency cogeneration	GWh/a	51.110
		Other technologies	GWh/a	103.279
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	13.747
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	11.805
		Other technologies	GWh/a	45.967
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.928
		Other technologies	GWh/a	0.000

5.30. Warmińsko-Mazurskie Province

Table 65. Heating and cooling supply in the Warmińsko-Mazurskie Province

Energy provided on-site		WARMIŃSKO-MAZURSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	5 579.711
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	7.829
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	637.826
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	77.311
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	32.420
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	152.582
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	7.231
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	40.837
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	90.058
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	18.790
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	1.093

Off-site		WARMIŃSKO-MAZURSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	305.170
		Other technologies	GWh/a	253.648
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	27.667
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	24.866
		Other technologies	GWh/a	33.586
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	3.658
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	21.920
		High-efficiency cogeneration	GWh/a	61.937
		Other technologies	GWh/a	103.279
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	13.747
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	38.873
		Other technologies	GWh/a	45.967
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	4.928
		Other technologies	GWh/a	0.000

5.31. Poznań

Table 66. Heating and cooling supply in Poznań

Energy provided on-site		Poznań City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1 403.251
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	28.311
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	262.214
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	419.556
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1.306
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	1.706
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	168.100
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	16.487
		Other technologies	GWh/a	2.282

Off-site		Poznań City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	1.941
		High-efficiency cogeneration	GWh/a	499.164
		Other technologies	GWh/a	400.534
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	137.120
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.693
		High-efficiency cogeneration	GWh/a	178.293
		Other technologies	GWh/a	143.064
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	48.977
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.125
		High-efficiency cogeneration	GWh/a	32.031
		Other technologies	GWh/a	25.702
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.799
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.575
		High-efficiency cogeneration	GWh/a	147.904
		Other technologies	GWh/a	118.679
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	40.629
		Other technologies	GWh/a	0.000

5.32. Wielkopolskie Province

Table 67. Heating and cooling supply in the Wielkopolskie Province

Energy provided on-site		WIELKOPOLSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	14 638.412
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	4.307
		Other technologies	GWh/a	1 424.598
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	455.027
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	108.097
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	545.225
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1.306
		Heat pumps	GWh/a	0.710
		Other technologies	GWh/a	2.028
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	255.411
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	16.621
		Other technologies	GWh/a	10.987

Off-site		WIELKOPOLSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	1.941
		High-efficiency cogeneration	GWh/a	499.164
		Other technologies	GWh/a	400.534
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	137.120
		Other technologies	GWh/a	0.000
Service sector	Fossil sources	Waste heat	GWh/a	0.693
		High-efficiency cogeneration	GWh/a	178.293
		Other technologies	GWh/a	143.064
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	48.977
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Waste heat	GWh/a	0.125
		High-efficiency cogeneration	GWh/a	32.031
		Other technologies	GWh/a	25.702
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	8.799
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Waste heat	GWh/a	0.575
		High-efficiency cogeneration	GWh/a	147.904
		Other technologies	GWh/a	118.679
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	40.629
		Other technologies	GWh/a	0.000

5.33. Szczecin

Table 68. Heating and cooling supply in Szczecin

Energy provided on-site		Szczecin City District	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	1 691.261
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	2.239
		Other technologies	GWh/a	25.776
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	5.955
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	22.582
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	0.000
		Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
		Other technologies	GWh/a	0.317
		High-efficiency cogeneration	GWh/a	0.000
	Renewables	Heat-only boilers	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	8.958
		Other technologies	GWh/a	28.237

Off-site		Szczecin City District	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	283.003
		Other technologies	GWh/a	258.617
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	257.778
		Other technologies	GWh/a	60.911
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	52.408
		Other technologies	GWh/a	47.892
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	47.737
		Other technologies	GWh/a	11.280
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	10.482
		Other technologies	GWh/a	9.578
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	9.547
		Other technologies	GWh/a	2.256
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	73.371
		Other technologies	GWh/a	67.049
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	66.831
		Other technologies	GWh/a	15.792

5.34. Zachodniopomorskie Province

Table 69. Heating and cooling supply in the Zachodniopomorskie Province

Energy provided on-site		ZACHODNIOPOMORSKIE	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	0.000
Residential sector	Fossil sources	Other technologies	GWh/a	6 615.221
Residential sector	Fossil sources	High-efficiency cogeneration	GWh/a	0.000
Residential sector	Renewables	Heat-only boilers	GWh/a	0.000
Residential sector	Renewables	High-efficiency cogeneration	GWh/a	0.000
Residential sector	Renewables	Heat pumps	GWh/a	2.541
Residential sector	Renewables	Other technologies	GWh/a	1 435.747
Service sector	Fossil sources	Heat-only boilers	GWh/a	0.000
Service sector	Fossil sources	Other technologies	GWh/a	131.710
Service sector	Fossil sources	High-efficiency cogeneration	GWh/a	0.000
Service sector	Renewables	Heat-only boilers	GWh/a	0.000
Service sector	Renewables	High-efficiency cogeneration	GWh/a	0.000
Service sector	Renewables	Heat pumps	GWh/a	0.000
Service sector	Renewables	Other technologies	GWh/a	638.329
Industry sector	Fossil sources	Heat-only boilers	GWh/a	0.000
Industry sector	Fossil sources	Other technologies	GWh/a	46.235
Industry sector	Fossil sources	High-efficiency cogeneration	GWh/a	0.000
Industry sector	Renewables	Heat-only boilers	GWh/a	0.000
Industry sector	Renewables	High-efficiency cogeneration	GWh/a	0.000
Industry sector	Renewables	Heat pumps	GWh/a	0.000
Industry sector	Renewables	Other technologies	GWh/a	0.000
Other sectors	Fossil sources	Heat-only boilers	GWh/a	0.000
Other sectors	Fossil sources	Other technologies	GWh/a	47.287
Other sectors	Fossil sources	High-efficiency cogeneration	GWh/a	0.000
Other sectors	Renewables	Heat-only boilers	GWh/a	0.000
Other sectors	Renewables	High-efficiency cogeneration	GWh/a	0.000
Other sectors	Renewables	Heat pumps	GWh/a	8.958
Other sectors	Renewables	Other technologies	GWh/a	28.531

Off-site		ZACHODNIOPOMORSKIE	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	496.932
		Other technologies	GWh/a	258.617
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	257.778
		Other technologies	GWh/a	60.911
Service sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	77.358
		Other technologies	GWh/a	47.892
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	47.737
		Other technologies	GWh/a	11.280
Industry sector	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	29.615
		Other technologies	GWh/a	9.578
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	9.547
		Other technologies	GWh/a	2.256
Other sectors	Fossil sources	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	106.206
		Other technologies	GWh/a	67.049
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	66.831
		Other technologies	GWh/a	15.792

5.35. Poland

Table 70. Heating and cooling supply in Poland

Energy provided on-site		POLAND	Unit	Value
Residential sector	Fossil sources	Heat-only boilers	GWh/a	838.297
		Other technologies	GWh/a	146 202.170
		High-efficiency cogeneration	GWh/a	47.595
	Renewables	Heat-only boilers	GWh/a	26.249
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	395.820
		Other technologies	GWh/a	15 381.934
Service sector	Fossil sources	Heat-only boilers	GWh/a	167.658
		Other technologies	GWh/a	2 737.296
		High-efficiency cogeneration	GWh/a	99.128
	Renewables	Heat-only boilers	GWh/a	5.249
		High-efficiency cogeneration	GWh/a	0.000
		Heat pumps	GWh/a	19.839
		Other technologies	GWh/a	1 891.354
Industry sector	Fossil sources	Heat-only boilers	GWh/a	204.659
		Other technologies	GWh/a	2 878.827
		High-efficiency cogeneration	GWh/a	3.765
	Renewables	Heat-only boilers	GWh/a	14.031
		High-efficiency cogeneration	GWh/a	56.656
		Heat pumps	GWh/a	9.838
		Other technologies	GWh/a	187.505
Other sectors	Fossil sources	Heat-only boilers	GWh/a	466.298
		Other technologies	GWh/a	2 058.158
		High-efficiency cogeneration	GWh/a	17.996
	Renewables	Heat-only boilers	GWh/a	0.512
		High-efficiency cogeneration	GWh/a	22.000
		Heat pumps	GWh/a	154.497
		Other technologies	GWh/a	298.014

Off-site		POLAND	Unit	Value
Residential sector	Fossil sources	Waste heat	GWh/a	1.941
		High-efficiency cogeneration	GWh/a	28 531.210
		Other technologies	GWh/a	10 911.572
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	1 421.814
		Other technologies	GWh/a	75.490
Service sector	Fossil sources	Waste heat	GWh/a	0.693
		High-efficiency cogeneration	GWh/a	4 270.662
		Other technologies	GWh/a	1 973.172
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	269.781
		Other technologies	GWh/a	15.167
Industry sector	Fossil sources	Waste heat	GWh/a	22.045
		High-efficiency cogeneration	GWh/a	2 516.454
		Other technologies	GWh/a	1 250.247
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	137.780
		Other technologies	GWh/a	4.816
Other sectors	Fossil sources	Waste heat	GWh/a	0.575
		High-efficiency cogeneration	GWh/a	5 145.498
		Other technologies	GWh/a	2 051.967
	Renewables	Waste heat	GWh/a	0.000
		High-efficiency cogeneration	GWh/a	303.150
		Other technologies	GWh/a	17.436

6. Transmission networks

Table 71. Boiler plants and district heating network by ownership form and location in 2019

Boiler plants and district heating network by ownership form and location in 2019						
	Total			In housing cooperatives		
Province	Total boiler plants	Length of the heat transmission and distribution network	Length of connections to buildings	Total boiler plants	Length of the heat transmission and distribution network	Length of connections to buildings
POLAND	33 858	16 381.2	8 869.4	1 742	262.7	243.9
DOLNOŚLĄSKIE	3 201	1 179.1	560.5	255	6.2	5.1
KUJAWSKO-POMORSKIE	2 049	1 026.3	434.7	127	21.2	14
LUBELSKIE	1 463	834.7	558.4	99	26.3	98.6
LUBUSKIE	1 448	371.1	144.5	67	0.7	5.9
ŁÓDZKIE	1 639	1 209	655	52	15.2	12
MAŁOPOLSKIE	2 520	1 427.3	608.4	167	21.3	10.7
MAZOWIECKIE	3 142	2 253.2	1 326.1	160	47.6	21.8
OPOLSKIE	1 203	454.3	252.7	42	0.4	1.3
PODKARPACKIE	2 171	673.6	415.9	89	17.5	11.1
PODLASKIE	854	543.4	291.9	22	5.5	4.7
POMORSKIE	1 837	1 199.4	699.6	51	6.5	5.9

ŚLĄSKIE	4 006	2 393	1 244	122	21.6	6.4
ŚWIĘTOKRZYSKIE	967	435.4	207.7	39	15.7	13.6
WARMIŃSKO-MAZURSKIE	1 359	629.2	374.6	78	39.8	13.9
WIELKOPOLSKIE	4 220	1 048.7	703.9	246	11.9	16.6
ZACHODNIOPOMORSKIE	1 779	703.5	391.5	126	5.3	2.3

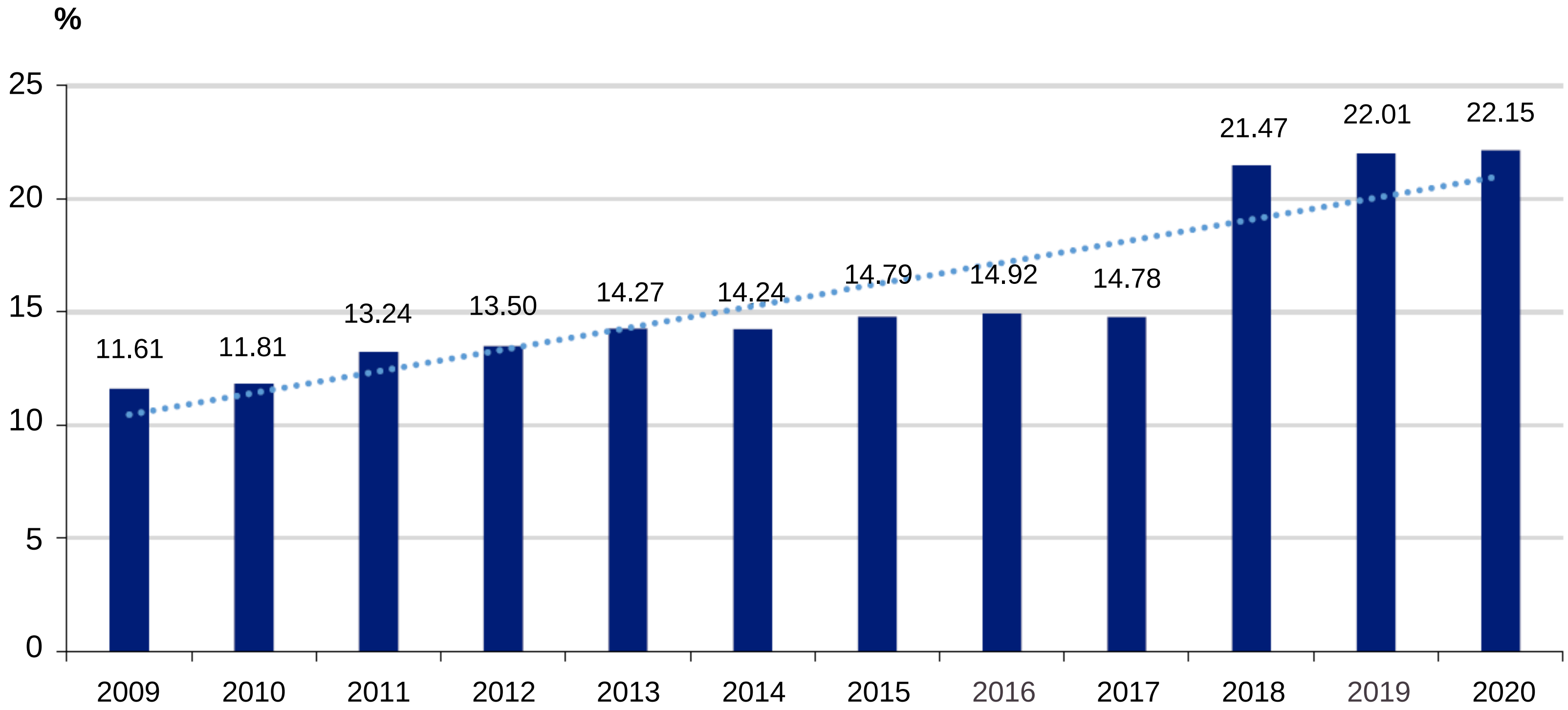
Source: Statistics Poland – Local Data Bank

At the end of 2019, the density of the district heating network in Poland was 8.1 km per 100 km2. The greatest density of the district heating network has been found for the following provinces: Śląskie (29.5 km per 100 km2), Małopolskie (13.4 km per 100 km2), Pomorskie (10.4 km per 100 km2), Łódzkie (10.2 km per 100 km2), and Mazowieckie (10.1 km per 100 km2), while the smallest for: Lubuskie (3.7 km per 100 km2), Podlaskie (4.1 km per 100 km2), Warmińsko-Mazurskie (4.2 km per 100 km2), and Zachodniopomorskie (4.8 km per 100 km2).

7. Share of energy from renewable sources in gross final consumption in heating and cooling

The share of renewable energy in gross final consumption of energy in heating and cooling increased by 0.15 pp relative to 2019. The rise stems from the less pronounceable decrease in the gross final renewable energy consumption for heating and cooling (by 1.21%) than the recorded decrease in the total gross final energy consumption for heating and cooling (by 1.86%).

Figure 1. Share of energy from renewable sources in gross final consumption in heating and cooling in 2020.



Source: Statistics Poland – Renewable Energy in 2020

8. Graphic visualisation mapping the data from the heating overview

The data presented in the heating and cooling overview is shown as a national map, available on the website: https://iip.ekoportal.gov.pl/.

9. Analysis of the economic potential related to heating and cooling

9.1. Assumptions

The cost-benefit analysis (CBA) was based on heat demand determined for individual territorial units (geographical boundaries), with breakdowns by sector, technology and fuel.

The values of the adopted indicators and economic-technological parameters (including unit capital expenditure (CAPEX), fixed and variable operating expenses (fixed OPEX, variable OPEX)) are presented in ANNEX 2 – SUMMARY OF ECONOMIC AND TECHNICAL ASSUMPTIONS ADOPTED IN THE COST-BENEFIT ANALYSIS.

9.2. Description of the methodology

The CBA involved the following steps:

1. Based on the heating and cooling overview, the current state was assessed with a breakdown by sector (residential, service, industry and other);
2. The classification with breakdowns by sector, type of generation (on-site, off-site), fuel (fossil, renewables), technology (heat-only boilers, high-efficiency cogeneration, heat pumps, other), was attributed technologies that can be deployed, i.e. (i) cogeneration using natural gas, biogas[2], solid biomass, coal as fuel; (ii) heat-only boilers using natural gas, coal, heating oil, biomass; (iii) heat pumps[3]. The attribution is intended to take account of the technical limitations in applying the technologies and the availability of fuel.
3. Waste incineration technology was taken into account at the heating demand overview stage (so it is included in the baseline scenario). Given the expected lack of development of the technology, only existing installations and those planned in the near future are taken into account:

[2] Agricultural, wastewater treatment, landfill biogas.

[3] For example, cogeneration involving agricultural biogas cannot be taken into account in the service sector.

- Zakład Unieszkodliwiania Odpadów Komunalnych w Białymstoku, ul. Generała Władysława Andersa 40F, capacity: 6.08 MWe and 17.5 MWt
- Zakład Unieszkodliwiania Odpadów Komunalnych Bydgoszcz, ul. Ernsta Petersona 22, capacity: 27.7 MWt and 9.2 MWe
- Instalacja Termicznego Przekształcania Odpadów w Olsztynie (to be completed in 2023), ul. Mariana Bublewicza 6, capacity: 28 MWt and 10 MWe
- Instalacja Termicznego Przekształcania Odpadów Komunalnych w Poznaniu, ul. Energetyczna 5, capacity: 1.4 MWe and 9.1 MWt
- Zakład Termicznego Przekształcania Odpadów w Koninie, ul. Sulańska 11, capacity: 15.5 MWt and 4.4 MWe
- Zakład Termicznego Przekształcania Odpadów w Krakowie, ul. Jerzego Giedroycia 23, cogeneration capacity: 10.7 MWe and 35 MWt
- Zakład Unieszkodliwiania Stałych Odpadów Komunalnych (planned), ul. Zabranieckiej 2, capacity: 1.4 MWe and 9.1 MWt
- Zakład Termicznego Unieszkodliwiania Odpadów Szczecin, ul. Logistyczna 22, capacity: 32 MWt and 9.4 MWe
- Instalacja Termicznego Przetwarzania z Odzyskiem Energii Rzeszów, ul. Ciepłownicza, capacity: 16.5 MWt and 4.6 MWe
- Zakład Utylizacji Odpadów Katowice, Hutnicza 8, capacity:
- Instalacja Termicznego Przekształcania Odpadów Łódź, ul. Jadzi Andrzejewskiej 5, capacity: 50 MWt and 24.5 MWe (planned)

4. For the purposes of the calculations for the alternative scenarios, an objective function that was a graphical representation of the fuel mix search criterion was defined. Depending on the scenario, the function graphs NPVs[4] and is maximised or is the sum of CO_2 emissions and represents the criterion of the greatest possible emission reductions. The NPV is calculated for each analysed area, for the years 2020-2050, in 1-year steps. For each year, cash flows comprising costs and revenues are calculated. The following items are included in the cost category: CAPEX[5], fixed and variable OPEX, costs of fuels, costs of CO_2 quotas. The revenue side comprises revenues from selling heat and electricity. Assumptions for the baseline and alternative scenarios were defined. The alternative scenarios include economic, environmental and moderate scenarios.

[4] a discount rate of 5% is adopted. This is consistent with the recommended social discount rate. (European Commission, 2019. COMMISSION RECOMMENDATION (EU) 2019/1659 of 25 September 2019 on the content of the comprehensive assessment of the potential for efficient heating and cooling under article 14 of Directive 2012/27/EU, p. 114).

[5] The financing of investments with a loan repayable over 10 years was assumed.

5. For the classification chart (4 – CLASSIFICATION OF THE TECHNOLOGY SOLUTIONS ANALYSED IN THE CBA), constraints in terms of the use of respective types of technology and/or fuels were attributed taking into account the assumptions made for the analysed scenarios[6].
6. The calculations were carried out.
7. A sensitivity analysis was performed for selected values (the scope is presented in Annex 3).
8. Presentation of results

Baseline scenario of the fuel and energy mix identified for 2020. A linear programming method implemented in an Excel spreadsheet (Solver add-in) was used to identify the technology and fuel mix.

The method considers the following:

- Technologies:
    1. gas turbine, natural gas, CHP,
    2. agricultural biogas, CHP
    3. wastewater treatment biogas, CHP
    4. landfill biogas, CHP
    5. solid biomass, CHP
    6. hard coal, CHP
    7. district heating boiler, coal
    8. district heating boiler, natural gas
    9. boiler, fuel oil,
    10. district heating boiler, biomass and other renewables (collectors, geothermal energy),
    11. heat pumps, electricity,
    12. waste heat;
- 4 sectors (residential, industry, services, other),
- 3 periods designated 2020; 2035; 2050.

The linear programming method consists of an objective function (OF) and constraints. The objective function has two forms:

1. Balance of cash flows in 2020-2050, expressed as the NPV. The FC is maximised, used in alternative scenarios S1, S3;
2. Total CO_2 emissions maximisation employed in alternative scenario S2.

[6] It must be emphasised that the attribution is non-binding in nature and does not determine the final outcome in each case. The solution to the problem is obtained by maximisation of the objective function. Constraints relate to borderline cases.

Constraints:

1. A balancing constraint, which requires that the demand for heat in a given sector and period be satisfied.
2. A constraint on the maximum shares of the respective technologies (see Table 105 and

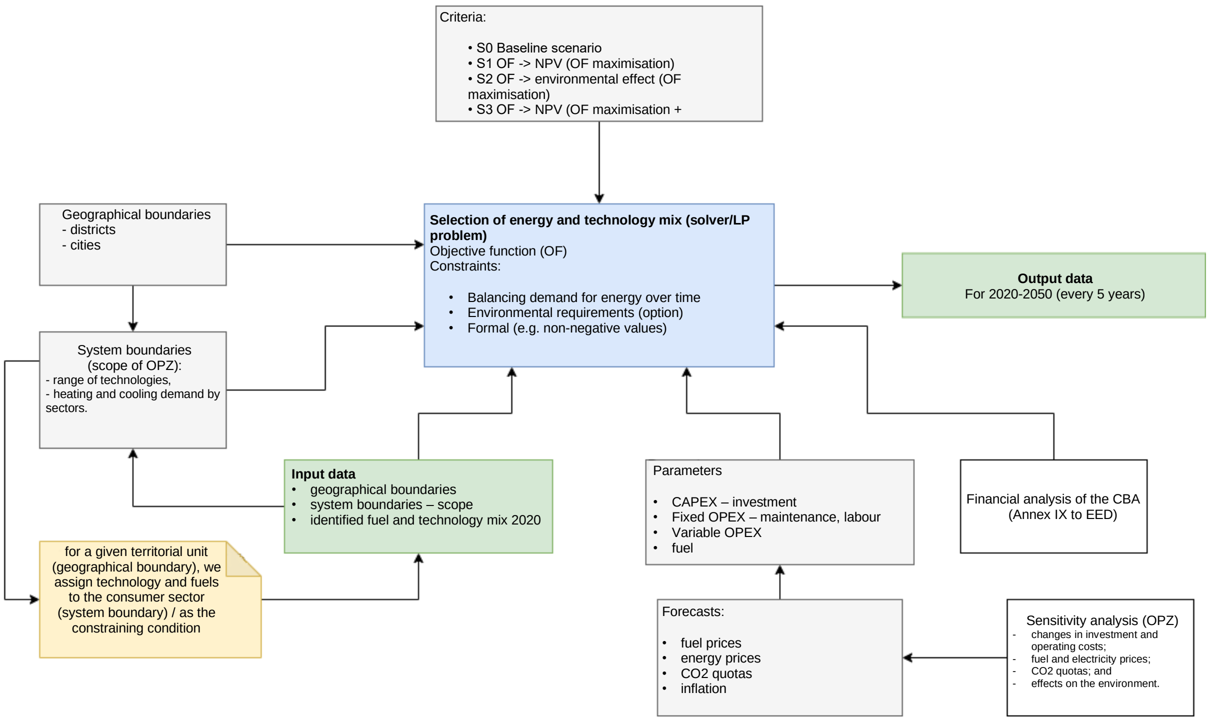
3. Table 106 and Table 108) in the sector and period examined.

4. A formal constraint, the values of decision variables, heat power demand, cannot be negative.

The decision variables that are the solution to the formulated problem mean the demand for heat power in a given period and a given technology, the summative value of which (the sum of heat power available from the individual technologies) is to satisfy the demand over a given period.

The method is show in the flowchart below (Figure 2).

Figure 2. Cost-benefit analysis flowchart



<u>Objective function</u>

Objective function for alternative scenarios, S1 – economic scenario, S2 – environmental scenario and S3 – moderate transition scenario. The moderate transition scenario describes financial flows in the individual periods.

<u>The cost category comprises:</u>

1. CAPEX,

2. Fixed costs,

3. Variable costs (excluding fuel and CO_2 quotas),

4. Fuel costs,

5. Costs of CO_2 quotas.

The revenue category comprises:

1. Revenues from selling heat or cold,

2. For cogeneration technologies – revenues from selling electricity and heat or cold.

The solution to the optimisation problem is a fuel-technology mix that satisfies the conditions specified in the constraints.

9.3. Description of scenarios

The following scenarios are considered in the analysis:

1. Baseline scenario (S0)

1) This scenario identifies the current situation. Environmental requirements are not taken into account, transition in the sector is not enforced through restrictions and criteria regarding CO_2 emissions. The future fuel mix is determined by the economic environment. There are no restrictions on the development of specific decarbonisation technologies.
2) It is assumed that the existing infrastructure will be maintained until 2050, with capital expenditure on infrastructure refurbishment assumed at 50% of the CAPEX for a given technology.
3) It is assumed that the demand for primary energy will fall as a result of the pre-insulation of district heating networks (7.5 percent over 15 years).

2. Alternative scenarios:

1) Economic scenario (S1) – Use of the NPV criterion

2.1.1. The scenario illustrates the economic criterion, the estimated investments are

to translate into the best financial result.

2.1.2. It is assumed that the demand for primary energy will be reduced through

the pre-insulation of district heating networks (7.5 percent over 15 years).

Analysis of the objective – Achieving the lowest heat prices and the lowest capital expenditures

Strengths	Weaknesses
S1. Lowest CAPEX; S2. Lower heat price for consumers; S3. Utilisation and development of current supply logistics systems; S4. Greater share of proven technology and known suppliers; S5. Possibility to use the existing infrastructure with no need for major relocation of installations.	W1. Self-financing of investments not possible; W2. Negative NPV of investments; W3. Non-compliance with requirements applicable to installations; W4. High CAPEX on filtration systems; W5. High emission fees.
Opportunities	**Threats**
O1. Incentive for new consumers to connect on account of the low price of heat; O2. Partial decarbonisation of the sector; O3. Maintaining stable employment in the sector; O4. Fewer failures on account of lower risk of design-, construction- and operation-stage errors with a greater share of known technologies; O5. Possibility to implement some projects on the basis of public-private partnership.	T1. Funding limited due to the Green Deal and the applicable ESG requirements (CSRD); T2. Deterioration of the environment; T3. Low level of supply diversification and energy security; T4. Legislative revisions towards a stricter decarbonisation regime; T5. Impact of factors beyond the company's control – change in prices of fuels (coal, gas fuel).

Impact matrix

	O1	O2	O3	O4	O5		T1	T2	T3	T4	T5
S1	2	2	0	1	1		1	0	1	0	0
S2	2	2	0	2	1		1	0	1	0	0
S3	0	2	2	2	0		0	0	2	0	1
S4	0	0	2	2	0		0	0	1	1	1
S5	0	1	2	2	0		0	0	1	1	1
W1	1	0	0	1	2		2	2	2	2	2
W2	1	2	2	1	2		2	0	1	2	2
W3	1	1	1	2	1		2	2	2	2	2
W4	1	2	1	2	1		2	2	0	2	1
W5	1	2	1	1	0		2	2	1	2	2

0 – no impact, 1 – weak impact, 2 – strong impact

Quadrant 1 – will the strength allow for opportunities to be exploited?
Quadrant 2 – does the strength overcome the threat?
Quadrant 3 – does the opportunity overcome the weakness?
Quadrant 4 – does the threat amplify the weakness?

Strategy impact results	
28 – aggressive	13 – conservative
30 – competitive	**43 – defensive**

3. Environmental scenario (S2) – Use of the environmental effect maximisation criterion
   1) The scenario assumes the pursuit of decarbonisation, which involves the reduction of coal consumption over the years. The CO_2 emissions minimisation criterion reflects the pursuit of climate neutrality.
   2) It is assumed that the demand for primary energy will fall as a result of the pre-insulation of district heating networks (7.5 percent over 15 years).

Analysis of the objective – Maximum decarbonisation of the sector

Strengths	Weaknesses
S1. Lower expenditure on the purchase of emission quotas; S2. Significant reduction of pollutant emissions; S3. Diversification of supplies; S4. Building a positive image; S5. Reduction of direct nuisance for heat consumers – improved air quality; S6. Better use of the human resources potential through improvement of qualifications; S7. New production area – electricity and related additional revenues.	W1. High level of capital expenditure; W2. Difficulty in obtaining fuel (limited amount); W3. Need to create a new fuel sourcing system and change contractors; W4. Negative NPV of investments; W5. Self-financing of investments not possible; W6. Long-term investment period; W7. In the case of geothermal sources, wastewater treatment biogas, waste heat – need to build new network infrastructure due to dependence on the location of the source.
Opportunities	**Threats**
O1. Lower health care spending; O2. Alignment with EU's energy policy; O3. New jobs, e.g. in connection with local fuel sourcing and construction of new installations; O4. Incentive for new consumers to connect given the environmentally friendly nature of the solution; O5. Potential for deriving additional revenue from the sale of energy certificates of origin; O6. Possibility to implement some projects on the basis of public-private partnership and a greater opportunity to obtain funding in the face of ESG legislation; O7. Increasing the share of electricity from renewable sources in the national energy mix.	T1. Delays in implementation due to high investment costs; T2. Degradation of soil and water due to increased biomass harvesting; T3. A growing number of entities using a similar fuel mix and deteriorating availability of resources; T4. New technologies – risk of errors at the design and construction stages; T5. Frequent amendments to RES and energy transition legislation; T6. Possible errors at the operation stage – need to train staff; T7. Changes in RES and cogeneration support schemes.

Impact matrix

	O1	O2	O3	O4	O5	O6	O7		T1	T2	T3	T4	T5	T6	T7
S1	1	2	2	1	2	1	2		1	0	0	1	0	1	1
S2	2	2	2	2	2	2	2		1	1	0	0	0	0	0
S3	0	1	2	1	1	2	2		2	1	2	0	0	0	1
S4	2	2	2	2	1	2	1		0	0	0	0	0	0	0
S5	2	2	0	2	1	2	0		0	1	0	0	0	0	0
S6	0	1	2	1	1	2	0		1	0	1	1	0	1	0
S7	1	2	2	2	2	2	2		1	0	0	0	0	0	0
W1	1	2	0	2	2	2	0		2	1	2	2	1	2	1
W2	0	0	2	1	0	0	0		0	2	2	0	2	1	2
W3	0	0	2	0	2	2	1		1	2	2	1	1	2	1
W4	1	1	0	2	2	2	1		2	0	0	2	2	1	2
W5	1	0	0	2	2	2	1		2	0	1	2	2	0	2
W6	0	1	1	0	1	2	0		2	0	0	2	2	0	2
W7	0	2	2	2	2	2	2		2	0	1	2	2	2	2

0 – no impact, 1 – weak impact, 2 – strong impact

Quadrant 1 – will the strength allow for opportunities to be exploited?

Quadrant 2 – does the strength overcome the threat?

Quadrant 3 – does the opportunity overcome the weakness?

Quadrant 4 – does the threat amplify the weakness?

Strategy impact results	
75 – aggressive	18 – conservative
53 – competitive	67 – defensive

4. Moderate transition scenario (S3)

    1) The scenario incorporates intermediate assumptions between the economic and environmental scenarios.
    2) NPV maximisation is the criterion for solving the problem.
    3) Lesser constraints on fossil fuels are applied (cf. Table 108)

Analysis of the objective – transformation assuming a slower transition to renewable energy technologies

Strengths	**Weaknesses**
S1. Greater share of proven technologies and known suppliers; S2. Relatively moderate capital expenditures; S3. Possibility to use the existing infrastructure with no need to relocate installations, focus on network development through the connection of new consumers; S4. Utilisation and development of current supply logistics systems; S5. Maintaining the level of employment and similar personnel costs (less need to employ specialists in new technologies); S6. Longer operation of existing installations; S7. Moderate investment risk.	W1. High price of heat; W2. Lowest decarbonisation level of all the scenarios; W3. Self-financing of investments not possible; W4. Non-compliance with requirements applicable to installations; W5. High CAPEX on filtration systems; W6. High emission fees; W7. Negative NPV of investments;
Opportunities	**Threats**
O1. Maintaining stable employment in the sector; O2. Fewest potential errors at the operation stage since the technology is known; O3. Lowest risk of failure on account of fewer potential design- and construction-stage errors with a greater share of known technologies; O4. Possibility to implement some projects on the basis of public-private partnership. O5. Greater access to the resources to be phased out in Europe; O6. Partial decarbonisation of the sector; O7. Less nuisance for the region as a result of the construction of installations in new locations.	T1. Funding limited due to the Green Deal and the applicable ESG requirements (CSRD); T2. No diversification of supplies and energy security; T3. Deterioration of the environment; T4. Legislative revisions towards a stricter decarbonisation regime; T5. Impact of factors beyond the company's control – change in prices of fuels (coal, gas fuel). T6. Highest risk of company insolvency; T7. Risk of losing reputation and trust of consumers.

Impact matrix

	O1	O2	O3	O4	O5	O6	O7		T1	T2	T3	T4	T5	T6	T7
S1	2	2	2	0	1	0	2		0	0	0	0	1	0	0
S2	0	1	1	1	0	0	0		1	1	0	0	1	1	0
S3	2	2	2	0	2	1	2		1	1	0	0	0	1	0
S4	2	2	2	0	2	0	1		0	1	0	0	0	0	0
S5	2	2	2	0	0	0	1		0	0	0	0	0	2	1
S6	2	2	2	0	1	0	2		1	2	0	0	0	2	0
S7	1	1	2	0	1	1	0		0	1	0	1	1	1	0
W1	0	1	1	1	0	2	2		2	2	2	2	2	2	2
W2	1	1	1	0	2	2	1		2	2	2	2	2	2	2
W3	1	2	2	1	1	0	1		2	1	0	2	2	2	2
W4	0	1	1	0	2	2	1		2	2	2	2	1	2	2
W5	0	0	0	0	2	0	2		2	0	2	2	0	2	0
W6	0	0	0	0	2	0	2		2	0	2	2	2	2	1
W7	1	2	2	1	1	1	1		2	0	0	2	2	2	2

0 – no impact, 1 – weak impact, 2 – strong impact

Quadrant 1 – will the strength allow for opportunities to be exploited?

Quadrant 2 – does the strength overcome the threat?

Quadrant 3 – does the opportunity overcome the weakness?

Quadrant 4 – does the threat amplify the weakness?

Strategy impact results	
54 – aggressive	21 – conservative
47 – competitive	**81 – defensive**

9.4. Sensitivity analysis

Sensitivity analysis aims to assess the impact of selected parameters on the final outcomes. The parameters analysed and the scope of their changes are presented in Annex 3. The convention of the sensitivity analysis assumes 3 variants of changes. V1 – decrease, V2 – parameters unchanged, V3 – increase of parameters. In each variant, the parameters are treated as a set and are recalculated jointly in the same manner as with the calculation of the outcomes for the individual scenarios (the same calculations with changed parameters are repeated iteratively).

The outcomes of the sensitivity analysis are presented as an annex to this document (Poland) (Table 111).

9.5. Summary of scenario outcomes

Table 71. Summary of scenario outcomes for Poland

POLAND		2020-2050	2020	2035	2050
Average capex					
S0 – baseline scenario	PLN thousand	80 098 737.38			
S1 – economic scenario		67 101 693.45			
S2 – environmental scenario		98 661 983.24			
S3 – moderate transition scenario		76 281 502.70			
Average NPV					
S0 – baseline scenario	PLN thousand	-364 174 739.47			
S1 – economic scenario		-270 169 294.28			
S2 – environmental scenario		-311 339 727.78			
S3 – moderate transition scenario		-297 161 072.99			
Average RES share					
S0 – baseline scenario	%		8.88%	8.88%	8.88%
S1 – economic scenario			8.88%	57.49%	57.49%
S2 – environmental scenario			8.88%	73.08%	73.08%
S3 – moderate transition scenario			8.88%	55.81%	55.81%
Average annual CO_2 emissions					
S0 – baseline scenario	thousand tonnes		39 228.07	34 413.44	33 009.17
S1 – economic scenario			39 228.07	7 443.93	6 882.43
S2 – environmental scenario			39 228.07	4 242.64	3 926.97
S3 – moderate transition scenario			39 228.07	7 704.86	7 125.95
Average heat generation price					
S0 – baseline scenario	PLN/GJ		116.06	261.05	231.41
S1 – economic scenario			116.06	158.79	110.39
S2 – environmental scenario			116.06	194.04	123.06
S3 – moderate transition scenario			116.06	189.06	133.38
Average heat generation					
S0 – baseline scenario	GWh		15 228.00	13 347.01	12 770.35
S1 – economic scenario			15 228.00	13 347.01	12 770.35
S2 – environmental scenario			15 228.00	13 347.01	12 770.35
S3 – moderate transition scenario			15 228.00	13 347.01	12 770.35
Average primary energy consumption					
S0 – baseline scenario	TJ		138 131.06	120 999.11	115 670.75
S1 – economic scenario			138 131.06	75 341.92	69 662.90
S2 – environmental scenario			138 131.06	90 947.03	84 130.31
S3 – moderate transition scenario			138 131.06	86 065.40	79 612.48

Table 72. Summary of scenario outcomes for the Dolnośląskie Province

DOLNOŚLĄSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		4 211 505.29			
S1 – economic scenario		3 567 240.88			
S2 – environmental scenario		5 246 431.17			
S3 – moderate transition scenario		4 059 514.44			
Average NPV	PLN thousand				
S0 – baseline scenario		-20 928 906.01			
S1 – economic scenario		-15 225 737.25			
S2 – environmental scenario		-17 521 758.58			
S3 – moderate transition scenario		-16 753 023.01			
Average RES share	%				
S0 – baseline scenario			10.99%	10.99%	10.99%
S1 – economic scenario			10.99%	56.92%	56.92%
S2 – environmental scenario			10.99%	71.84%	71.84%
S3 – moderate transition scenario			10.99%	54.90%	54.90%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			2 248.48	1 981.83	1 919.38
S1 – economic scenario			2 248.48	404.05	373.26
S2 – environmental scenario			2 248.48	242.35	224.66
S3 – moderate transition scenario			2 248.48	424.02	392.04
Average heat generation price	PLN/GJ				
S0 – baseline scenario			122.52	275.61	244.05
S1 – economic scenario			122.52	160.80	111.27
S2 – environmental scenario			122.52	198.26	125.80
S3 – moderate transition scenario			122.52	192.92	135.76
Average heat generation	GWh				
S0 – baseline scenario			800.54	706.19	684.78
S1 – economic scenario			800.54	706.19	684.78
S2 – environmental scenario			800.54	706.19	684.78
S3 – moderate transition scenario			800.54	706.19	684.78
Average primary energy consumption	TJ				
S0 – baseline scenario			7 516.62	6 623.24	6 411.47
S1 – economic scenario			7 516.62	4 031.73	3 719.20
S2 – environmental scenario			7 516.62	4 909.02	4 530.89
S3 – moderate transition scenario			7 516.62	4 642.82	4 285.06

Table 73. Summary of scenario outcomes for the Kujawsko-Pomorskie Province

KUJAWSKO-POMORSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		4 949 275.90			
S1 – economic scenario		3 790 382.36			

S2 – environmental scenario		5 571 264.34			
S3 – moderate transition scenario		4 303 122.79			
Average NPV	PLN thousand				
S0 – baseline scenario		-23 735 077.37			
S1 – economic scenario		-16 801 402.25			
S2 – environmental scenario		-18 985 546.91			
S3 – moderate transition scenario		-18 202 710.04			
Average RES share	%				
S0 – baseline scenario			10.94%	10.94%	10.94%
S1 – economic scenario			10.94%	58.86%	58.86%
S2 – environmental scenario			10.94%	76.22%	76.22%
S3 – moderate transition scenario			10.94%	58.15%	58.15%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			2 473.35	2 156.36	2 041.27
S1 – economic scenario			2 473.3	400.76	373.38
S2 – environmental scenario			2 473.3	207.89	194.01
S3 – moderate transition scenario			2 473.35	406.99	379.32
Average heat generation price	PLN/GJ				
S0 – baseline scenario			128.33	288.38	259.26
S1 – economic scenario			128.33	155.03	108.59
S2 – environmental scenario			128.33	185.24	116.76
S3 – moderate transition scenario			128.33	180.95	127.85
Average heat generation	GWh				
S0 – baseline scenario			869.32	757.59	716.70
S1 – economic scenario			869.32	757.59	716.70
S2 – environmental scenario			869.32	757.59	716.70
S3 – moderate transition scenario			869.32	757.59	716.70
Average primary energy consumption	TJ				
S0 – baseline scenario			8 530.42	7 432.19	7 028.50
S1 – economic scenario			8 530.42	4 221.80	3 931.22
S2 – environmental scenario			8 530.42	5 040.42	4 694.42
S3 – moderate transition scenario			8 530.42	4 772.77	4 445.09

Table 74. Summary of scenario outcomes for the Lubelskie Province

LUBELSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		2 762 413.01			
S1 – economic scenario		2 184 065.12			
S2 – environmental scenario		3 209 870.52			
S3 – moderate transition scenario		2 480 257.05			
Average NPV	PLN thousand				
S0 – baseline scenario		-14 856 198.12			
S1 – economic scenario		-10 333 902.22			
S2 – environmental scenario		-11 625 336.51			
S3 – moderate transition scenario		-11 169 877.10			
Average RES share	%				
S0 – baseline scenario			10.41%	10.41%	10.41%
S1 – economic scenario			10.41%	58.46%	58.46%
S2 – environmental scenario			10.41%	75.40%	75.40%
S3 – moderate transition scenario			10.41%	57.54%	57.54%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			1 564.27	1 361.78	1 290.70
S1 – economic scenario			1 564.27	235.00	217.70
S2 – environmental scenario			1 564.27	126.32	117.18
S3 – moderate transition scenario			1 564.27	240.21	222.60
Average heat generation price	PLN/GJ				
S0 – baseline scenario			134.88	303.26	273.90
S1 – economic scenario			134.88	156.31	109.36
S2 – environmental scenario			134.88	188.09	118.86
S3 – moderate transition scenario			134.88	183.56	129.74
Average heat generation	GWh				
S0 – baseline scenario			500.10	435.47	412.88
S1 – economic scenario			500.10	435.47	412.88
S2 – environmental scenario			500.10	435.47	412.88
S3 – moderate transition scenario			500.10	435.47	412.88
Average primary energy consumption	TJ				
S0 – baseline scenario			5 053.38	4 399.25	4 169.63
S1 – economic scenario			5 053.38	2 440.39	2 259.76
S2 – environmental scenario			5 053.38	2 926.85	2 710.68
S3 – moderate transition scenario			5 053.38	2 770.65	2 565.99

Table 75. Summary of scenario outcomes for the Lubuskie Province

LUBUSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		1 207 875.36			
S1 – economic scenario		1 124 318.98			
S2 – environmental scenario		1 653 006.22			
S3 – moderate transition scenario		1 277 148.82			
Average NPV	PLN thousand				
S0 – baseline scenario		-6 255 081.49			
S1 – economic scenario		-4 577 571.65			
S2 – environmental scenario		-5 239 022.06			
S3 – moderate transition scenario		-5 005 008.15			
Average RES share	%				
S0 – baseline scenario			9.35%	9.35%	9.35%
S1 – economic scenario			9.35%	58.34%	58.34%
S2 – environmental scenario			9.35%	74.98%	74.98%
S3 – moderate transition scenario			9.35%	57.23%	57.23%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			696.24	618.37	593.40
S1 – economic scenario			696.24	120.27	113.02
S2 – environmental scenario			696.24	64.26	60.51
S3 – moderate transition scenario			696.24	123.01	115.65
Average heat generation price	PLN/GJ				
S0 – baseline scenario			118.81	267.57	240.76
S1 – economic scenario			118.81	156.49	108.97
S2 – environmental scenario			118.81	188.56	118.81
S3 – moderate transition scenario			118.81	184.00	129.56
Average heat generation	GWh				
S0 – baseline scenario			252.57	224.38	215.37
S1 – economic scenario			252.57	224.38	215.37
S2 – environmental scenario			252.57	224.38	215.37
S3 – moderate transition scenario			252.57	224.38	215.37
Average primary energy consumption	TJ				
S0 – baseline scenario			2 253.46	2 001.43	1 920.62
S1 – economic scenario			2 253.46	1 255.68	1 179.22
S2 – environmental scenario			2 253.46	1 504.49	1 413.24
S3 – moderate transition scenario			2 253.46	1 424.29	1 337.89

Table 76. Summary of scenario outcomes for the Łódzkie Province

ŁÓDZKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		5 585 136.12			
S1 – economic scenario		4 296 596.68			
S2 – environmental scenario		6 316 624.14			
S3 – moderate transition scenario		4 884 287.66			
Average NPV	PLN thousand				
S0 – baseline scenario		-24 250 868.79			
S1 – economic scenario		-17 684 211.22			
S2 – environmental scenario		-20 339 286.90			
S3 – moderate transition scenario		-19 428 056.23			
Average RES share	%				
S0 – baseline scenario			9.63%	9.63%	9.63%
S1 – economic scenario			9.63%	57.25%	57.25%
S2 – environmental scenario			9.63%	72.71%	72.71%
S3 – moderate transition scenario			9.63%	55.54%	55.54%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			2 506.60	2 218.68	2 149.84
S1 – economic scenario			2 506.60	474.84	443.04
S2 – environmental scenario			2 506.60	270.64	252.75
S3 – moderate transition scenario			2 506.60	492.01	459.19
Average heat generation price	PLN/GJ				
S0 – baseline scenario			120.77	271.24	237.43
S1 – economic scenario			120.77	160.01	110.56
S2 – environmental scenario			120.77	196.42	124.07
S3 – moderate transition scenario			120.77	191.23	134.18
Average heat generation	GWh				
S0 – baseline scenario			964.93	853.52	826.15
S1 – economic scenario			964.93	853.52	826.15
S2 – environmental scenario			964.93	853.52	826.15
S3 – moderate transition scenario			964.93	853.52	826.15
Average primary energy consumption	TJ				
S0 – baseline scenario			9 130.83	8 072.02	7 806.84
S1 – economic scenario			9 130.83	4 828.86	4 504.36
S2 – environmental scenario			9 130.83	5 836.65	5 445.07
S3 – moderate transition scenario			9 130.83	5 522.57	5 152.03

Table 77. Summary of scenario outcomes for the Małopolskie Province

MAŁOPOLSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		6 658 919.16			
S1 – economic scenario		5 114 220.66			
S2 – environmental scenario		7 519 056.58			
S3 – moderate transition scenario		5 814 433.64			
Average NPV	PLN thousand				
S0 – baseline scenario		-32 179 323.38			
S1 – economic scenario		-22 809 760.11			
S2 – environmental scenario		-25 982 674.50			
S3 – moderate transition scenario		-24 896 366.75			
Average RES share	%				
S0 – baseline scenario			11.12%	11.12%	11.12%
S1 – economic scenario			11.12%	57.50%	57.50%
S2 – environmental scenario			11.12%	73.14%	73.14%
S3 – moderate transition scenario			11.12%	55.87%	55.87%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			3 331.99	2 935.84	2 833.96
S1 – economic scenario			3 331.99	566.49	526.72
S2 – environmental scenario			3 331.99	324.55	302.42
S3 – moderate transition scenario			3 331.99	587.76	546.79
Average heat generation price	PLN/GJ				
S0 – baseline scenario			128.93	289.68	256.35
S1 – economic scenario			128.93	159.07	110.33
S2 – environmental scenario			128.93	194.35	122.96
S3 – moderate transition scenario			128.93	189.32	133.24
Average heat generation	GWh				
S0 – baseline scenario			1 152.67	1 015.63	980.38
S1 – economic scenario			1 152.67	1 015.63	980.38
S2 – environmental scenario			1 152.67	1 015.63	980.38
S3 – moderate transition scenario			1 152.67	1 015.63	980.38
Average primary energy consumption	TJ				
S0 – baseline scenario			11 411.54	10 049.41	9 692.53
S1 – economic scenario			11 411.54	5 750.92	5 342.92
S2 – environmental scenario			11 411.54	6 956.03	6 464.50
S3 – moderate transition scenario			11 411.54	6 581.44	6 116.26

Table 78. Summary of scenario outcomes for the Mazowieckie Province

MAZOWIECKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		14 561 892.16			
S1 – economic scenario		17 334 904.98			
S2 – environmental scenario		25 481 349.11			
S3 – moderate transition scenario		19 692 764.01			
Average NPV	PLN thousand				
S0 – baseline scenario		-65 108 529.88			
S1 – economic scenario		-55 179 457.16			
S2 – environmental scenario		-65 545 378.10			
S3 – moderate transition scenario		-61 915 005.12			
Average RES share	%				
S0 – baseline scenario			2.96%	2.96%	2.96%
S1 – economic scenario			2.96%	57.39%	57.39%
S2 – environmental scenario			2.96%	73.03%	73.03%
S3 – moderate transition scenario			2.96%	55.77%	55.77%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			8 325.74	7 311.15	6 991.44
S1 – economic scenario			8 325.74	1 876.56	1 748.22
S2 – environmental scenario			8 325.74	1 024.52	955.46
S3 – moderate transition scenario			8 325.74	1 925.94	1 794.72
Average heat generation price	PLN/GJ				
S0 – baseline scenario			89.71	202.78	181.92
S1 – economic scenario			89.71	159.59	110.36
S2 – environmental scenario			89.71	195.48	123.41
S3 – moderate transition scenario			89.71	190.36	133.60
Average heat generation	GWh				
S0 – baseline scenario			3 932.50	3 453.56	3 304.07
S1 – economic scenario			3 932.50	3 453.56	3 304.07
S2 – environmental scenario			3 932.50	3 453.56	3 304.07
S3 – moderate transition scenario			3 932.50	3 453.56	3 304.07
Average primary energy consumption	TJ				
S0 – baseline scenario			28 350.21	24 882.62	23 775.76
S1 – economic scenario			28 350.21	19 398.55	18 066.39
S2 – environmental scenario			28 350.21	23 310.50	21 712.55
S3 – moderate transition scenario			28 350.21	22 063.94	20 551.28

Table 79. Summary of scenario outcomes for the Opolskie Province

OPOLSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		696 167.99			
S1 – economic scenario		946 681.27			
S2 – environmental scenario		1 391 141.84			
S3 – moderate transition scenario		1 076 047.80			
Average NPV	PLN thousand				
S0 – baseline scenario		-3 358 960.57			
S1 – economic scenario		-2 950 802.81			
S2 – environmental scenario		-3 546 721.67			
S3 – moderate transition scenario		-3 344 492.89			
Average RES share	%				
S0 – baseline scenario			7.81%	7.81%	7.81%
S1 – economic scenario			7.81%	56.54%	56.54%
S2 – environmental scenario			7.81%	71.31%	71.31%
S3 – moderate transition scenario			7.81%	54.49%	54.49%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			453.78	395.75	379.13
S1 – economic scenario			453.78	106.22	97.86
S2 – environmental scenario			453.78	61.88	57.06
S3 – moderate transition scenario			453.78	110.35	101.70
Average heat generation price	PLN/GJ				
S0 – baseline scenario			87.87	198.86	178.70
S1 – economic scenario			87.87	162.47	112.11
S2 – environmental scenario			87.87	201.89	128.07
S3 – moderate transition scenario			87.87	196.25	137.82
Average heat generation	GWh				
S0 – baseline scenario			214.52	187.62	180.47
S1 – economic scenario			214.52	187.62	180.47
S2 – environmental scenario			214.52	187.62	180.47
S3 – moderate transition scenario			214.52	187.62	180.47
Average primary energy consumption	TJ				
S0 – baseline scenario			1 475.79	1 287.14	1 233.19
S1 – economic scenario			1 475.79	1 066.36	982.37
S2 – environmental scenario			1 475.79	1 293.39	1 191.64
S3 – moderate transition scenario			1 475.79	1 223.52	1 127.26

Table 80. Summary of scenario outcomes for the Podkarpackie Province

PODKARPACKIE		2020-2050	2020	2035	2050
Average capex					
S0 – baseline scenario	PLN thousand	2 400 847.44			
S1 – economic scenario		1 922 023.88			
S2 – environmental scenario		2 821 647.18			
S3 – moderate transition scenario		2 185 254.04			
Average NPV					
S0 – baseline scenario	PLN thousand	-12 079 960.42			
S1 – economic scenario		-8 689 178.85			
S2 – environmental scenario		-9 984 185.49			
S3 – moderate transition scenario		-9 562 269.81			
Average RES share	%				
S0 – baseline scenario			19.24%	19.24%	19.24%
S1 – economic scenario			19.24%	54.42%	54.42%
S2 – environmental scenario			19.24%	66.88%	66.88%
S3 – moderate transition scenario			19.24%	51.18%	51.18%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			1 271.75	1 108.78	1 066.28
S1 – economic scenario			1 271.75	227.09	204.88
S2 – environmental scenario			1 271.75	142.85	128.92
S3 – moderate transition scenario			1 271.75	238.99	215.65
Average heat generation price					
S0 – baseline scenario	PLN/GJ		126.10	283.51	244.58
S1 – economic scenario			126.10	169.25	114.80
S2 – environmental scenario			126.10	217.06	137.83
S3 – moderate transition scenario			126.10	210.20	146.31
Average heat generation					
S0 – baseline scenario	GWh		432.76	377.86	364.29
S1 – economic scenario			432.76	377.86	364.29
S2 – environmental scenario			432.76	377.86	364.29
S3 – moderate transition scenario			432.76	377.86	364.29
Average primary energy consumption					
S0 – baseline scenario	TJ		4 258.89	3 712.54	3 569.19
S1 – economic scenario			4 258.89	2 184.40	1 970.61
S2 – environmental scenario			4 258.89	2 683.83	2 421.28
S3 – moderate transition scenario			4 258.89	2 536.86	2 288.68

Table 81. Summary of scenario outcomes for the Podlaskie Province

PODLASKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		3 280 369.41			
S1 – economic scenario		2 254 514.44			
S2 – environmental scenario		3 314 156.65			
S3 – moderate transition scenario		2 559 748.87			
Average NPV	PLN thousand				
S0 – baseline scenario		-13 467 844.24			
S1 – economic scenario		-9 597 713.65			
S2 – environmental scenario		-10 896 163.04			
S3 – moderate transition scenario		-10 430 623.98			
Average RES share	%				
S0 – baseline scenario			17.14%	17.14%	17.14%
S1 – economic scenario			17.14%	58.66%	58.66%
S2 – environmental scenario			17.14%	75.72%	75.72%
S3 – moderate transition scenario			17.14%	57.78%	57.78%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			1 334.15	1 170.39	1 108.58
S1 – economic scenario			1 334.15	238.11	221.91
S2 – environmental scenario			1 334.15	123.45	115.29
S3 – moderate transition scenario			1 334.15	241.92	225.56
Average heat generation price	PLN/GJ				
S0 – baseline scenario			124.76	279.85	247.82
S1 – economic scenario			124.76	155.58	108.87
S2 – environmental scenario			124.76	186.49	117.68
S3 – moderate transition scenario			124.76	182.10	128.65
Average heat generation	GWh				
S0 – baseline scenario			514.32	450.70	426.36
S1 – economic scenario			514.32	450.70	426.36
S2 – environmental scenario			514.32	450.70	426.36
S3 – moderate transition scenario			514.32	450.70	426.36
Average primary energy consumption	TJ				
S0 – baseline scenario			5 110.37	4 476.89	4 232.23
S1 – economic scenario			5 110.37	2 511.09	2 338.69
S2 – environmental scenario			5 110.37	2 997.63	2 792.51
S3 – moderate transition scenario			5 110.37	2 838.48	2 644.21

Table 82. Summary of scenario outcomes for the Pomorskie Province

POMORSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		7 479 981.73			
S1 – economic scenario		5 404 827.93			
S2 – environmental scenario		7 946 427.68			
S3 – moderate transition scenario		6 142 697.61			
Average NPV	PLN thousand				
S0 – baseline scenario		-40 462 139.05			
S1 – economic scenario		-27 364 385.86			
S2 – environmental scenario		-30 645 517.54			
S3 – moderate transition scenario		-29 507 073.02			
Average RES share	%				
S0 – baseline scenario			7.00%	7.00%	7.00%
S1 – economic scenario			7.00%	57.99%	57.99%
S2 – environmental scenario			7.00%	74.21%	74.21%
S3 – moderate transition scenario			7.00%	56.66%	56.66%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			4 110.88	3 617.48	3 478.05
S1 – economic scenario			4 110.88	590.10	550.35
S2 – environmental scenario			4 110.88	328.81	307.40
S3 – moderate transition scenario			4 110.88	608.75	568.07
Average heat generation price	PLN/GJ				
S0 – baseline scenario			146.34	328.72	293.89
S1 – economic scenario			146.34	157.55	109.68
S2 – environmental scenario			146.34	190.94	120.68
S3 – moderate transition scenario			146.34	186.18	131.25
Average heat generation	GWh				
S0 – baseline scenario			1 222.11	1 075.56	1 034.28
S1 – economic scenario			1 222.11	1 075.56	1 034.28
S2 – environmental scenario			1 222.11	1 075.56	1 034.28
S3 – moderate transition scenario			1 222.11	1 075.56	1 034.28
Average primary energy consumption	TJ				
S0 – baseline scenario			13 267.11	11 674.76	11 224.79
S1 – economic scenario			13 267.11	6 060.53	5 647.44
S2 – environmental scenario			13 267.11	7 301.91	6 806.39
S3 – moderate transition scenario			13 267.11	6 910.34	6 441.27

Table 83. Summary of scenario outcomes for the Śląskie Province

ŚLĄSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		16 973 714.43			
S1 – economic scenario		12 228 807.81			
S2 – environmental scenario		17 964 897.12			
S3 – moderate transition scenario		13 902 790.58			
Average NPV	PLN thousand				
S0 – baseline scenario		-77 187 848.29			
S1 – economic scenario		-55 059 854.52			
S2 – environmental scenario		-62 977 874.10			
S3 – moderate transition scenario		-60 336 256.13			
Average RES share	%				
S0 – baseline scenario			5.64%	5.64%	5.64%
S1 – economic scenario			5.64%	56.08%	56.08%
S2 – environmental scenario			5.64%	70.23%	70.23%
S3 – moderate transition scenario			5.64%	53.69%	53.69%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			7 810.19	6 806.09	6 521.07
S1 – economic scenario			7 810.19	1 400.75	1 271.80
S2 – environmental scenario			7 810.19	843.58	767.26
S3 – moderate transition scenario			7 810.19	1 463.95	1 329.80
Average heat generation price	PLN/GJ				
S0 – baseline scenario			129.54	290.81	252.79
S1 – economic scenario			129.54	163.67	112.67
S2 – environmental scenario			129.54	204.63	130.06
S3 – moderate transition scenario			129.54	198.78	139.55
Average heat generation	GWh				
S0 – baseline scenario			2 774.87	2 416.01	2 310.71
S1 – economic scenario			2 774.87	2 416.01	2 310.71
S2 – environmental scenario			2 774.87	2 416.01	2 310.71
S3 – moderate transition scenario			2 774.87	2 416.01	2 310.71
Average primary energy consumption	TJ				
S0 – baseline scenario			28 031.04	24 391.01	23 311.45
S1 – economic scenario			28 031.04	13 825.56	12 544.66
S2 – environmental scenario			28 031.04	16 857.47	15 299.71
S3 – moderate transition scenario			28 031.04	15 941.76	14 468.39

Table 84. Summary of scenario outcomes for the Świętokrzyskie Province

ŚWIĘTOKRZYSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		1 575 888.54			
S1 – economic scenario		1 455 715.50			
S2 – environmental scenario		2 138 159.94			
S3 – moderate transition scenario		1 653 288.84			
Average NPV	PLN thousand				
S0 – baseline scenario		-7 206 718.48			
S1 – economic scenario		-5 542 283.98			
S2 – environmental scenario		-6 438 727.78			
S3 – moderate transition scenario		-6 130 404.83			
Average RES share	%				
S0 – baseline scenario			2.12%	2.12%	2.12%
S1 – economic scenario			2.12%	56.87%	56.87%
S2 – environmental scenario			2.12%	72.10%	72.10%
S3 – moderate transition scenario			2.12%	55.08%	55.08%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			812.63	706.16	671.41
S1 – economic scenario			812.63	161.48	147.79
S2 – environmental scenario			812.63	91.43	83.58
S3 – moderate transition scenario			812.63	166.38	152.25
Average heat generation price	PLN/GJ				
S0 – baseline scenario			107.70	242.53	213.91
S1 – economic scenario			107.70	161.48	111.73
S2 – environmental scenario			107.70	199.66	126.59
S3 – moderate transition scenario			107.70	194.20	136.55
Average heat generation	GWh				
S0 – baseline scenario			332.49	288.94	274.44
S1 – economic scenario			332.49	288.94	274.44
S2 – environmental scenario			332.49	288.94	274.44
S3 – moderate transition scenario			332.49	288.94	274.44
Average primary energy consumption	TJ				
S0 – baseline scenario			2 830.45	2 457.77	2 333.49
S1 – economic scenario			2 830.45	1 634.65	1 496.94
S2 – environmental scenario			2 830.45	1 975.04	1 808.33
S3 – moderate transition scenario			2 830.45	1 868.78	1 711.06

Table 85. Summary of scenario outcomes for the Warmińsko-Mazurskie Province

WARMIŃSKO-MAZURSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		1 096 253.38			
S1 – economic scenario		1 097 685.39			
S2 – environmental scenario		1 618 706.57			
S3 – moderate transition scenario		1 252 113.09			
Average NPV	PLN thousand				
S0 – baseline scenario		-4 159 929.77			
S1 – economic scenario		-3 548 699.80			
S2 – environmental scenario		-4 380 456.13			
S3 – moderate transition scenario		-4 130 828.21			
Average RES share	%				
S0 – baseline scenario			10.49%	10.49%	10.49%
S1 – economic scenario			10.49%	53.77%	53.77%
S2 – environmental scenario			10.49%	65.23%	65.23%
S3 – moderate transition scenario			10.49%	49.84%	49.84%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			495.08	441.05	429.61
S1 – economic scenario			495.08	137.90	126.04
S2 – environmental scenario			495.08	97.64	89.48
S3 – moderate transition scenario			495.08	150.24	137.43
Average heat generation price	PLN/GJ				
S0 – baseline scenario			90.19	203.60	175.17
S1 – economic scenario			90.19	166.61	113.77
S2 – environmental scenario			90.19	217.41	139.92
S3 – moderate transition scenario			90.19	210.57	148.30
Average heat generation	GWh				
S0 – baseline scenario			244.49	218.94	214.54
S1 – economic scenario			244.49	218.94	214.54
S2 – environmental scenario			244.49	218.94	214.54
S3 – moderate transition scenario			244.49	218.94	214.54
Average primary energy consumption	TJ				
S0 – baseline scenario			1 868.91	1 665.14	1 621.58
S1 – economic scenario			1 868.91	1 261.37	1 151.58
S2 – environmental scenario			1 868.91	1 584.68	1 447.52
S3 – moderate transition scenario			1 868.91	1 499.70	1 369.94

Table 86. Summary of scenario outcomes for the Wielkopolskie Province

WIELKOPOLSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		3 130 199.05			
S1 – economic scenario		2 392 269.24			
S2 – environmental scenario		3 517 961.30			
S3 – moderate transition scenario		2 721 557.60			
Average NPV	PLN thousand				
S0 – baseline scenario		-10 477 123.55			
S1 – economic scenario		-8 304 753.81			
S2 – environmental scenario		-9 821 994.48			
S3 – moderate transition scenario		-9 311 038.57			
Average RES share	%				
S0 – baseline scenario			3.08%	3.08%	3.08%
S1 – economic scenario			3.08%	57.33%	57.33%
S2 – environmental scenario			3.08%	72.74%	72.74%
S3 – moderate transition scenario			3.08%	55.56%	55.56%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			1 075.48	952.07	924.69
S1 – economic scenario			1 075.48	268.35	248.78
S2 – environmental scenario			1 075.48	157.96	146.94
S3 – moderate transition scenario			1 075.48	280.49	260.25
Average heat generation price	PLN/GJ				
S0 – baseline scenario			104.24	233.88	201.81
S1 – economic scenario			104.24	159.26	110.66
S2 – environmental scenario			104.24	195.13	123.87
S3 – moderate transition scenario			104.24	190.07	134.11
Average heat generation	GWh				
S0 – baseline scenario			538.25	474.97	459.14
S1 – economic scenario			538.25	474.97	459.14
S2 – environmental scenario			538.25	474.97	459.14
S3 – moderate transition scenario			538.25	474.97	459.14
Average primary energy consumption	TJ				
S0 – baseline scenario			4 640.62	4 091.86	3 951.11
S1 – economic scenario			4 640.62	2 697.50	2 497.45
S2 – environmental scenario			4 640.62	3 275.85	3 034.43
S3 – moderate transition scenario			4 640.62	3 099.35	2 870.85

Table 87. Summary of scenario outcomes for the Zachodniopomorskie Province

ZACHODNIOPOMORSKIE		2020-2050	2020	2035	2050
Average capex	PLN thousand				
S0 – baseline scenario		3 566 470.48			
S1 – economic scenario		2 125 360.04			
S2 – environmental scenario		3 122 768.16			
S3 – moderate transition scenario		2 414 769.45			
Average NPV	PLN thousand				
S0 – baseline scenario		-8 462 024.68			
S1 – economic scenario		-6 856 494.54			
S2 – environmental scenario		-8 171 409.51			
S3 – moderate transition scenario		-7 720 446.70			
Average RES share	%				
S0 – baseline scenario			25.40%	25.40%	25.40%
S1 – economic scenario			25.40%	55.75%	55.75%
S2 – environmental scenario			25.40%	69.65%	69.65%
S3 – moderate transition scenario			25.40%	53.25%	53.25%
Average annual CO_2 emissions	thousand tonnes				
S0 – baseline scenario			717.45	631.64	610.38
S1 – economic scenario			717.45	235.97	217.65
S2 – environmental scenario			717.45	134.50	124.05
S3 – moderate transition scenario			717.45	243.85	224.94
Average heat generation price	PLN/GJ				
S0 – baseline scenario			101.70	227.13	183.63
S1 – economic scenario			101.70	164.96	112.59
S2 – environmental scenario			101.70	207.46	131.15
S3 – moderate transition scenario			101.70	201.37	140.38
Average heat generation	GWh				
S0 – baseline scenario			481.57	421.85	404.15
S1 – economic scenario			481.57	421.85	404.15
S2 – environmental scenario			481.57	421.85	404.15
S3 – moderate transition scenario			481.57	421.85	404.15
Average primary energy consumption	TJ				
S0 – baseline scenario			4 401.42	3 853.31	3 688.30
S1 – economic scenario			4 401.42	2 388.41	2 203.39
S2 – environmental scenario			4 401.42	2 887.93	2 664.16
S3 – moderate transition scenario			4 401.42	2 732.44	2 520.73

9.6. Summary/conclusions of the analysis of the economic potential for efficient heating and cooling.

This summary presents the following outcomes in tabular and graphic form (charts) (for each of the analysed scenarios):

1. Total capex in 2020-2050.
2. Net present value (NPV).
3. Energy mix, fuel consumption breakdown for 2020, 2035 and 2050 at national, town/city and provincial levels.
4. Share of individual technologies, with an indication of the amount of energy generated (GWh), for the years 2020, 2035 and 2050 at national, town/city and provincial levels.
5. Average annual CO_2 emissions (broken down by sector, where possible).

9.6.1. Summary of capex and NPV scenarios

Table 88. Summary of the outcomes of CAPEX scenarios for all provinces.

Summary of CAPEX outcomes for provinces				
Province	PLN thousand			
	S0	S1	S2	S3
	baseline scenario	economic scenario	environmental scenario	moderate transition scenario
DOLNOŚLĄSKIE	4 211 505.29	3 567 240.88	5 246 431.17	4 059 514.44
KUJAWSKO-POMORSKIE	4 949 275.90	3 790 382.36	5 571 264.34	4 303 122.79
LUBELSKIE	2 762 413.01	2 184 065.12	3 209 870.52	2 480 257.05
LUBUSKIE	1 207 875.36	1 124 318.98	1 653 006.22	1 277 148.82
ŁÓDZKIE	5 585 136.12	4 296 596.68	6 316 624.14	4 884 287.66
MAŁOPOLSKIE	6 658 919.16	5 114 220.66	7 519 056.58	5 814 433.64
MAZOWIECKIE	14 561 892.16	17 334 904.98	25 481 349.11	19 692 764.01
OPOLSKIE	696 167.99	946 681.27	1 391 141.84	1 076 047.80
PODKARPACKIE	2 400 847.44	1 922 023.88	2 821 647.18	2 185 254.04
PODLASKIE	3 280 369.41	2 254 514.44	3 314 156.65	2 559 748.87
POMORSKIE	7 479 981.73	5 404 827.93	7 946 427.68	6 142 697.61
ŚLĄSKIE	16 973 714.43	12 228 807.81	17 964 897.12	13 902 790.58
ŚWIĘTOKRZYSKIE	1 575 888.54	1 455 715.50	2 138 159.94	1 653 288.84
WARMIŃSKO-MAZURSKIE	1 096 253.38	1 097 685.39	1 618 706.57	1 252 113.09
WIELKOPOLSKIE	3 130 199.05	2 392 269.24	3 517 961.30	2 721 557.60
ZACHODNIOPOMORSKIE	3 566 470.48	2 125 360.04	3 122 768.16	2 414 769.45
POLAND	80 098 737.38	67 101 693.45	98 661 983.24	76 281 502.70

As shown by the summary per province presented in the table (see Table 88. Summary of the outcomes of CAPEX scenarios for all provinces), capital expenditure in the baseline scenario ranges from PLN 696 167 990 to PLN 16 973 714 430, averaging PLN 5 008 556 840. The capex figures in the economic scenario range from PLN 946 681 270 to PLN 17 334 904 980, with an average of PLN 4 202 475 950. Analysis of the environmental scenario shows capital expenditure to be between PLN 1 391 141 840 and PLN 25 481 349 110, averaging PLN 6 177 091 780. In the moderate transition scenario, capex falls between PLN 1 076 047 800 and PLN 19 692 764 010, amounting to PLN 4 776 237 270 on average. In each scenario, the lowest values are those for the Opolskie Province. The baseline scenario (S0) displays the highest capex for the Śląskie Province, with the Mazowieckie Province ranking first in all the remaining scenarios.

Table 89. Summary of the outcomes of NPV scenarios for provinces.

Summary of NPV outcomes for provinces				
Province	PLN thousand			
	S0	S1	S2	S3
	baseline scenario	economic scenario	environmental scenario	moderate transition scenario
DOLNOŚLĄSKIE	-20 928 906.01	-15 225 737.25	-17 521 758.58	-16 753 023.01
KUJAWSKO-POMORSKIE	-23 735 077.37	-16 801 402.25	-18 985 546.91	-18 202 710.04
LUBELSKIE	-14 856 198.12	-10 333 902.22	-11 625 336.51	-11 169 877.10
LUBUSKIE	-6 255 081.49	-4 577 571.65	-5 239 022.06	-5 005 008.15
ŁÓDZKIE	-24 250 868.79	-17 684 211.22	-20 339 286.90	-19 428 056.23
MAŁOPOLSKIE	-32 179 323.38	-22 809 760.11	-25 982 674.50	-24 896 366.75
MAZOWIECKIE	-65 108 529.88	-55 179 457.16	-65 545 378.10	-61 915 005.12
OPOLSKIE	-3 358 960.57	-2 950 802.81	-3 546 721.67	-3 344 492.89
PODKARPACKIE	-12 079 960.42	-8 689 178.85	-9 984 185.49	-9 562 269.81
PODLASKIE	-13 467 844.24	-9 597 713.65	-10 896 163.04	-10 430 623.98
POMORSKIE	-40 462 139.05	-27 364 385.86	-30 645 517.54	-29 507 073.02
ŚLĄSKIE	-77 187 848.29	-55 059 854.52	-62 977 874.10	-60 336 256.13
ŚWIĘTOKRZYSKIE	-7 206 718.48	-5 542 283.98	-6 438 727.78	-6 130 404.83
WARMIŃSKO-MAZURSKIE	-4 159 929.77	-3 548 699.80	-4 380 456.13	-4 130 828.21
WIELKOPOLSKIE	-10 477 123.55	-8 304 753.81	-9 821 994.48	-9 311 038.57
ZACHODNIOPOMORSKIE	-8 462 024.68	-6 856 494.54	-8 171 409.51	-7 720 446.70
POLAND	-364 174 739.47	-270 169 294.28	-311 339 727.78	-297 161 072.99

It follows from the summary for provinces shown in the table (see Table 89) that the lowest NPVs are seen by the Mazowieckie Province, except for the S0 scenario, where the Śląskie Province ranks lowest; the highest values are identified for the Opolskie Province. In the baseline scenario, the values are PLN -77 187 848 290 and PLN -3 358 960 570, respectively. The average NPV is PLN -22 761 033 380. In the economic scenario, NPV falls between PLN -55 179 457 160 and PLN -2 950 802 810, averaging PLN -16 907 888 110. The environmental scenario shows values ranging from PLN -65 545 378 100 to PLN -3 546 721 670 and displays an average of PLN -19 506 378 330. In the moderate transition scenario, the minimum NPV is PLN -61 915 005 120, while the maximum PLN -3 344 492 890. The average value is PLN -18 615 217 530.

The largest deviations from the average are observable for the Śląskie, Mazowieckie and Pomorskie Provinces (below-average values) and the Opolskie, Warmińsko-Mazurskie and Lubuskie Provinces (above-average values).

It follows from the mean values that the average economic balance of the analysed investments is not viable.

The highest nationwide NPV is displayed by the economic scenario (PLN -270 169 294 280), which is PLN 94 005 445 190 (34.80%) higher than in the baseline scenario and PLN 41 170 433 500 (15.24%) and PLN 26 991 778 710 (9.99%) higher than in the environmental and moderate scenarios, respectively.

The lowest nationwide NPV is produced by the baseline scenario (PLN -364 174 739 470), which is PLN 52 835 011 690 (15.50%) lower than in the environmental scenario and PLN 67 013 666 480 (18.40%) lower than in the moderate transition scenario.

The average NPV is highest for the economic scenario (PLN -16 907 888 110), and lowest for the baseline scenario (PLN -22 761 033 380). The difference between these figures is PLN 5 853 145 280 (25.72%).

9.6.2. Summary in the context of RES shares

Table 90. Summary of the outcomes of RES share scenarios for provinces

Summary of RES share outcomes for provinces												
Province	%											
	S0 baseline scenario			S1 economic scenario			S2 environmental scenario			S3 moderate transition scenario		
	2020	2035	2050	2020	2035	2050	2020	2035	2050	2020	2035	2050
DOLNOŚLĄSKIE	10.99%	10.99%	10.99%	10.99%	56.92%	56.92%	10.99%	71.84%	71.84%	10.99%	54.90%	54.90%
KUJAWSKO-POMORSKIE	10.94%	10.94%	10.94%	10.94%	58.86%	58.86%	10.94%	76.22%	76.22%	10.94%	58.15%	58.15%
LUBELSKIE	10.41%	10.41%	10.41%	10.41%	58.46%	58.46%	10.41%	75.40%	75.40%	10.41%	57.54%	57.54%
LUBUSKIE	9.35%	9.35%	9.35%	9.35%	58.46%	58.46%	9.35%	75.40%	75.40%	9.35%	57.54%	57.54%
ŁÓDZKIE	9.63%	9.63%	9.63%	9.63%	57.25%	57.25%	9.63%	72.71%	72.71%	9.63%	55.54%	55.54%
MAŁOPOLSKIE	11.12%	11.12%	11.12%	11.12%	57.50%	57.50%	11.12%	73.14%	73.14%	11.12%	55.87%	55.87%
MAZOWIECKIE	2.96%	2.96%	2.96%	2.96%	57.39%	57.39%	2.96%	73.03%	73.03%	2.96%	55.77%	55.77%
OPOLSKIE	7.81%	7.81%	7.81%	7.81%	56.54%	56.54%	7.81%	71.31%	71.31%	7.81%	54.49%	54.49%
PODKARPACKIE	19.24%	19.24%	19.24%	19.24%	54.42%	54.42%	19.24%	66.88%	66.88%	19.24%	51.18%	51.18%
PODLASKIE	17.14%	17.14%	17.14%	17.14%	58.66%	58.66%	17.14%	75.72%	75.72%	17.14%	57.78%	57.78%
POMORSKIE	7.00%	7.00%	7.00%	7.00%	57.99%	57.99%	7.00%	74.21%	74.21%	7.00%	56.66%	56.66%
ŚLĄSKIE	5.64%	5.64%	5.64%	5.64%	56.08%	56.08%	5.64%	70.23%	70.23%	5.64%	53.69%	53.69%
ŚWIĘTOKRZYSKIE	2.12%	2.12%	2.12%	2.12%	56.87%	56.87%	2.12%	72.10%	72.10%	2.12%	55.08%	55.08%
WARMIŃSKO-MAZURSKIE	10.49%	10.49%	10.49%	10.49%	53.77%	53.77%	10.49%	65.23%	65.23%	10.49%	49.84%	49.84%
WIELKOPOLSKIE	3.08%	3.08%	3.08%	3.08%	57.33%	57.33%	3.08%	72.74%	72.74%	3.08%	55.56%	55.56%
ZACHODNIOPOMORSKIE	25.40%	25.40%	25.40%	25.40%	55.75%	55.75%	25.40%	69.65%	69.65%	25.40%	53.25%	53.25%
POLAND	8.88%	8.88%	8.88%	8.88%	57.49%	57.49%	8.88%	73.08%	73.08%	8.88%	55.81%	55.81%

As shown by the table (see Table 90), the RES share values across the scenarios range from 2.12% (Świętokrzyskie) to 25.40% (Zachodniopomorskie) in 2020, averaging 8.88%. In each scenario, the share of renewables for 2035 and 2050 is the same. In the baseline scenario, the shares are also the same as for 2020. For both 2035 and 2050, the economic scenario shows a RES share ranging between 53.77% (Warmińsko-Mazurskie) and 58.86% (Kujawsko-Pomorskie). Likewise, both in 2035 and 2050, the environmental scenario identifies the same RES shares, which range from 65.23% in Warmińsko-Mazurskie to 76.22% in Kujawsko-Pomorskie. The moderate transition scenario identifies the extreme RES share values in 2035 and 2050 for the same provinces at the level between 49.84% and 58.15%.

The lowest average shares of renewables for Poland emerge from the baseline scenario (8.88% in each of the years examined). The highest average share is displayed by the environmental scenario (8.88% in 2020 and 73.08% in 2035 and 2050). The difference between the lowest and the highest levels in 2035 and 2050 is 64.2 percentage points.

A large number of coal-fired district heating plants that supply heat to medium-sized and small district heating systems (with installed capacity below 50 MW) declare that they can potentially use biofuels (usually wood chips, rarely pellets) in a district heat production process that involves the co-firing of biomass and coal.

The vast majority of small and medium-sized district heating plants are fitted with stoker-fired coal boilers. Biomass can be co-fired in such boilers at a ratio of 15-20% of the nominal consumption of coal with no major impact of such admixture on the combustion process parameters.

The fuel balances compiled in this document for the 18 largest district heating systems in the country are based on data sourced directly from the operators of these systems, which have provided the same data to the drafters of the core planning document regarding the satisfaction of a municipality's energy needs, namely the 'heat, electricity and gas fuel supply plan' (plan zaopatrzenia w ciepło, energię elektryczną i paliwa gazowe), and are generally very accurate. This follows from the fact that a supply plan addresses all relevant matters related to heat generation, including:

- characteristics of the district heating installation,
- type of generating equipment,
- the way the equipment is used,
- energy efficiency of the equipment,
- district heating network losses,
- types and characteristics of fuels used,
- annual fuel consumption figures.

The structure of fuel consumption in a complex district heating system is determined not only by the generating equipment the system consists of, but also by the way the equipment is used, which is principally influenced by:

- fuel prices,
- availability of fuels on the market,
- supply logistics.

These factors seriously constrain the potential for the full exploitation of biomass in national heating.

Discrepancies in the balance biomass amounts may result from the method of accounting for the actual amounts of combusted biomass with the declared, potential amounts that can be used in the heat generation process.

9.6.3. Summary in the context of average annual CO_2 emissions

Table 91. Summary of the outcomes of average annual CO_2 emission scenarios for provinces

Summary of CO_2 emission outcomes												
Province	thousand tonnes											
	S0 baseline scenario			S1 economic scenario			S2 environmental scenario			S3 moderate transition scenario		
	2020	2035	2050	2020	2035	2050	2020	2035	2050	2020	2035	2050
DOLNOŚLĄSKIE	2 248.48	1 981.83	1 919.38	2 248.48	404.05	373.26	2 248.48	242.35	224.66	2 248.48	424.02	392.04
KUJAWSKO-POMORSKIE	2 473.35	2 156.36	2 041.27	2 473.35	400.76	373.38	2 473.35	207.89	194.01	2 473.35	406.99	379.32
LUBELSKIE	1 564.27	1 361.78	1 290.70	1 564.27	235.00	217.70	1 564.27	126.32	117.18	1 564.27	240.21	222.60
LUBUSKIE	696.24	618.37	593.40	696.24	120.27	113.02	696.24	64.26	60.51	696.24	123.01	115.65
ŁÓDZKIE	2 506.60	2 218.68	2 149.84	2 506.60	474.84	443.04	2 506.60	270.64	252.75	2 506.60	492.01	459.19
MAŁOPOLSKIE	3 331.99	2 935.84	2 833.96	3 331.99	566.49	526.72	3 331.99	324.55	302.42	3 331.99	587.76	546.79
MAZOWIECKIE	8 325.74	7 311.15	6 991.44	8 325.74	1 876.56	1 748.22	8 325.74	1 024.52	955.46	8 325.74	1 925.94	1 794.72
OPOLSKIE	453.78	395.75	379.13	453.78	106.22	97.86	453.78	61.88	57.06	453.78	110.35	101.70
PODKARPACKIE	1 271.75	1 108.78	1 066.28	1 271.75	227.09	204.88	1 271.75	142.85	128.92	1 271.75	238.99	215.65
PODLASKIE	1 334.15	1 170.39	1 108.58	1 334.15	238.11	221.91	1 334.15	123.45	115.29	1 334.15	241.92	225.56
POMORSKIE	4 110.88	3 617.48	3 478.05	4 110.88	590.10	550.35	4 110.88	328.81	307.40	4 110.88	608.75	568.07
ŚLĄSKIE	7 810.19	6 806.09	6 521.07	7 810.19	1 400.75	1 271.80	7 810.19	843.58	767.26	7 810.19	1 463.95	1 329.80
ŚWIĘTOKRZYSKIE	812.63	706.16	671.41	812.63	161.48	147.79	812.63	91.43	83.58	812.63	166.38	152.25
WARMIŃSKO-MAZURSKIE	495.08	441.05	429.61	495.08	137.90	126.04	495.08	97.64	89.48	495.08	150.24	137.43
WIELKOPOLSKIE	1 075.48	952.07	924.69	1 075.48	268.35	248.78	1 075.48	157.96	146.94	1 075.48	280.49	260.25
ZACHODNIOPOMORSKIE	717.45	631.64	610.38	717.45	235.97	217.65	717.45	134.50	124.05	717.45	243.85	224.94
POLAND	39 228.07	34 413.44	33 009.17	39 228.07	7 443.93	6 882.43	39 228.07	4 242.64	3 926.97	39 228.07	7 704.86	7 125.95

As follows from the compilation in the table (see Table 91), in each scenario, the average annual CO2 emissions for 2020 show the same values, with all the scenarios demonstrating the highest values for the same province, namely Mazowieckie, and the lowest for Opolskie. In 2020, the volumes range from 453 780 tonnes to 3 331 990 tonnes, totalling 39 228 070 tonnes for Poland as a whole. For the baseline scenario, in 2035, the lowest value is 395 750 tonnes, and the highest 7 311 150 tonnes. The total average annual emissions countrywide in that year amount to 34 413 440 tonnes. For 2050, the average annual emissions range from 379 130 tonnes to 6 991 440 tonnes, totalling 33 009 170 tonnes on a nationwide level.

In the economic scenario, the average annual CO2 emissions in 2035 range from 106 220 tonnes (Opolskie) and 469 140 tonnes (Mazowieckie) to 1 876 560 tonnes, and from 97 860 tonnes to 1 748 220 tonnes in the same provinces in 2050. The summative nationwide figure for the above years is 1 843 320 tonnes and 1 706 490 tonnes respectively.

The environmental scenario identifies the minimum values of 61 880 tonnes in 2035 and 57 060 tonnes in 2050 (both for Opolskie) and the maximum figures of 1 024 520 tonnes in 2035 and 955 460 tonnes in 2050 (both for Mazowieckie). The totals for Poland are PLN 4 242 640 tonnes (2035) and 3 926 970 tonnes (2050).

The last scenario, namely that of economic transition, likewise identifies the lowest average annual CO2 emissions for the Opolskie Province at the levels of 110 350 tonnes in 2035 and 101 700 tonnes in 2050. As in the previous scenarios, the highest values – 1 925 940 tonnes (2035) and 1 794 720 tonnes (2050) – are identified for the Mazowieckie Province. The countrywide total is 7 704 860 tonnes in 2035, and 7 125 950 tonnes in 2050.

The lowest value of the average annual CO2 emissions for the country is identified in the environmental scenario (4 242 640 tonnes in 2035 and 3 926 970 tonnes in 2050), while the highest in the baseline scenario (34 413 440 tonnes in 2035 and 33 009 170 tonnes in 2050).

For 2035 and 2050, in each scenario, values much above the average are shown by Mazowieckie, Śląskie and Pomorskie, and below the average by Opolskie, Warmińsko-Mazurskie and Lubuskie, except in the environmental scenario, where the lowest values are attributable to Opolskie, Świętokrzyskie and Warmińsko-Mazurskie.
Relative to 2020, by 2035 and 2050, the average annual CO2 emissions will have decreased by 12.27% and 15.85% respectively in the baseline scenario, by 81.02% and 82.46% in the economic scenario, by 89.19% and 89.99% in the environmental scenario, and by 80.36% and 81.84% in the moderate transition scenario.

9.6.4. Summary in the context of average heat generation price

Table 92. Summary of outcomes for heat generation price scenarios for provinces

Summary of outcomes for heat generation price for provinces												
Province	PLN/GJ											
	S0 baseline scenario			S1 economic scenario			S2 environmental scenario			S3 moderate transition scenario		
	2020	2035	2050	2020	2035	2050	2020	2035	2050	2020	2035	2050
DOLNOŚLĄSKIE	122.52	275.61	244.05	122.52	160.80	111.27	122.52	198.26	125.80	122.52	192.92	135.76
KUJAWSKO-POMORSKIE	128.33	288.38	259.26	128.33	155.03	108.59	128.33	185.24	116.76	128.33	180.95	127.85
LUBELSKIE	134.88	303.26	273.90	134.88	156.31	109.36	134.88	188.09	118.86	134.88	183.56	129.74
LUBUSKIE	118.81	267.57	240.76	118.81	156.49	108.97	118.81	188.56	118.81	118.81	184.00	129.56
ŁÓDZKIE	120.77	271.24	237.43	120.77	160.01	110.56	120.77	196.42	124.07	120.77	191.23	134.18
MAŁOPOLSKIE	128.93	289.68	256.35	128.93	159.07	110.33	128.93	194.35	122.96	128.93	189.32	133.24
MAZOWIECKIE	89.71	202.78	181.92	89.71	159.59	110.36	89.71	195.48	123.41	89.71	190.36	133.60
OPOLSKIE	87.87	198.86	178.70	87.87	162.47	112.11	87.87	201.89	128.07	87.87	196.25	137.82
PODKARPACKIE	126.10	283.51	244.58	126.10	169.25	114.80	126.10	217.06	137.83	126.10	210.20	146.31
PODLASKIE	124.76	279.85	247.82	124.76	155.58	108.87	124.76	186.49	117.68	124.76	182.10	128.65
POMORSKIE	146.34	328.72	293.89	146.34	157.55	109.68	146.34	190.94	120.68	146.34	186.18	131.25
ŚLĄSKIE	129.54	290.81	252.79	129.54	163.67	112.67	129.54	204.63	130.06	129.54	198.78	139.55
ŚWIĘTOKRZYSKIE	107.70	242.53	213.91	107.70	161.48	111.73	107.70	199.66	126.59	107.70	194.20	136.55
WARMIŃSKO-MAZURSKIE	90.19	203.60	175.17	90.19	166.61	113.77	90.19	217.41	139.92	90.19	210.57	148.30
WIELKOPOLSKIE	104.24	233.88	201.81	104.24	159.26	110.66	104.24	195.13	123.87	104.24	190.07	134.11
ZACHODNIOPOMORSKIE	101.70	227.13	183.63	101.70	164.96	112.59	101.70	207.46	131.15	101.70	201.37	140.38
POLAND	116.06	261.05	231.41	116.06	158.79	110.39	116.06	194.04	123.06	116.06	189.06	133.38

As shown by the data compiled in the table (see Table 92), the average heat generation prices are the same for 2020 in each of the scenarios, ranging from PLN 87.87/GJ in Opolskie to PLN 146.34/GJ in Mazowieckie. In 2035, the prices range from PLN 198.86/GJ in Opolskie to PLN 328.72/GJ in Mazowieckie in the baseline scenario, from PLN 155.03/GJ in Kujawsko-Pomorskie to PLN 169.25/GJ in Podkarpackie in the economic scenario, from PLN 185.24 in Kujawsko-Pomorskie to PLN 217.41/GJ in Warmińsko-Mazurskie in the environmental scenario, and from PLN 180.95/GJ in Kujawsko-Pomorskie to PLN 210.57/GJ in Warmińsko-Mazurskie in the moderate transition scenario. In 2050, they range from PLN 175.17/GJ in Wielkopolskie to PLN 293.89/GJ in Pomorskie in the baseline scenario, from PLN 108.57/GJ in Kujawsko-Pomorskie to PLN 114.8/GJ in Podkarpackie in the economic scenario, from PLN 116.76/GJ in Kujawsko-Pomorskie to PLN 139.92/GJ in Warmińsko-Mazurskie in the environmental scenario, and from PLN 127.85/GJ in Kujawsko-Pomorskie to PLN 148.3/GJ in Warmińsko-Mazurskie in the moderate transition scenario.

The average value (of all the scenarios) of heat generation prices for Poland is PLN 116.40/GJ in 2020, PLN 203.2/GJ in 2035, and PLN 150.56/GJ in 2050. The presented data imply that, by 2035, the average heat generation price is bound to increase relative to 2020 under each of the scenarios and to decrease by 2050 relative to 2035.

9.6.5. Summary in the context of average heat generation for provinces

Table 93. Summary of the outcomes for average heat production scenarios for provinces

Summary of heat generation outcomes												
Province	GWh											
	S0 baseline scenario			S1 economic scenario			S2 environmental scenario			S3 moderate scenario		
	2020	2035	2050	2020	2035	2050	2020	2035	2050	2020	2035	2050
DOLNOŚLĄSKIE	800.54	706.19	684.78	800.54	706.19	684.78	800.54	706.19	684.78	800.54	706.19	684.78
KUJAWSKO-POMORSKIE	869.32	757.59	716.70	869.32	757.59	716.70	869.32	757.59	716.70	869.32	757.59	716.70
LUBELSKIE	500.10	435.47	412.88	500.10	435.47	412.88	500.10	435.47	412.88	500.10	435.47	412.88
LUBUSKIE	252.57	224.38	215.37	252.57	224.38	215.37	252.57	224.38	215.37	252.57	224.38	215.37
ŁÓDZKIE	964.93	853.52	826.15	964.93	853.52	826.15	964.93	853.52	826.15	964.93	853.52	826.15
MAŁOPOLSKIE	1 152.67	1 015.63	980.38	1 152.67	1 015.63	980.38	1 152.67	1 015.63	980.38	1 152.67	1 015.63	980.38
MAZOWIECKIE	3 932.50	3 453.56	3 304.07	3 932.50	3 453.56	3 304.07	3 932.50	3 453.56	3 304.07	3 932.50	3 453.56	3 304.07
OPOLSKIE	214.52	187.62	180.47	214.52	187.62	180.47	214.52	187.62	180.47	214.52	187.62	180.47
PODKARPACKIE	432.76	377.86	364.29	432.76	377.86	364.29	432.76	377.86	364.29	432.76	377.86	364.29
PODLASKIE	514.32	450.70	426.36	514.32	450.70	426.36	514.32	450.70	426.36	514.32	450.70	426.36
POMORSKIE	1 222.11	1 075.56	1 034.28	1 222.11	1 075.56	1 034.28	1 222.11	1 075.56	1 034.28	1 222.11	1 075.56	1 034.28
ŚLĄSKIE	2 774.87	2 416.01	2 310.71	2 774.87	2 416.01	2 310.71	2 774.87	2 416.01	2 310.71	2 774.87	2 416.01	2 310.71
ŚWIĘTOKRZYSKIE	332.49	288.94	274.44	332.49	288.94	274.44	332.49	288.94	274.44	332.49	288.94	274.44
WARMIŃSKO-MAZURSKIE	244.49	218.94	214.54	244.49	218.94	214.54	244.49	218.94	214.54	244.49	218.94	214.54
WIELKOPOLSKIE	538.25	474.97	459.14	538.25	474.97	459.14	538.25	474.97	459.14	538.25	474.97	459.14
ZACHODNIOPOMORSKIE	481.57	421.85	404.15	481.57	421.85	404.15	481.57	421.85	404.15	481.57	421.85	404.15
POLAND	15 228.00	13 347.01	12 770.35	15 228.00	13 347.01	12 770.35	15 228.00	13 347.01	12 770.35	15 228.00	13 347.01	12 770.35

As follows from the table (cf. Table 93), in 2020, the average values of heat generation are the same for each of the scenarios (baseline, economic, environmental, moderate) and range from 214.52 GWh in Opolskie to 3932.50 GWh in Mazowieckie. In 2035, they range from 187.62 GWh in Opolskie to 3 453.56 GWh in Mazowieckie, while in 2050, from 180.47 GWh in Opolskie to 3 304.07 GWh in Mazowieckie.

The greatest deviations from the average occur in Mazowieckie, Śląskie and Pomorskie (above-average values) and in Opolskie, Warmińsko-Mazurskie and Lubuskie (below-average values).

The mean for Poland is 951.75 GWh in 2020, 834.92 GWh in 2035, and 800.54 GWh in 2050.

The presented data show that Poland will see a drop of 12.3% in the value of average heat production by 2035 compared to 2020 and further decrease of approx. 4.1% by 2050 relative to 2035.

9.6.6. Summary of the outcomes of average primary energy consumption scenarios for provinces

Table 94. Summary of the outcomes of average primary energy consumption scenarios for provinces

Summary of primary energy consumption outcomes												
Province	TJ											
	S0 baseline scenario			S1 economic scenario			S2 environmental scenario			S3 moderate transition scenario		
	2020	2035	2050	2020	2035	2050	2020	2035	2050	2020	2035	2050
DOLNOŚLĄSKIE	7 516.62	6 623.24	6 411.47	7 516.62	4 031.73	3 719.20	7 516.62	4 909.02	4 530.89	7 516.62	4 642.82	4 285.06
KUJAWSKO-POMORSKIE	8 530.42	7 432.19	7 028.50	8 530.42	4 221.80	3 931.22	8 530.42	5 040.42	4 694.42	8 530.42	4 772.77	4 445.09
LUBELSKIE	5 053.38	4 399.25	4 169.63	5 053.38	2 440.39	2 259.76	5 053.38	2 926.85	2 710.68	5 053.38	2 770.65	2 565.99
LUBUSKIE	2 253.46	2 001.43	1 920.62	2 253.46	1 255.68	1 179.22	2 253.46	1 504.49	1 413.24	2 253.46	1 424.29	1 337.89
ŁÓDZKIE	9 130.83	8 072.02	7 806.84	9 130.83	4 828.86	4 504.36	9 130.83	5 836.65	5 445.07	9 130.83	5 522.57	5 152.03
MAŁOPOLSKIE	11 411.54	10 049.41	9 692.53	11 411.54	5 750.92	5 342.92	11 411.54	6 956.03	6 464.50	11 411.54	6 581.44	6 116.26
MAZOWIECKIE	28 350.21	24 882.62	23 775.76	28 350.21	19 398.55	18 066.39	28 350.21	23 310.50	21 712.55	28 350.21	22 063.94	20 551.28
OPOLSKIE	1 475.79	1 287.14	1 233.19	1 475.79	1 066.36	982.37	1 475.79	1 293.39	1 191.64	1 475.79	1 223.52	1 127.26
PODKARPACKIE	4 258.89	3 712.54	3 569.19	4 258.89	2 184.40	1 970.61	4 258.89	2 683.83	2 421.28	4 258.89	2 536.86	2 288.68
PODLASKIE	5 110.37	4 476.89	4 232.23	5 110.37	2 511.09	2 338.69	5 110.37	2 997.63	2 792.51	5 110.37	2 838.48	2 644.21
POMORSKIE	13 267.11	11 674.76	11 224.79	13 267.11	6 060.53	5 647.44	13 267.11	7 301.91	6 806.39	13 267.11	6 910.34	6 441.27
ŚLĄSKIE	28 031.04	24 391.01	23 311.45	28 031.04	13 825.56	12 544.66	28 031.04	16 857.47	15 299.71	28 031.04	15 941.76	14 468.39
ŚWIĘTOKRZYSKIE	2 830.45	2 457.77	2 333.49	2 830.45	1 634.65	1 496.94	2 830.45	1 975.04	1 808.33	2 830.45	1 868.78	1 711.06
WARMIŃSKO-MAZURSKIE	1 868.91	1 665.14	1 621.58	1 868.91	1 261.37	1 151.58	1 868.91	1 584.68	1 447.52	1 868.91	1 499.70	1 369.94
WIELKOPOLSKIE	4 640.62	4 091.86	3 951.11	4 640.62	2 697.50	2 497.45	4 640.62	3 275.85	3 034.43	4 640.62	3 099.35	2 870.85
ZACHODNIOPOMORSKIE	4 401.42	3 853.31	3 688.30	4 401.42	2 388.41	2 203.39	4 401.42	2 887.93	2 664.16	4 401.42	2 732.44	2 520.73
POLAND	138 131.06	120 999.11	115 670.75	138 131.06	75 341.92	69 662.90	138 131.06	90 947.03	84 130.31	138 131.06	86 065.40	79 612.48

It follows from the data compiled in the table (see Table 93. Summary of the outcomes for average heat production scenarios for provinces

Error! Reference source not found.) that the values of average primary energy consumption are the same for 2020 across the scenarios, ranging from 1475.79 TJ in Opolskie to 28 350.21 TJ in Mazowieckie. In 2035, they range from 1 066.36 GWh in Opolskie (economic scenario) to 24 882.62 TJ in Mazowieckie (baseline scenario), while in 2050, from 982.37 GWh in Opolskie (economic scenario) to 23 775.76 TJ in Mazowieckie (baseline scenario).

The average value (of all the scenarios) for all provinces is 8 633.19 TJ in 2020, 5 850 TJ in 2035 and 5 470.94 TJ in 2050.

The greatest deviations from the average occur in Mazowieckie, Śląskie and Pomorskie (above-average values) and in Opolskie, Warmińsko-Mazurskie and Lubuskie (below-average values).

It is concluded on the basis of the presented data that Poland will see a drop of 32% in the value of average (all scenarios) heat production by 2035 compared to 2020 and further decrease of approx. 6.5% by 2050 relative to 2035.

9.6.7. Summary in graphic form

Chart 1. Average capital expenditures for provinces in individual scenarios

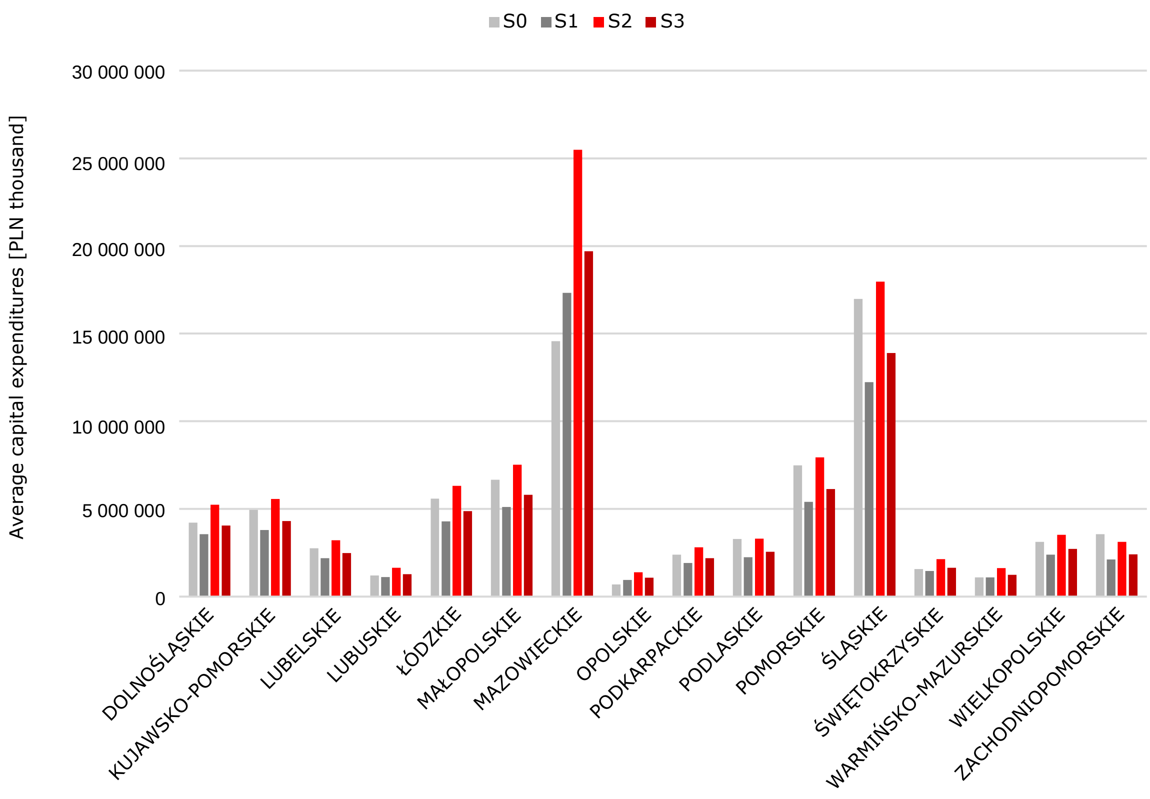


Chart 2. Average NPV for provinces in individual scenarios

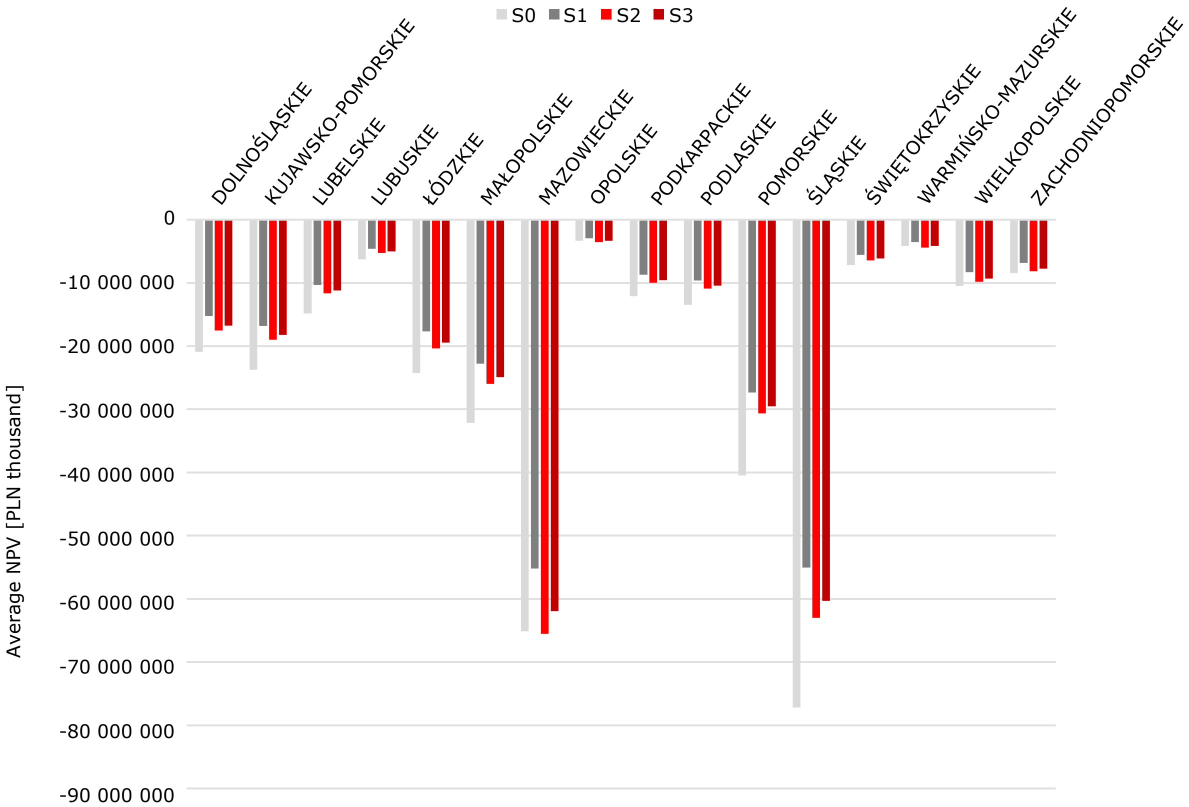


Chart 3. Average RES shares in 2035 for provinces in individual scenarios.

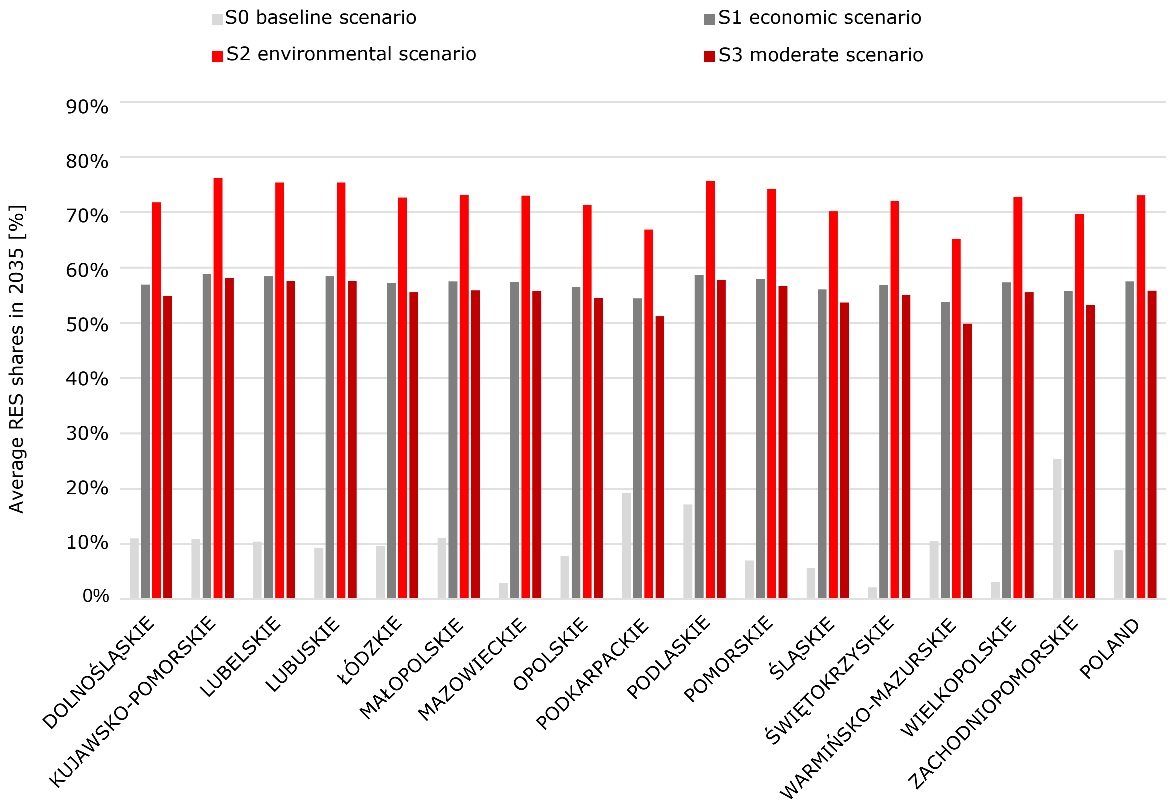


Chart 4. Average CO_2 emissions in 2035 for provinces in individual scenarios.

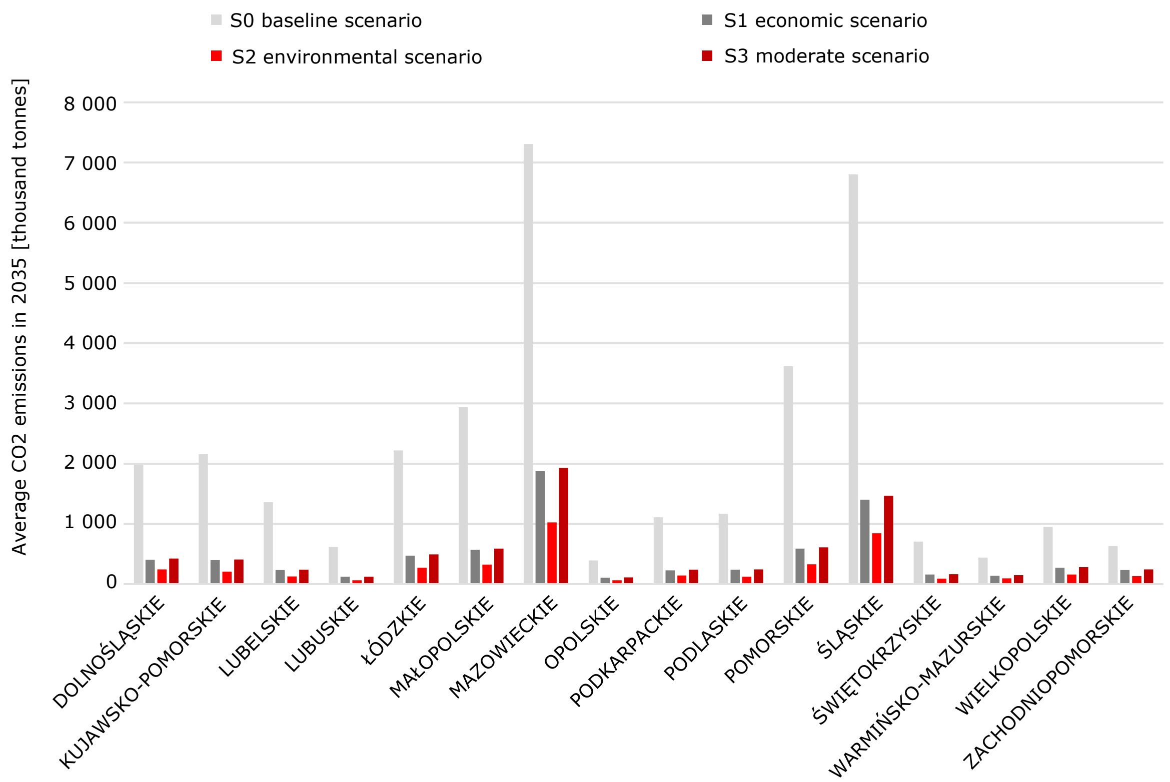


Chart 5. Average heat prices for provinces in individual scenarios.

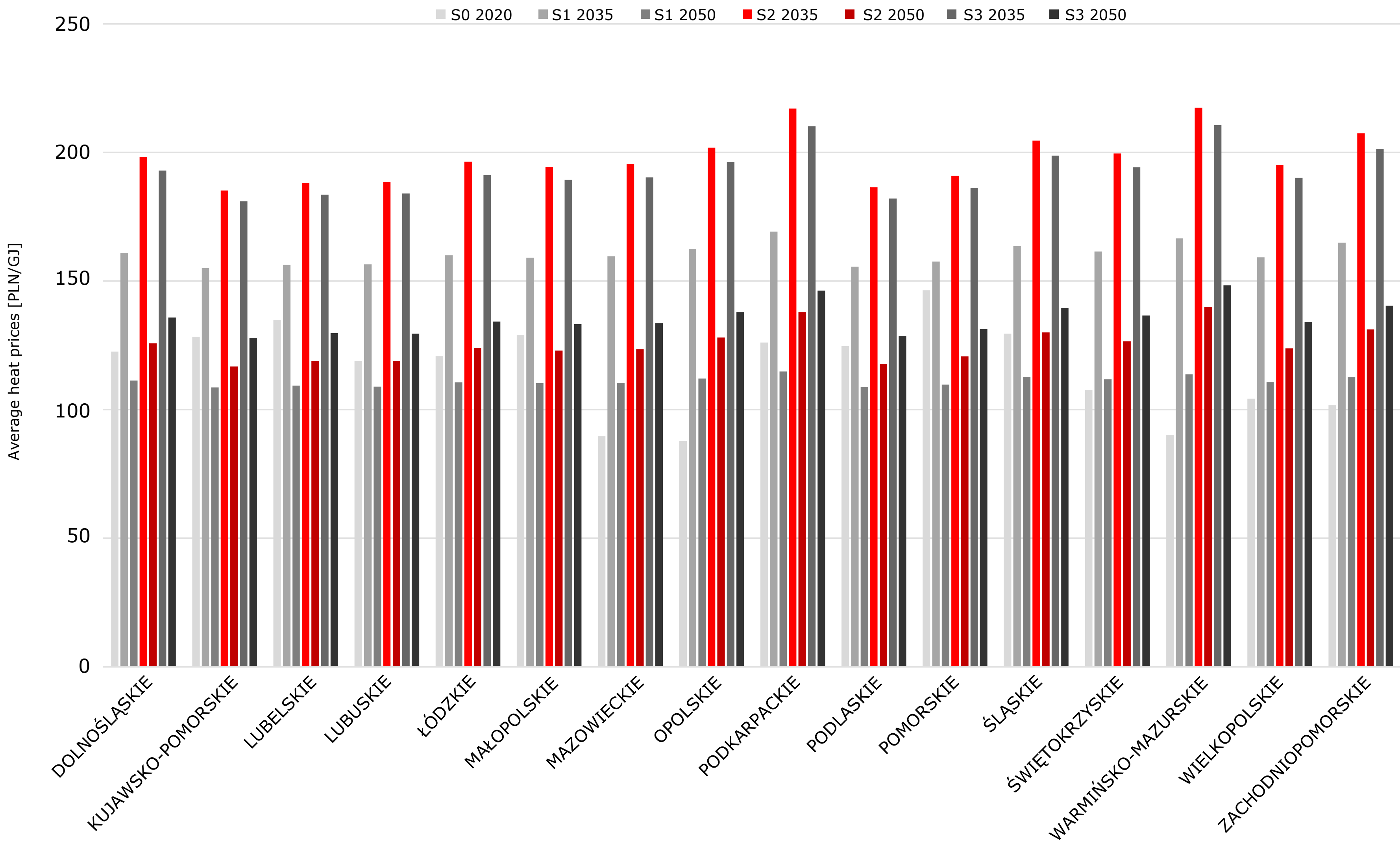


Chart 6. Average amounts of generated heat for provinces in individual scenarios.

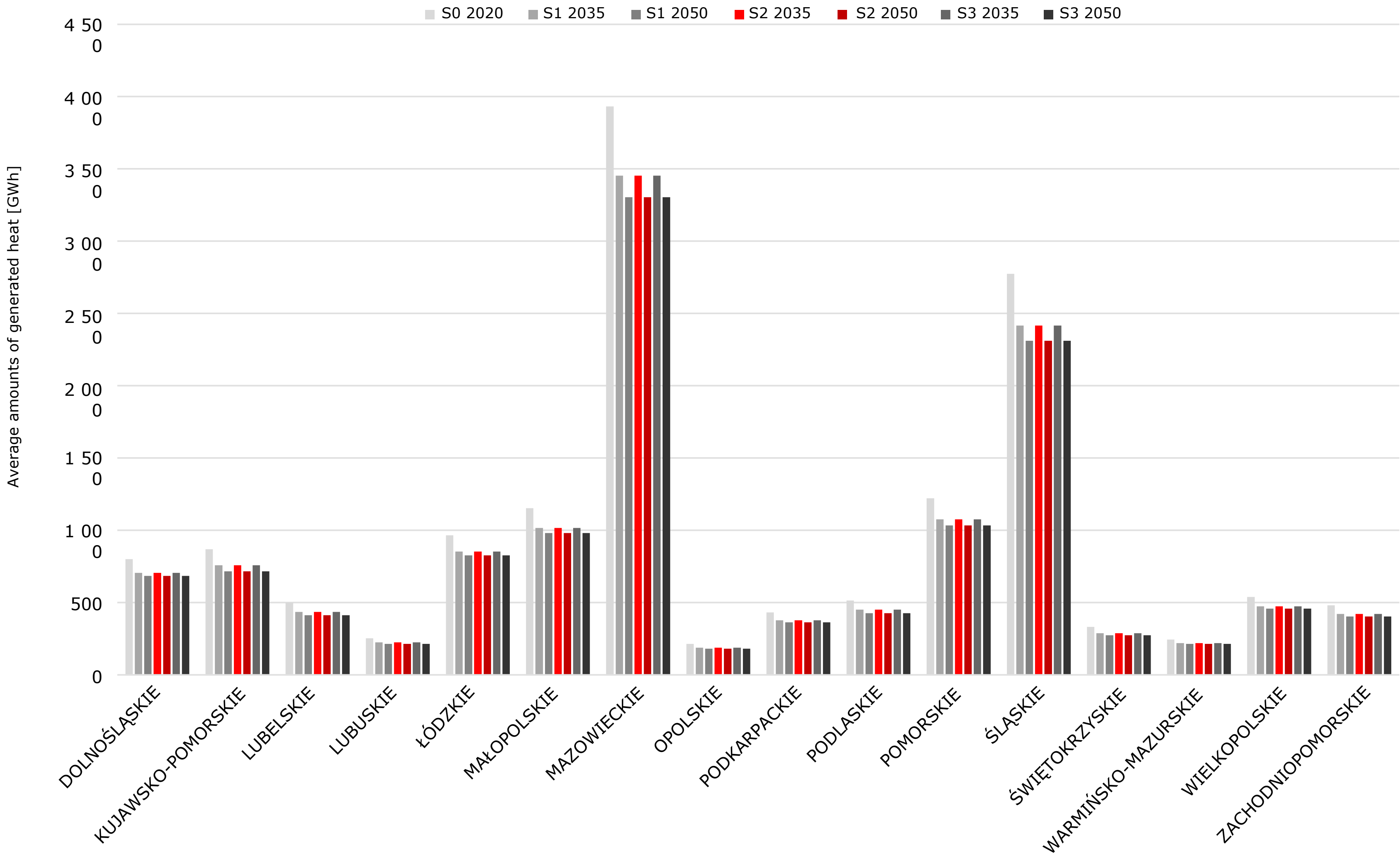
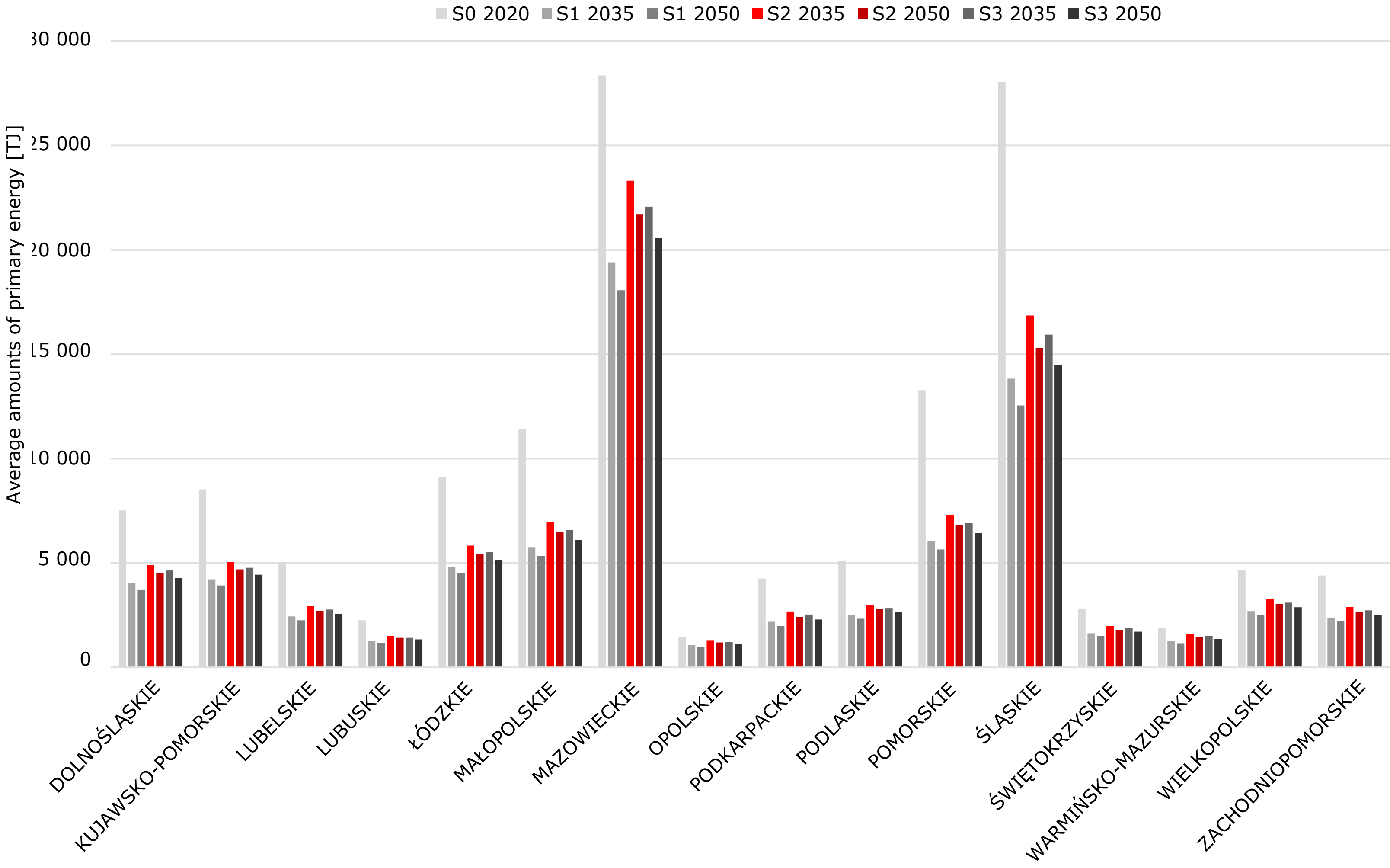


Chart 7. Average amounts of primary energy for provinces in individual scenarios.



10. Waste heat use analysis

Waste heat is produced by technological processes in which heat is a by-product of these processes or the heat transfer medium necessary for the processes to run properly. The first type of source where waste heat can occur includes energy companies that convert chemical energy contained in fuels into usable forms of energy, i.e. electricity, heat and cold.

The second type of source that can generate waste heat are industrial companies where electricity, heat and cold are necessary for them to carry out their manufacturing operations.

In the vast majority of territorial units, industrial plants are situated far from residential areas due to the environmental nuisance caused by industry, especially for residents, which results from the nature of the operations run by these plants, namely intensified transport needs, noise, and environmental pollution. This means that the potential for using industry's energy resources, e.g. by utilising the potential of waste heat produced by various technological processes consuming large amounts of heat, can be exploited on site and used for the plant's own production purposes, increasing the efficiency of energy use in the plant, reducing energy consumption, and consequently the consumption of fuels, which translates into lower expenses, production costs and less pollution emitted by the plant into the environment.

By contrast, the former type of source, namely energy companies, are intended to meet the energy needs of consumers off-site. The energy efficiency of these companies can be improved and their harmful impact on the environment eliminated through efficiency activities, such as improving the energy efficiency of equipment, replacing energy conversion technology, switching from heat-only technology to cogeneration, changing the fuel mix, using fuels that emit less pollutants, as well as minimising the waste heat associated with energy processes employed by the company.

Potential waste heat resources in energy companies vary depending on the type of technology employed in the process for converting chemical energy from fuels into useful energy – heat, cold, electricity.

Given the specificities of these processes, the following groups of useful energy sources are distinguished:

1. plants using conventional (fossil) fuels;
    1) condensing thermal power plants;
    2) CHP plants;
    3) district heating plants, local boiler plants;
2. plants using unconventional fuels (biofuels, RES);
    1) condensing thermal power plants (biomass);
    2) CHP plants (biomass, biogas);
    3) district heating plants (biomass);
    4) waste incineration plants.

Each of the listed groups (power plants, CHP plants, district heating plants, waste incineration plants) is characterised by similar features, although the first of them relies on a different type of heat transfer medium responsible for the waste heat potential generation process.

The table below presents the types and parameters of these media.

Table 95. Types and parameters of media in heating plants

Item	Type of source	Medium	Medium temperature level [^{0}C]
1.	Condensing power plant	water	25
		exhaust gases	250
2.	CHP plant	exhaust gases	250
3.	District heating plant	exhaust gases	250
4.	Waste incineration plants	exhaust gases	250

Typically, waste incineration plants function as district network sources supplying district heating systems and are cogeneration plants, which are distinguishable from other types of installations by the type of fuel, namely combustible fractions of waste.

10.1. Waste heat in power plants

10.1.1. Medium – water

The thermodynamic cycle in a condensing power plant requires receiving large amounts of evaporation heat from the working medium, i.e. steam. The steam condenses in the turbine's condenser in the process of exchange of heat between the steam in the circuit and cooling water. Cooling water can be supplied from an open or closed cycle. In the former case, it can come from a river, lake, or the sea, while in the latter, from a cooling system, e.g. one featuring cooling towers. In both cases, huge amounts of waste heat are lost for the environment (river water heating, water drift and evaporation in the cooling tower). Given the low temperature of the medium (cooling water), the heat is of the low-temperature type.

10.1.2. Medium – exhaust gases

The combustion of hydrocarbons (fossil fuels) always entails the formation of combustion products – exhaust gases. The amount of exhaust gas depends on the amount of combusted fuel and the amount of air supplied for the combustion.

The temperature of the exhaust gases that leave the furnace reaches several hundred ^{0}C, while that of exhaust gases at the outlet of the stack ranges from 200 to 300 ^{0}C, which means that large amounts of heat are emitted into the atmosphere with the exhaust gases. It is the second – next to cooling water – source of waste heat.

10.1.3. Waste heat in the other plants

It is assumed that CHP plants, district heating plants and waste incineration plants do not require additional cooling systems and useful heat is fully utilised by the heat generated by the plant. However, here too, as in power plants, stack losses occur as a result of the formation of high-temperature exhaust gases at the outlet of the stack.

10.2. Quantification of waste heat

10.2.1. Power plants

The waste heat potential in a power plant was determined as follows. On the basis of the known annual electricity production of the power plant and its energy efficiency, the heat contained in the fuel used in the power plant was quantified. The waste heat was determined as the difference between the annual value of the heat contained in the fuel and the value of the electricity produced by the plant annually.

10.2.2. CHP plants

A CHP plant is a cogeneration installation. It simultaneously produces heat and electricity. For the purposes of quantifying the potential of waste heat from cogeneration, the heat production and electricity production from cogeneration are calculated/quantified on the basis of fuel consumption, which is known, and waste heat potential is estimated as the difference between the heat contained in the fuel and the electricity and heat production taken together.

In the absence of either of the balance data, i.e. electricity or heat production, use is made of the information set out in Part I of Annex I General principles to Directive of 25 October 2012 on energy efficiency, regarding the default power to heat ratio for various types of cogeneration systems.

10.2.3. District heating plants, local boiler plants

In order to quantify the waste heat potential, the known value of heat contained in the fuel and the value of heat production are used. Waste heat potential is measured as the difference between the heat contained in the fuel and that generated by the plant.

10.2.4. Waste incineration plants

A waste incineration plant is a cogeneration system. It produces both heat and electricity. As in the case of CHP plants, its waste heat potential is quantified as the difference between the heat contained in the fuel (waste) and the sum of heat and electricity produced.

10.2.5. Quantification of waste heat potential of power plants, CHP plants, local boiler plants, and waste incineration plants

The results of the compiled analyses are presented in the table below:

Table 96. Results of analyses of the waste heat potential of power plants, CHP plants, district heating plants and local boiler plants, as well as of waste incineration plants.

Item	City	Conv. CHP	RES CHP	Inc. plant	Conv. DHP	RES DHP	Waste heat	Total
		Qwaste	Qwaste	Qwaste	Qwaste	Qwaste	Qwaste	Qwaste
		GWh	GWh	GWh	GWh	GWh	GWh	GWh
1.	Białystok	45.32	79.73		64.59			189.64
2.	Bydgoszcz	130.23		12.75	21.91			164.89
3.	Gdańsk	234.59			20.28			254.88
4.	Gorzów Wielkopolski	16.66			11.15			27.81
5.	Katowice		3.33		269.76	34.64		307.73
6.	Kraków	251.78	8.72		111.53		84.43	456.45
7.	Kielce	21.41	5.11		81.10			107.61
8.	Lublin	118.74			49.28			168.02
9.	Łódź	249.56	27.70		164.65			441.91
10.	Olsztyn	21.91			94.06	10.26		126.23
11.	Opole	13.76			80.19			93.95
12.	Poznań	113.29	21.84	9.28	109.09		3.33	256.83
13.	Rzeszów	33.28		3.82	56.62			93.73
14.	Szczecin	54.17	33.20	16.14	58.17	18.52		180.19
15.	Toruń	71.47	0.40		7.31			79.17
16.	Warsaw	652.25	27.59	2.58	536.91			1219.34
17.	Wrocław	156.39	6.50		137.08			299.96
18.	Zielona Góra	29.29			10.24			39.53

Abbreviations used in the table:

- Conv. CHP – conventional CHP plants (fired with fossil fuels),

- RES CHP – CHP plants fired with renewable fuel,
- Inc. plant - waste incineration plant (incinerating combustible fraction of municipal waste),
- Conv. DHP - district heating plant fired with conventional fuel,
- RES DHP – district heating plant fired with renewable fuel,
- Waste heat – industrial waste heat supplied to a district heating system

10.3. Industry sector

Based on data on the amount of heat generated in conventional heat generation units in industry, the waste heat potential was calculated as the difference between the estimated amount of heat in the fuel and the heat energy generated, using pre-defined heat generation efficiency in the non-CHP unit. For the data available on the volume of heat generated in CHP units, first the total volume of generated energy (heat and electricity combined) was estimated, and based on the assumed efficiency of the CHP unit, the waste heat potential was calculated as the difference between the estimated energy contained in the fuel and the combined energy generated. The calculated values of waste heat potentials were summed up for each province. The outcomes are presented in the table below.

Table 97. Estimated waste heat potential in the industry sector

Name	**Estimated waste heat potential [GWh]**
DOLNOŚLĄSKIE	118.98
KUJAWSKO-POMORSKIE	72.15
LUBELSKIE	610.40
LUBUSKIE	12.88
ŁÓDZKIE	149.50
MAŁOPOLSKIE	316.13
MAZOWIECKIE	575.31
OPOLSKIE	111.70
PODKARPACKIE	129.96
PODLASKIE	51.33
POMORSKIE	34.09
ŚLĄSKIE	319.16
ŚWIĘTOKRZYSKIE	97.25
WARMIŃSKO-MAZURSKIE	12.75
WIELKOPOLSKIE	134.88
ZACHODNIOPOMORSKIE	5.16
POLAND	**2 751.63**

10.4. Waste cold

In Poland, there are no district cooling systems that are supplied from centralised sources. Management of cold mainly involves satisfying the needs of individual consumers. Local supply of cold, which is very rare, serves to satisfy the needs of isolated or 'island' consumers – food cold storage facilities, agricultural and food storage warehouses, wholesalers, office buildings.

Cold for these consumers is sourced from compressor installations, which have their technical parameters tailored to the needs of these consumers and do not offer any utilisable waste cold potential for technical and technological reasons.

11. Strategies and policy measures, and the main objectives of the heating sector in Poland

The National Energy and Climate Plan 2021-2030 (hereinafter: NECP) is a document whose implementation stems from Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action. The Regulation requires all Member States to prepare a strategic document on energy and climate protection. The document was adopted by the Committee for European Affairs at a meeting on 18 December 2019. The NECP presents assumptions and objectives, as well as policies and measures towards the implementation of the 5 dimensions of the Energy Union:

1. Energy security.
2. Internal energy market.
3. Energy efficiency.
4. Decarbonisation.
5. Research, innovation and competitiveness.

The NECP was drafted further to the conclusions of inter-ministerial work and public consultations, as well as the findings of regional consultations and Commission Recommendation C(2019)4421 of 18 June 2019. It was prepared on the basis of national development strategies approved at the governmental level (including *Sustainable Transport Development Strategy 2030, State Environmental Policy 2030, Strategy for Sustainable Development of Agriculture, Rural Areas and Fisheries 2030*), and with account taken of the draft *Energy Policy of Poland until 2040.*

The Energy Policy of Poland until 2040 (hereinafter: EPP 2040) responds to the key challenges to be faced by the Polish energy sector in the coming decades and sets development lines for the sector, taking into account the tasks necessary to be implemented in the short term. The document sets the following three strategic goals for the Polish energy sector:

- energy security;
- competitiveness and improving energy efficiency;
- reducing environmental footprint.

The above goals of the EPP 2040 will be pursued through eight specific objectives in the fuel and energy sector, which are split into implementing tasks. As regards heating, tasks incorporated in the following specific objectives are to be implemented:

- development of district heating and cogeneration, and
- improving energy efficiency.

Other documents relevant to the delivery of heating policies in Poland are as follows:

- The National Air Pollution Control Programme;
- The European Green Deal (EGD);
- Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814 (European Trading System Directive – ETSD).
- Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Renewable Energy Directive II – RED II).
- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Industrial Emissions Directive – IED)
- Directive of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (Energy Efficiency Directive – EED).
- Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants (Medium Combustion Plants Directive – MCPD);
- Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (Energy Performance of Buildings Directive – EPBD).

The year 2023 is to see the approval of a sectoral planning document entitled 'Heating Sector Strategy for 2030 with an Outlook for 2040' (hereinafter the Strategy). The purpose of the document is to implement the provisions set out by the abovementioned national and EU documents, while addressing the need to meet the overriding requirement to ensure the technical and economic security of the supplies of heat to consumers and taking into account the central role of local governments as the entities responsible for managing these supplies. The Strategy focuses on the 2030 horizon and district heating, presenting the potential for further development of the sector until 2040. The Strategy is consistent with the policies that work towards achieving the five dimensions of the Energy Union.

Given the need for the implementation of the above national and EU documents, the key current challenges for the Polish heating sector are as follows:

- Bringing the systems to the status of efficient district heating systems;
- minimising long-term increase in heat prices caused by the rising prices of CO2 quotas;
- increasing renewable energy production;
- adapting the sector to the requirements of the technical conditions for new and comprehensively energy-renovated buildings;
- ensuring the attractiveness of district heating as the most popular source of heat among Polish households.

11.1. Bringing the systems to the status of efficient district heating systems

The definition of an efficient district heating system set out in the EED has been transposed into the Polish Energy Law, and is worded by Article 7b(4) as follows: 'Efficient district heating and cooling means a district heating or cooling system using at least 50% renewable energy, 50% waste heat, 75% cogenerated heat or 50% of a combination of such energy and heat.'

The share of efficient systems on a nationwide scale is lower than 20%. The small number of efficient district heating systems in Poland is due to the fact that in most systems heat is generated in coal-fired water boilers. Typically, efficient district heating systems in Poland are supplied by installations based on the generation of heat in cogeneration, which also relies on coal.

Therefore, in order for the status of efficient district heating system to be attained, there is a need for a large number of installations to be replaced and for the associated fuel switch to be effected, which requires incurring substantial capital expenditures and associated costs of capital, and entails increased operating expenses related to the depreciation of the new assets. These increases will largely be offset by the reduction or complete avoidance of costs related to greenhouse gas emissions. When effecting the conversion, district heating companies should consider the option of replacing a single central unit with several smaller units in order to enhance flexibility and diversify energy products.

In order to optimise the investment in the plant, some companies prefer to upgrade the network first, but the criterion of achieving an efficient system as a result of the investment is one of the conditions for obtaining public financial support for upgrading district heating systems. Commission Regulation (EU) 651/2014 provides that only efficient district heating systems will be eligible for public aid for upgrading and development.

Pursuant to Article 7b(1) of the Energy Law, buildings not connected to a network or not equipped with an individual source of heat supply are required to connect to the district heating network. However, pursuant to Article 24(2) RED II, Member States will need to guarantee, under certain conditions, the right to disconnect from an inefficient district heating system that does not become efficient by 31 December 2025. Therefore, the Strategy foresees the need to invest first in district heating/cooling plants, and only then, at a later stage, in the heat distribution network.

Efficient systems are mainly located in major cities and have the largest installed capacities. As a consequence, 68% of the volume of district heat is supplied by efficient systems, mostly in metropolitan areas, which, at the same time, represent less than 20% of the total number of all systems in Poland.

As a result, the most sizable capex on upgrading the district heating sector towards increasing the number of efficient systems will need to be made by companies in small and medium-sized cities (district cities), which have limited financial and organisational resources. Such companies, many of which are owned by local governments, have limited creditworthiness, with them unable to even accept the conditions of preferential loans supported by subsidies. Given the limited availability of capital to smaller entities, district heating systems may be forced to change ownership when faced with the need to undergo radical transition.

11.2. Minimising long-term increase in heat prices caused by the rising prices of CO2 quotas

Having been subject to the CO2 emissions trading system, the district heating sector has experienced serious difficulties in recent years due to the steep increase in emission-related costs. In 2017, the price of CO2 emission allowances was around EUR 5, to rise to EUR 30 in 2020 and approach EUR 100 in 2022.

Such rapid increases have a negative effect on the finances of enterprises, which are unable to fully reflect the allowance price growth rate in their heat tariffs as approved by the President of the Energy Regulatory Office (ERO). This affects the financial liquidity of enterprises, which are forced to contract debt in order to cover their current operating expenses. The tightening EU climate policy and the decision of the European Council to raise the 2030 emissions reduction target to 55% will drive further increase in the prices of emission quotas in the years to come.

If this trend continues, heat consumers may disconnect from the network in favour of cheaper, individual solutions, causing the destruction of economically weaker district heating systems, and as a consequence, even disruption to the supply of heat to consumers. Therefore, production in district heating plants must be decarbonised through the replacement of water boilers with high-efficiency cogeneration units and integration of renewable sources. Such activities can mitigate the impact of EUA costs on heat prices and reduce heat tariffs for final consumers in the medium and long terms.

This cost represents the most significant alternative cost of no transition towards low-carbon and carbon-free sources in the district heating sector. This requires systemic actions towards the decarbonisation of the district heating sector (t CO2/GJ) in order to make heat prices less dependent on allowance prices.

11.3. Increasing renewable energy production;

Decarbonisation targets can be attained by increasing the share of renewables. Article 23 RED II sets the annual rate of increase in the share of heat and cooling from renewables for at least 1.1 percentage points as an average calculated for the periods 2021-2025 and 2026-2030 relative to the share of renewable energy in the district heating and cooling sector achieved in 2020. In accordance with the target set out in the EPP 2040, the share of renewables in the Polish heating sector should amount to 28.4% in 2030.

The target share of renewables refers to the total heat generated, which is notable in the context of the difficulties in deploying renewable heat in existing district heating systems. The development of renewable technologies in district heating will also be stimulated by the adopted caps on the demand for non-renewable primary energy set for new and comprehensively energy-renovated buildings. This means that building designs will need to be aligned to the new standards, the attainment of which will be possible along with the growth in the share of renewables. The choice of heating based on low-carbon technologies associated with renewable energy sources will become a natural option for investors. District heating companies must adapt their offer to the abovementioned requirements by providing dedicated solutions at the level of district-heating substations (heat pumps) or in microsystems not connected to the district heating network ('island' installations).

In district heating, it is necessary for the heat generation units and networks to be configured in a way that enables their efficient joint operation, taking into account the operating profile of RES units, which – aside from biomass-fired installations – differs from the profile of conventional sources. The use of such RES generation units requires keeping a stable conventional unit on standby as a backup source.

In smaller district heating systems, utilising geothermal, biogas and local biomass will be possible provided that these technologies can be deployed in a given location. At the ends of the system, solar collectors and heat pumps supported by photovoltaics will also be installed for them to operate as ‘island’ systems, with heat from the main system treated as a peak-load and back-up source.

In the largest district heating systems, given the need to install very high-capacity generation units, the transition towards RES sources is a major technical and logistical challenge (e.g. delivery of very large amounts of biomass, the required temperature of the working medium in the network, etc.). The greening of large district heating systems is primarily possible at the level of the distribution network (use of heat pumps).

11.4. Ensuring the attractiveness of district heating as the most popular source of heat among Polish households.

As is implied by the challenges described above, over the next decade, district heating will face a number of challenges related to the unprecedented scale of capital expenditures on upgrading efforts.

Despite the need for it to purchase emission allowances and comply with stringent environmental standards, the district heating sector continues to be competitive compared to individual sources of heat energy. Even despite the current energy mix in the sector, district heating is also the most environmentally friendly source of heat, which allows for emissions of PM and other harmful substances into the atmosphere to be reduced. Low emissions of pollutants into the air contribute to reducing external costs, e.g. health impacts.

The construction of new heating plants will be the most capital-intensive element of the modernisation of the district heating sector. The multi-billion scale of investment will translate into increases in heat prices generated by the expected return on capital and depreciation. The transformation of district heating must take into account the prices of heat from alternative sources and the emergence of substitute competition on the heat market. This may prompt consumers to disconnect from district heating networks and, more importantly, prevent new connections. The above phenomena will give rise to further heat tariff increases as a result of the growing share of fixed opex, which could render district heat unattractive.

Counteracting these risks requires designing a system of support for new investment and communication between stakeholders in the sector. Heat consumers must be aware that the temporary increase in heat tariffs due to investment is less burdensome than the petrification of the current situation, which gives rise to exponential increases in heat prices due to the upward movement of carbon and fuel prices. Not investing in low-carbon or carbon-free heat generation units will lead to gradual disintegration of inefficient district heating systems, from which, as is professed by RED II, consumers will disconnect.

12. Potential new strategies and policy measures

12.1. Target operating model of the district heating sector

Heat demand should be satisfied in the first place by district heat, if available. Modern district heating systems ensure high fuel efficiency, user comfort, attractive heat prices and clean air. In addition to providing benefits to district heating companies, newly built cogeneration units will enable the integration of renewables into the electricity industry by balancing the national electricity system, especially in combination with heat storage, which adds flexibility to the operation of individual units. An increased share of cogeneration and improved flexibility in the operation of heating units will foster cooperation between the district heating sector and the electricity industry, which will indirectly enable further dynamic growth in the share of renewables in the electricity sector.

Ultimately, district heating will be a conglomerate of diversified technologies and should optimally utilise local energy resources and sources, which includes efficient use of heat and electricity generated through cogeneration, in installations for thermal treatment of the high-calorific fraction of municipal waste, and from the treatment of municipal waste, as well as waste heat from industrial processes.

Ongoing urbanisation and suburbanisation requires a growing number of buildings to be connected to district heating networks, while the target of the EPP2040 is to connect 1.5 million new households to district heating networks by 2030. Achieving this will require an active role from and cooperation by local government units and heating companies in the preparation of heat supply plans and regulatory facilitation for connecting new consumers to 'island' district heating networks operating on the basis of RES technologies.

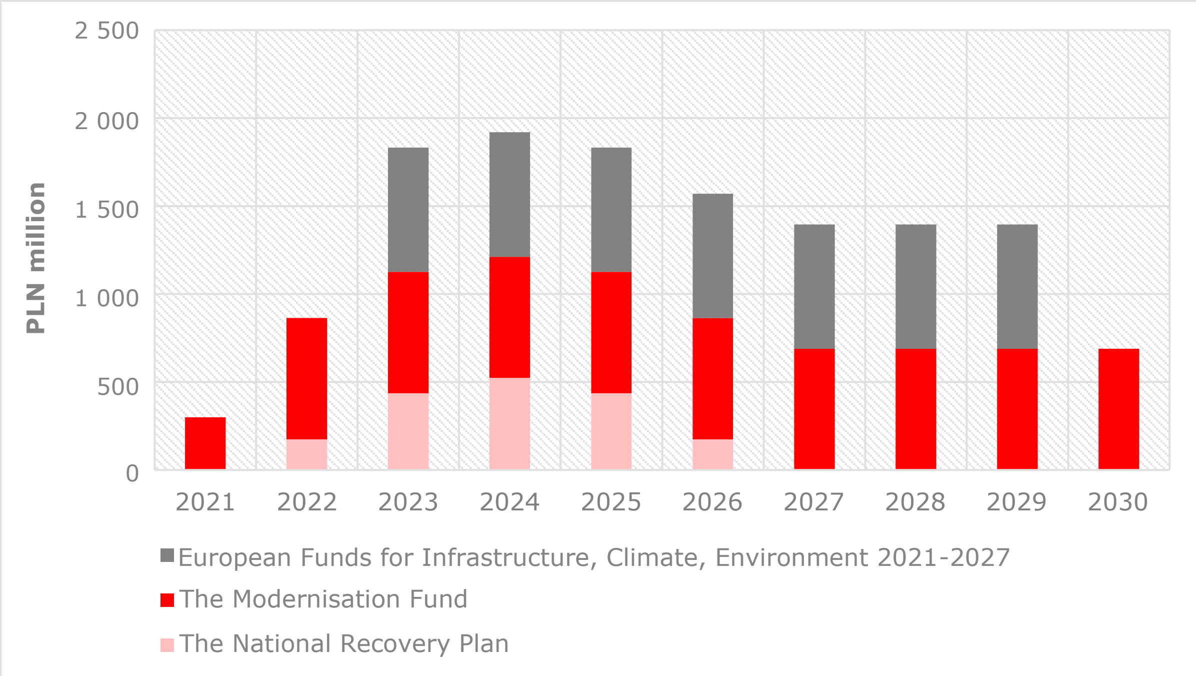
The development of district heating systems will focus on reducing heat losses in the network and lowering the temperature of the heat transfer medium, which will enable the integration of a wide range of RES-based technologies from distributed sources. Managing multiple installations in a district-heating system will be possible as a result of parallel large-scale deployment of smart district heating networks and heating supply and demand management systems. As a result of these activities, CO2 emissions from the regulated (licence-based) district heating system should decrease by at least 34% by 2030 relative to 2019.

12.2. Plant replacement activities

12.2.1. Financing the construction of new plants

The currently available funding for the refurbishment of the district heating sector has a specific time perspective: 2026 for the National Recovery Plan, 2030 for the Modernisation Fund, and 2021-2027 (n+3) for the Infrastructure and Environment Operational Programme (IEOP). Funding available from the above sources will be spent in the first place on the transition in the sector towards effective district heating systems (NRP, MF), as well as on the refurbishment of district heating networks and increasing the share of renewables (IEOP).

Figure 3. Forecast public subsidy-based funding for district heating.



Given the limitations of public funding, which is fully available only to systems that meet the requirements of an efficient heating system or to those that will become efficient as a result of obtaining the support, it is necessary to finance first the retrofitting of heating plants.

12.2.2. Continuation of support for high-efficiency cogeneration

In order to maintain its status, high-efficiency cogeneration eligible for support must demonstrate adequate primary energy savings and appropriate sales of useful heat. The construction of modern gas-fired CHP plants with a flexible operating profile benefits the operation of the national electricity system by ensuring more evenly spread geographic distribution of energy generation and periodic balancing of generation from renewable energy sources. This technology has the advantage of it being recognised as a source bringing the district heating system closer to the efficient status.

In addition to reducing CO2 emissions by up to 60% compared to coal-based generation, natural gas practically eliminates the formation of particulate matter, and emissions of sulphur and nitrogen compounds are also substantially reduced. Given the economic and legislative environment, the decommissioning of coal-fired plants is bound to accelerate in the current decade. The role of natural gas in the district heating sector will grow, as it is an essential element of the energy transition in Poland.

Recognising the potential of cogeneration, in 2018 the Sejm (lower house of the Polish Parliament) passed the Act on promoting electricity from high-efficiency cogeneration. The introduced support measures are expected to translate, among other things, into the construction of 5.1 GW of installed electrical capacity in new cogeneration units, fired mainly with natural gas, which will replace, above all, coal-fired district heating plants that utilise outmoded water boilers.

According to the data of the electricity transmission system operator, in 2019, 71.9% of the domestic demand was covered by energy derived from the combustion of coal. The electrification of the district heating sector will depend on the pace at which the Polish electricity industry is ‘greened’ and the resulting impact on energy prices.

In parallel, the oldest coal-fired generating units will be shut down, which entails a risk to the security of electricity supply, as has been found by reports of the Energy Regulatory Office and of PSE (Polish electricity transmission system operator). Both reports were compiled before the steep rise in the price of emission allowances, which has rendered production in older coal-fired installations even less viable, so the risk may be even greater. The construction of large, flexible cogeneration units and gas-fired power plants will fill the emerging gap, allowing the stability of the electricity system to be maintained until nuclear units come into being.

In the long term, after 2040, given the need to achieve the goal of climate neutrality, the share of natural gas-fired cogeneration units should be gradually reduced, and their role in the operation on the district heating curve will move towards peak-load sources.

The system for promoting electricity from high-efficiency cogeneration is subject to continuous evaluation and will be modified with a view to achieving the assumed effects. Based on completed analyses, an obligation for 4 auctions and 2 rounds of competitive bidding per year has been put in place and the requirement for a valid building permit to be submitted already at the stage when admission to the support system is sought has been abolished. These developments will contribute to increasing the availability of the support mechanism for investment projects that work towards the decarbonisation of the district heating sector and will help optimise the investment financing schemes available.

12.2.3. District heating greening scheme

Given the continued prevalence of fossil fuels, especially in district heating, and the high cost of the deployment of RES, the sector is in need of additional support. The current RES capacity growth rate is too slow for the assumed 28.4% RES share to be attained by 2030. According to data from a study of the President of ERO, the share of renewables among the fuels used in the regulated district heating sector increased from 2.9% to 9.5% between 2002 and 2019.

In order to ensure continued financing after the funds from the National Recovery Plan are exhausted, a scheme that guarantees long-term increase in the share of renewables will need to be developed. Given that an obligation to integrate renewables into every district heating system would be redundant and inefficient, there is a need for a mechanism that would incentivise district heating companies into integrating specific technologies. To achieve this, the introduction of a fixed, minimum return on capital invested in a RES installation in the district heating sector is being considered.

After 2030, in the face of constant pressure to increase the share of RES, it may be necessary to put in place solutions dedicated to further development of renewables after the subsidies are no longer available.

Another idea is to facilitate the greening of district heat by exempting plants with an installed capacity of up to 5 MW, which are characterised by a non-renewable primary energy input factor not higher than 0.8 and in which renewable heat accounts for at least 60% of the generated energy from the obligation to have heat tariffs approved by the President of ERO. This will contribute to gradual decarbonisation of district heating systems through the construction and connection of small, distributed installations, primarily at the ends of the system. The regulatory revisions and the support system will add to promoting the development of district heating in suburban areas in the form of 'island' systems.

12.2.4. Local utilisation of the high-calorific fraction of waste

In accordance with a regulation of the Minister for the Economy, landfilling of municipal waste with a calorific value above 6 MJ/kg is illegal. However, despite technology developments, the recycling of all materials is not possible. The stream of unutilised combustible municipal waste not suitable for recycling will be approximately 1.5-1.8 million tonnes per year in 2034. In addition, a large proportion of this category of waste is landfilled illegally, posing a constant fire hazard. With the 8 currently operating waste incineration plants, the 3 plants under construction, and cement plants (which also utilise waste), the capacity of installations capable of treating the high-calorific fraction of waste should be considered far from sufficient. This waste must be managed in dedicated cogeneration incineration units or qualified as fuel for local district heating plants and used in the vicinity of the place where it is generated. As a result of the construction of waste incineration plants working in the cogeneration mode and simultaneous application of the waste management hierarchy, the district heating sector will contribute to solving the problem of handling the high-calorific fraction of municipal waste. Given the thermal capacity of the existing installations and their processing capacity, it can be roughly estimated that the utilisation of the entire unused waste stream would entail the construction of generating units with a total capacity of several hundred megawatts.

12.2.5. Utilisation of waste heat

Pursuant to RED II, waste heat means unavoidable heat as by-product in industrial or power generation installations, or in the tertiary sector, which would be dissipated unused in air or water without access to a district heating or cooling system. Even though Poland has opted out of including waste heat in the RES target, which would translate into an increase in the target from 1.1 pp/year to 1.3 pp/year, legislative solutions should be put in place to ensure that such heat is utilised as an important contributor to the achievement of the efficient system status. As part of the implementation of RED II, the definition of waste heat will be regulated by its inclusion in the Energy Law.

The greatest advantage of waste heat should be its low price, as netted of the costs of connection and heat recovery equipment. Utilising waste heat in the district heating system is an alternative means towards having such a system recognised as efficient. It is planned for the Energy Law to incorporate an obligation for waste heat sources to be registered and for waste heat to be utilised whenever economically viable.

12.2.6. Support for low-temperature systems

The development of heating technologies is heading towards designing networks with a lower temperature of the medium than at present. The underlying reasons are as follows:

- Lower temperatures of the medium will translate into lower heat losses.
- Most RES-based generation technologies supply heat in a medium with lower temperatures than currently deployed technologies based on fossil fuels.
- Newly constructed buildings are characterised by very good thermal insulation and will not need large amounts of heat.

Despite the abovementioned difficulties in the deployment of low-temperature solutions in large district heating networks, this will be a natural, evolutionary direction of change. All aid schemes will need to be extended to include support for low-temperature solutions, and later on the focus will need to be shifted to these technologies. The deployment of low-temperature solutions requires wider changes than just replacing the plant, namely reorganisation of the system. As district heating systems are gradually brought to the efficient status, public funding for district heating infrastructure will be growingly redirected towards the adaptation of systems to 4th and 5th generation networks. Currently, low-temperature technologies are supported primarily by the 'New Energy' priority scheme run by the National Fund for Environmental Protection and Water Management (NFOŚiGW).

12.2.7. Cooperation with the electricity sector

One of the challenges posed by the large share of unstable RES incorporated into the electricity system is the mismatch between electricity production and demand from consumers. Balancing energy in the national electricity system (hereinafter: NES) requires limiting or restarting the operation of conventional units, as the case may be.

This is a negative phenomenon hampering management of the electricity distribution system and hindering the operation of conventional units. Fluctuations in demand cause electricity trading on the markets to experience rapid price movements.

District heating systems will cooperate with the electricity industry on two levels: at times of electricity shortages, by generating electricity through the production of energy in high-efficiency cogeneration units, and at times of surplus production of electricity, by receiving and using this electricity in P2H (power-to-heat) technology by means of electrode boilers or heat pumps installed in district heating substations. The underlying concept is to convert surplus electricity into heat, which can then be stored. The deployment of this technology requires regulatory changes to make this type of investment viable and to support wide use of daily-cycle heat storage. Storing energy in this form is technologically simpler and cheaper than storing electricity, e.g. by means of chemical batteries.

Heat storage adds flexibility to production, since it enables electricity production in cogeneration units and simultaneous storage of generated heat until there is demand. Currently, short-term storage facilities that balance relatively small amounts of heat for daily-cycle needs are operated on a large scale. It is necessary to promote these further until each cogeneration unit with a capacity of more than 5 MW is able to work together with heat storage.

Another popular concept for using surplus electricity from renewables is to convert this into gas: P2G (power-to-gas). Electrolysis of water for the production of hydrogen is the most common way in which this concept is used. However, hydrogen infrastructure and demand for this fuel as an energy product has not yet been fully developed. Gases produced through P2G processes are considered decarbonised. Using such gas is most viable in high-efficiency processes, i.e. in cogeneration. In the case of hydrogen, this not only means combustion, but also cogeneration fuel cells. Existing schemes and funds will promote projects involving these technologies. The Polish hydrogen strategy provides for the development of co- and tri-generation systems across a wide range of capacities.

Article 24(8) RED II requires distribution system operators to assess, in cooperation with operators of district heating systems, the potential for district heating systems to provide support for the electricity system. This obligation will be transposed into Polish law by way of an amendment to the Energy Law. If duly complied with, this obligation has the potential to support transition in both sectors.

12.2.8. Environmental education and awareness-raising

Given the growing role of consumers in the energy market, public awareness of consumer rights and obligations will be a fundamental contributor to the transformation of heating. The public are aware of the importance of the problems posed by air pollution and global warming. Actions pursued should be focused on ensuring the appropriate air quality and reducing emissions of pollutants into the atmosphere.

The results of environmental awareness surveys commissioned by the Ministry of Climate and Environment are worth noting. According to those surveyed, air pollution is the greatest threat to the natural environment in Poland (59% of responses), although knowledge about the largest source of pollution, namely individual heat boilers, is not common (37% of responses). The surveys imply an improving perception of district heat among consumers. At the same time, the respondents point to comfort as the most appreciable feature of heating, which is the key advantage of district heat.

Communication between the public administration and citizens will be crucial in the district heating modernisation process. Given the investments to be carried out, the level of heat costs may temporarily increase, but in the longer run external costs, costs resulting from the EU ETS and the increase in fossil fuel prices will be avoided.

12.2.9. Support for the company transformation design and funding process

Companies operating in the district heating sector, most of which are small and medium-sized enterprises, often do not have the appropriate expertise and competence to deploy new technologies, such as to allow them to carry through a comprehensive transformation of their assets. Additionally, engaging consulting and engineering companies is a process that requires substantial expenditure, and is associated with the risk that the engaged entity will not have the appropriate expertise.

In order to address such challenges, the EU has established ELENA. Created in 2009 as the ‘EuropeanLocalENergyAssistance’ initiative, it is based on an agreement between the EIB and the European Commission. ELENA grants are available for the preparation (not implementation) of investment programmes in energy efficiency and sustainable urban transport.

Based on ELENA funding, Krajowa Agencja Poszanowania Energii has created the National Integrator of Investment Projects in District Heating Companies – Support Scheme for

Small and Medium-Sized DHCs (Krajowy Integrator Projektów Inwestycyjnych w Przedsiębiorstwach Energetyki Cieplnej – Program wsparcia małych i średnich Przedsiębiorstw Energetyki Cieplnej). The main goal of the concept is to support investment in the replacement of heat generation units by providing not just the funds, by also the competence necessary in the preparation and implementation of a project. The planned outcome of the scheme is the signature of letters of intent with over 40 enterprises.

Without appropriate readily-available competences in the use of RES in heating, the transition in the sector may be considerably hindered, regardless of how much funding is allocated under the support schemes.

12.3. Regulatory and administrative area

12.3.1. Introduction of a heat source hierarchy

The objectives of the climate policy require that the sector rethinks its philosophy of the heat generation business and that RES be integrated in the systems that undergo refurbishment wherever technically feasible. The increasing number of heat streams available necessitates the introduction of a hierarchy of sources. Currently, district heating network dispatchers are obliged to purchase heat from RES, provided that the heat sourced does not exceed the heat demand in the system, and the heat price is not higher than the average price of heat from other sources in the system.

However, in order to meet the requirements set by EPP 2040, it is necessary to put in place an extended hierarchy that takes into account more variables and sources of heat energy in correspondence to the findings of this document. The extended hierarchy should prioritise locally available fuels, including: Renewables, the calorific fraction of non-recyclable waste, waste heat from industrial processes.

The proposed hierarchy of the purchase of heat by the district heating network dispatcher is as follows:

1. The entire stream of heat from a waste incineration plant in proportion to the share the quantity of fuels formed by locally sourced waste has in the entire stream of fuels utilised for the combustion process in the unit (priority of work in the base).
2. The entire stream of waste heat, including that recovered from industrial processes and, for example, from wastewater or reversible heat pumps (priority of work in the base).
3. Geothermal energy, heat pumps other than those qualifying under point 2, solar installations operating on the return of the medium or under the heating curve.
4. Heat from other RES installations in proportion to the share the quantity of fuels representing renewable energy sources has in the entire stream of fuels utilised for the combustion process in the unit (priority of work in the base).
5. The entire heat stream from a set of sources (comprised of at least one cogeneration unit) that supply heat to a single district heating system, provided that the entire set of sources ensures the efficiency of the heating system and complies with all the applicable environmental standards and provides heat with the non-renewable energy input factor $w_{p,c} < 0.4$ (priority of work in the base).

6. The entire heat stream from a high-efficiency cogeneration unit (operation under the district heating curve, and if the system comprises several sources – proportionally in relation to the other sources).
7. Other types of heat (work proportional to the other sources).

12.3.2. Introducing guarantees of origin for district heat generated from renewables

It is planned for the system of guarantees of origin to be extended to include heat energy generated from renewables in district RES installations. A guarantee of origin for district heat generated from renewables in a RES installation will be a document certifying to the final consumer the environmental values resulting from avoided greenhouse gas emissions and that the amount of heat supplied to the network as specified by the document has been generated from renewables in RES installations.

The introduction of a system of guarantees of origin for heat from renewables is in line with RED II and will be implemented through a revision of the RES Act. In the case of the district heating sector, which, unlike the electricity system, consists of several hundred separate district heating systems, initially, guarantees of origin will have a purely informative and local dimension. However, it is likely to gain importance over the next decade along with the popularisation of RES installations within district heating systems, for example, in the context of the choice of business locations or the purchase of dwellings, and may accelerate the integration of RES in the district heating sector.

12.3.3. Changes in the tariff model

The current heat pricing and heat tariffing model is based on two approaches:

- Cost-based approach in the case of tariffs for heat generated by installations other than cogeneration units and tariffs of heat distributors – this method is based on the analysis of reasonable costs of running the operation, reasonable refurbishment costs, development and environmental costs, and a reasonable amount of return on capital employed in the activity. The analysis is used for estimating the planned revenue, which is the basis for calculating the prices and tariffs.
- Approach using a reference index and average heat prices for the four groups of fuels used – for heat produced in cogeneration units. Average heat prices are published by the President of ERO. This approach can be considered a benchmark based on average heat prices determined on the basis of reasonable costs and a reasonable return on capital.

The main reason why the tariffing rules must be revised is the permanent underfinancing of district heating companies as a result of limited investing possibilities. In the first place, this follows from a study of the President of ERO, which has found that the profitability of heat generation and distribution companies is on the verge of business viability, which was declining from 2016 to turn negative in 2019.

The need to change the heat tariffing approach will be responded to in two stages:

1. Analysing the reasonableness of amending Regulation of the Minister for Climate of 7 April 2020 on detailed rules for the determination and calculation of tariffs and heat supply settlements, insofar as the following are concerned:
    - ensuring a separate assessment of the stream of revenues determined on the basis of reasonable costs from the determination of the stream of planned return on capital so that the heat tariff approval procedure ensures a guaranteed rate of return on capital for energy companies,
    - indicating the possible adjustments to the individual cost items, which can be effected to balance the interests of consumers and energy companies and to streamline the tariff process.
2. Analysis whether the abovementioned regulation and, where applicable, the Energy Law can be amended in response to regulatory developments, notably in order to enable the deployment of emerging techniques and technologies in connection with the need for increased share of RES in district heating, which necessitates lowering the temperature of the heat transfer medium in networks and development of distributed heat generation units, as well as the development of district cooling supplies and sale of heat to absorption and adsorption chillers, and the use of heat storage, insofar as the following are concerned:
    - changes to the licencing rules,
    - analysis of the provisions set out by Article 7b of the Energy Law towards tightening the requirement for new facilities/buildings to be connected to a district heating network, which concerns both energy companies and designers of newly constructed buildings,
    - change of the tariff model towards more extensive use of benchmarking methods,
    - guaranteeing a minimum return on the capital employed in RES investments,
    - using a ceiling price that can be charged under contracts with heat consumers.

In order to streamline the heat tariff approval process, the President of ERO will conduct cyclical workshops dedicated to the standardisation of heat tariff applications and discussion of the most common mistakes in heat tariff applications.

12.3.4. Support for the poorest households that are particularly vulnerable to heat price increases

A high increase in energy prices on the EU and domestic markets has been observable in 2021. It results from a range of interconnected factors, including: record-high prices of allowances on the ETS market, unfavourable weather conditions (cold winter, exceptionally windless spring and summer), questionable practices of the dominant supplier of natural gas to the EU, low natural gas storage fill and increased demand for resources related to the economic recovery after the Covid-19 pandemic. Energy prices are also having a negative impact on inflation, which has been increasing steeply since the beginning of 2021.

This has an adverse effect on society and poses a risk of lowering the standard of living. In order to counteract these unfavourable developments, it is necessary to put in place mechanisms supporting the most needy citizens.

According to Statistics Poland (GUS), space heating accounts for approx. 65% of the total energy consumed in a household, which means that introducing a mechanism of support for households at risk of energy poverty in satisfying their heating needs is necessary within the framework of efforts aimed at reducing energy poverty in Poland.

The support mechanisms and tools will depend on the developments on the energy and fuel markets and the identified needs of the inhabitants of our country.

12.3.5. Implementation of municipal heat, electricity and gas fuel supply plans

Article 19 of the Energy Law requires the head of municipality (mayor of town or city) to prepare a document setting out the assumptions for the heat, electricity and gas fuel supply plan. There is a need for such assumptions for e.g. heat supply plans to be prepared and then implemented at the local level. As is found by EPP 2040, only 22% of municipalities had such a document in 2018.

Drafting an assumption document based on the requirements of the Strategy for the Heating Sector and of EPP 2040 should be made mandatory for entities seeking public financial support, whether from national or EU funds. The main objective and, at the same time, a requirement in the heat supply sector set forth by the Strategy would be to bring local district heating systems to an efficient status.

Account must be taken of the limited capacity of local administrations, and this task should be facilitated by allocating more funds for training energy advisers. Currently, a programme for educating energy experts for local and regional government administration units is operated under the project 'Nationwide system of advisory support in the field of energy efficiency and RES for the public, housing and enterprise sectors'. The programme is run by the National Fund for Environmental Protection in cooperation with Regional Environmental Protection Funds (wojewódzkie fundusze ochrony środowiska). Under the project, in addition to training municipal administration staff, the hired consultants support local governments in the delivery of investments in renewables and in the preparation of the low-carbon economy plan. According to current data, about 1 600 people have been trained.

These trained staff are a temporary solution to be resorted to until 2025. Ultimately, each municipality should have an independent position of an energy expert. Such a person, having technical education and on-hand experience related to energy generation and energy efficiency, would act towards the development of the municipality area in terms of energy by raising funds and generating savings as a result of reduced energy expenditure. The introduction of the above obligation will be effected through revision of the Municipal Government Act.

13. EU funding

13.1. The Just Transition Fund (JTF)

It is a new financial instrument implemented under the Cohesion Policy to support areas facing serious socio-economic challenges resulting from their transition towards climate neutrality. Its central objective will be to mitigate the effects of the transition by financing the diversification and modernisation of the local economy and mitigating the negative effects on employment. In order to attain the above objective, the JTF will support investments in areas such as digital connectivity, clean energy technologies, emission reduction, industrial regeneration, reskilling of workers and technical assistance. The Fund will also counteract the deepening of regional disparities.

Available funding:

For Poland – EUR 3.8 billion, assuming that climate neutrality is pursued.

Type of projects to be financed in the sector:

Investments consistent with the climate goals, e.g. heat from RES, in regions linked to coal mining.

13.2. The European Regional Development Fund

Amount of funding:

Approx. EUR 1.1 billion for district heating

What will be financed within the sector:

Heat sources and infrastructure.

The Fund aims to provide socio-economic support for EU regions, in particular regions which are economically weak. ERDF funding supports projects that enhance employment, boost entrepreneurship, develop infrastructure and foster competitiveness. Other targeted aspects include the protection of vulnerable groups and the environment, as well as cross-border cooperation. The ERDF activities help to strengthen economic and social cohesion while bridging gaps between regions. This is particularly important in relation to the challenges facing systems in smaller cities.

13.3. Funds of the European Investment Bank (EIB)

The EIB raises funds on capital markets and extends loans on preferential terms for projects supporting EU objectives, including the EU energy and climate policy. The institution has ambitions to transform into a 'Climate Bank' in order to focus on investments in sustainable development and combating climate change. At the end of 2021, the bank will stop financing oil and gas investments, unless the stakeholders prove that their projects will produce a positive effect by reducing emissions considerably. This translates into sizable funding in the form of preferential loans, e.g. for the development of renewable heat sources. As a rule, the European Investment Bank cooperates with the consumers of its financial products directly only in the case of large projects. Support for smaller investment projects is available through Bank Gospodarstwa Krajowego.

Amount of funding:

Generating EUR 1 trillion in climate investments across the EU by 2030

What will be financed within the sector:

Sustainable investments – RES generation units and infrastructure for efficient systems.

13.4. The Modernisation Fund

The Fund's resources are derived from proceeds from the ETS system – 2% of all funds from this system, including those from the sale of Polish allowances under the 'derogation pool' in what is referred to as the 'fourth trading period' of the EU ETS. The allocation of the funding is managed by the National Fund for Environmental Protection and Water Management (NFOŚiGW). The Fund is not only designated for district heating, but also for the overall decarbonisation effort.

Amount of funding:

At least PLN 6.5 billion for Polish district heating system.

What will be financed within the sector:

Generation units, digitisation of the network.

13.5. The Recovery and Resilience Facility (RRF)

Amount of funding:

EUR 300 million for Polish district heating.

What will be financed within the sector:

Units with a capacity of up to 50 MW.

The Recovery and Resilience Facility is a tool established for the purpose of fighting the crisis caused by the COVID-19 epidemic. It is the largest, so far, package of measures financed from the EU budget with a view to stimulating the economy, spurring economic growth during the recovery from the epidemic, and consequently avoiding a long-term crisis. In addition, a large proportion of the funds is to be allocated to investments aimed at 'greening' and digitising the economy. The allocation of funding within the Member States is defined by National Recovery Plans (NRPs). In the Polish NRP, PLN 300 million has been allocated for component B.1.1.1., which covers the replacement of heat generation units in district heating.

14. National funding

14.1. High-efficiency cogeneration support system

Act of 14 December 2018 on promoting electricity from high-efficiency cogeneration (Journal of Laws 2019, item 42) has put in place 4 cogeneration support mechanisms:

1. auction-based support scheme – in the form of a cogeneration premium for cogeneration units (new and substantially refurbished) with an installed electricity capacity between 1 MW and 50 MW, which win auctions announced, run and resolved by the President of ERO;
2. support scheme based on competitive bidding – in the form of an individual cogeneration premium for cogeneration units (new and substantially refurbished) with an installed electricity capacity of at least 50 MW, which will win competitive bidding procedures announced and run by the President of ERO;
3. scheme of support in the form of a guaranteed premium for:
   - cogeneration units (existing and refurbished) with an installed electricity capacity between 1 MW and 50 MW;
   - small cogeneration units (new, substantially refurbished, existing or refurbished) which are part of an installation with a total installed electricity capacity of up to 1 MW;
4. support scheme based on a guaranteed individual premium (the amount of the premium is determined individually through a decision of the President of ERO) for cogeneration units (existing and refurbished) with an installed electricity capacity of at least 50 MW.

Amount of funding:

Up to PLN 30 billion of support.

What will be financed within the sector:

High-efficiency cogeneration units.

The support scheme is financed by a cogeneration surcharge added to the electricity bill. The support is granted through auctioning, except for the largest installations, for which it is determined on an individual basis. Electro-intensive enterprises calculate the amount of the necessary surcharge from the amount of electricity that is reduced depending on the value of the electro-intensity co-efficient. The maximum surcharge reduction is 85%. The amount of the surcharge determined by the Minister for Energy is based on the forecast disbursements from and the balance of funds on the account kept by Zarządca Rozliczeń S.A.

14.2. Capacity market

Amount of funding:

The annual cost of the capacity market is approx. PLN 5 billion, with the amount of funding granted to cogeneration units dependent on the bids.

What will be financed within the sector:

High-efficiency cogeneration units.

The introduction of a capacity market means a change in the architecture of the energy market from a single-commodity market to a dual-commodity market, where in addition to the generated electricity, also the net available capacity, i.e. readiness to supply electricity to the grid, will be subject to trade through purchase-sale transactions. The selection of the capacity market units that will offer the service for appropriate compensation is based on the Dutch-type auction model, i.e. multiple rounds of auctioning with the price decreasing successively. Having completed successfully the general certification process, and then the certification process for the main auction, the capacity market units admitted to auctioning will leave the auction once the price of the successive round no longer ensures their anticipated compensation for capacity. As a result, auctions will be won by the cheapest bids with the technology neutrality maintained.

CHP plants can count on support from the capacity market. Some CHP plants must be retrofitted in order to offer greater production flexibility at times of increased demand for electricity, but especially new gas-fired cogeneration units supported within the capacity market will become an important and effective link in balancing the electricity system in the face of the increasing share of renewables, which depend on the forces of nature. Notably, revenues from the capacity market will be reduced by the level of support for high-efficiency cogeneration.

14.3. 'New Energy' priority scheme

Amount of funding:

PLN 2.5 billion for the entire scheme.

What will be financed within the sector:

Innovative technologies in

The overarching objective of the 'New Energy' priority scheme, which is implemented by the National Fund for Environmental Protection and Water Management, is to increase the level of innovation of technology solutions in the energy sector. The scheme has been conceived with a view to strengthening energy security, supporting innovative economy and technology, and adapting to global trends in the field of energy.

The scheme may provide support for innovative solutions in district heating, e.g. the use of hydrogen, heat and cold accumulation and storage, energy-efficient and plus-energy buildings, trigeneration, production of cold, heat pumps, high-temperature reactors (HTRs), microgeneration.

14.4. The Governmental Polish Deal (Polski Ład) Fund: Strategic Investment Programme

The scheme is financed by the COVID-19 Relief Fund referred to in Article 65 of the Act of 31 March 2020 amending the Act on special arrangements for the prevention, combating and control of COVID-19, other communicable diseases and related emergency situations and certain other acts.

The scheme is dedicated to co-funding investment projects implemented by municipalities, districts and cities or their unions throughout Poland. Only regional and local government units and their unions may seek the support, with municipal companies precluded from applying.

Amount of funding:

PLN 23 billion for the entire scheme.

What will be financed within the sector:

Infrastructure and generation units.

Applications for co-financing under the scheme are submitted to the Prime Minister, via Bank Gospodarstwa Krajowego (BGK), in electronic form. BGK verifies applications in formal terms, groups them according to priorities, drafts a report and notifies it to the Prime Minister. Support for the objectives of the sector may be provided under Priority 1:

- construction or refurbishment of carbon-free district heating installations,
- construction or refurbishment of waste management infrastructure, including incineration plants, biological treatment, segregation

or under Priority 2:

- construction or refurbishment of low-carbon district heating installations

ANNEX 1 – SOURCE DOCUMENTS USED IN THE ANALYSES

1. Warsaw

1) Assumptions for the heat, electricity and gas fuel supply plan for the capital city of Warsaw, Resolution of the Warsaw City Council No XXXV/1074/2020
2) Energy policy of the capital city of Warsaw until 2020
3) Analiza procesu wdrażania 'Polityki energetycznej m. st. Warszawy do 2020 r.' Zrównoważona karta wyników. Wykonanie za rok 2020 (Analysis of the implementation of the 'Energy policy of the capital city of Warsaw until 2020.' A balanced scorecard. Progress made in 2020).
4) Spatial development guidelines for the capital city of Warsaw. Resolution No LIII/1611/2021 of 26 August 2021 (amendment)
5) Low-carbon economy plan for the capital city of Warsaw. Resolution No XXI/522/2015 of the Warsaw City Council of 10 December 2015

2. Białystok

1) 'Assumptions for the heat, electricity and gas fuel supply plan for the city of Białystok 2012-2030'. Second 2021 revision
2) Spatial development guidelines for the city of Białystok. Resolution No XII/165/19 of 18 June 2019
3) Low-carbon economy plan for the city of Białystok and the municipalities of Choroszcz, Czarna Białostocka, Dobrzyniewo Duże, Juchnowiec Kościelny, Łapy, Supraśl, Wasilków, and Zabłudów until 2020.

3. Bydgoszcz

1) Revised assumptions for the heat, electricity and gas fuel supply plan for Bydgoszcz until 2025. 2021 revision.
2) Spatial development guidelines for the city of Bydgoszcz. Part I – Development conditions – Bydgoszcz 2009, Historical data
3) Revised sustainable energy action plan – Low-carbon economy plan for the city of Bydgoszcz for 2014-2020+. Bydgoszcz, June 2016.

4. Gdańsk

1) Low-carbon economy plan for the Gdańsk Metropolitan Area. Gdańsk 2015.
2) Draft revised assumptions for the heat, electricity and gas fuel supply plan of the city of Gdańsk. Opole 2015.
3) Spatial development guidelines for the city of Gdańsk. Resolution of the Gdańsk City Council No XII/218/19 of 27 June 2019

5. Gorzów Wielkopolski

1) Revised draft assumptions for the heat, electricity and gas fuel supply plan for the area of the city of Gorzów Wielkopolski until 2033. Bydgoszcz, September 2018.

2) Spatial development guidelines for the city of Gorzów Wielkopolski. Resolution No XXXIV/602/2021 of the Gorzów Wielkopolski City Council of 24 February 2021.

3) Low-carbon economy plan for the city of Gorzów Wielkopolski.

4) Resolution No XXXV/421/2016 of the Gorzów Wielkopolski City Council of 29 November 2016.

6. Katowice

1) 'Revised assumptions for the heat, electricity and gas fuel supply plan for the city of Katowice', Resolution of the Katowice City Council No LII/1059/2018 of 18 January 2018.

2) Spatial development guidelines for the city of Katowice. Rev. II Completion of public consultations, October 2022.

3) Low-carbon economy plan for the city of Katowice. Resolution of the Katowice City Council of 15 December 2015 on the adoption of the LCEP for implementation.

7. Kielce

1) 'Revised assumptions for the heat, electricity and gas fuel supply plan for the city of Kielce'. Kielce, November 2021

2) Low-carbon economy plan for the city of Kielce. Resolution of the Kielce City Council No XXVI/531/2016 of 14 June 2016

8. Kraków

1) 'Assumptions for the heat, electricity and gas fuel supply plan for the urban municipality of Kraków for 2014-2029'. Resolution No CXIX/1870/14 of the Kraków City Council of 22 October 2014.

2) Reports on the audit of compliance of the development plans of energy companies operating in the municipality with the 'Assumptions for the heat, electricity and gas fuel supply plan for the urban municipality of Kraków' in 2014-2029 for the years 2015, 2016, 2017, 2018, 2019.

3) Low-carbon economy plan for the urban municipality of Kraków. Resolution of the Kraków City Council No CXIV/3002/18 of 14 October 2018

4) Revised spatial development guidelines for the city of Kraków. Resolution No CXII/1700/14 of the Kraków City Council of 9 July 2014.

5) State of the City Report 2020. Department of Investment Strategy, Planning and Monitoring of the City of Kraków. Kraków 2021

9. Lublin

1) ‘Assumptions for the heat, electricity and gas fuel supply plan for the city of Lublin for 2019-2033’. Resolution No 496/XII/2019 of the Lublin City Council of 19 December 2019

2) Second revision of the low-carbon economy plan for the city of Lublin. Resolution of the Lublin City Council No 578/XVII/2020 of 26 March 2020

3) Spatial development guidelines for the city of Lublin. Resolution No 283/VIII/2019 of the Lublin City Council of 1 July 2019

10. Łódź

1) ‘Revised assumptions for the heat, electricity and gas fuel supply plan for the city of Łódź’. Łódź, October 2021

2) Spatial development guidelines for the city of Łódź. Resolution No LII/1605/21 of the Łódź City Council of 22 December 2021.

3) Low-carbon economy plan for the city of Łódź. Resolution No XVI/670/19 of the Łódź City Council of 20 November 2019 on the adoption for implementation of the low-carbon economy plan for the city of Łódź.

4) State of the City Report 2021. City Hall, Strategy and Development Department, City Strategy Office. Łódź 2021

11. Olsztyn

1) Revised assumptions for the heat, electricity and gas fuel supply plan for the city of Olsztyn. Resolution No XXXIII/554/21 of the Olsztyn City Council of 28 April 2021

2) Revised low-carbon economy plan for the city of Olsztyn. Resolution XXXIII/533/21 of the Olsztyn City Council of 28 April 2021

12. Opole

1) Revised draft assumptions for the heat, electricity and gas fuel supply plan for the city of Opole in 2019-2034. Opole 2019

2) Spatial development guidelines for the city of Opole. Resolution No LXVI/1248/18 of the Opole City Council of 5 July 2018

3) Low-carbon economy plan for the city of Opole – Revision. Opole, February 2020

13. Poznań

1) ‘Revised draft assumptions for the heat, electricity and gas fuel supply plan for the Poznań city area’. Resolution No VI/78/VIII/2019 of the Poznań City Council of 5 February 2019

2) Draft Spatial development guidelines for the city of Poznań. Miejska Pracownia Urbanistyczna (Municipal Urban Planning Studio) in Poznań, Poznań 2022

3) ‘Low-carbon economy plan for the city of Poznań’. Resolution No XXV/339/VII/2016 of 23 February 2016

4) State of the City Report 2020. Department of City Development and International Cooperation, Poznań 2021

14. Rzeszów

1) Revised assumptions for the heat, electricity and gas fuel supply plan for the city of Rzeszów. Resolution No XXXVIII/770/2020 of the Rzeszów City Council of 27 October 2020

2) Spatial development guidelines for the city of Rzeszów. Draft of May 2022

3) Low-carbon economy plan for the city of Rzeszów. Resolution No XLVIII/1031/2017 of the Rzeszów City Council of 29 August 2017

15. Szczecin

1) Assumptions for the heat, electricity and gas fuel supply plan for the urban municipality of Szczecin. Resolution No XLII/1185/22 of the Szczecin City Council of 6 September 2022

2) Spatial development guidelines for the city of Szczecin. Resolution No XXXIX/106/22 of the Szczecin City Council of 26 April 2022

3) Low-carbon economy plan for the urban municipality of Szczecin. Resolution No XVIII/576/20 of the Szczecin City Council of 26 May 2020

16. Toruń

1) Draft assumptions for the heat, electricity and gas fuel supply plan for the city of Toruń. 2020 revision.

2) Spatial development guidelines for the city of Toruń. Resolution No 805/18 of the Toruń City Council of 25 January 2018

3) PGE Toruń S.A. documents related to the tender for the preparation of a multi-variant concept for the development of the district heating system for PGE Toruń S.A. 2022

17. Wrocław

1) Assumptions for the heat, electricity and gas fuel supply plan for the municipality of Wrocław for 2020-2035. Resolution No XV/421/19 of the Wrocław City Council of 21 November 2019

2) Spatial development guidelines for the city of Wrocław. Resolution No L/1177/18 of the Wrocław City Council of 11 January 2018.

3) Low-carbon economy plan. For integrated territorial investments of the Wrocław functional urban area. Municipality of Wrocław. 2018 revision. Resolution No XII/300/2019 of 4 July 2019

18. Zielona Góra

1) Assumptions for the heat, electricity and gas fuel supply plan for the city of Zielona Góra. Resolution No XVII.132.2015 of the Zielona Góra City Council of 16 June 2015.

2) Revised spatial development guidelines for the city of Zielona Góra. Resolution No XVIII.139.2015 of the Zielona Góra City Council of 30 June 2015

3) Low-carbon economy plan for the city of Zielona Góra 2014-2020. Resolution No XVIII.148.2015 of the Zielona Góra City Council of 30 June 2015

ANNEX 2 – SUMMARY OF ECONOMIC AND TECHNICAL ASSUMPTIONS ADOPTED IN THE COST-BENEFIT ANALYSIS

Table 98. CAPEX assumptions

CAPEX	PLN thousand / MW		
	2020	**2035**	**2050**
GT, CHP	2 325.00	2 325.00	2 325.00
agricultural biogas, CHP	15 112.50	15 112.50	15 112.50
wastewater treatment biogas, CHP	16 275.00	16 275.00	16 275.00
landfill biogas, CHP	8 370.00	8 370.00	8 370.00
solid biomass, CHP	13 717.50	13 717.50	13 717.50
hard coal, CHP	10 462.50	10 462.50	10 462.50
district heating boiler, coal	1 627.50	1 627.50	1 627.50
district heating boiler, natural gas	697.50	697.50	697.50
district heating boiler, fuel oil	930.00	930.00	930.00
RES, district heating boiler, biomass, collectors, geothermal energy	2 325.00	2 325.00	2 325.00
heat pumps, electricity	1 700.00	1 700.00	1 700.00
waste heat*	2 325.00	2 325.00	2 325.00

Source: own study based on: Ministry of Climate and Environment, 2021. *Energy Policy of Poland until 2040, Annex 2 – Conclusions drawn from forecast analysis for the energy sector, pp. 7-8*

** values as for a biomass-fired district heating boiler were adopted.*

Table 99 Fixed OPEX assumptions

Fixed OPEX	PLN thousand / MW		
	2020	2035	2050
GT, CHP	74.40	74.40	74.40
agricultural biogas, CHP	1023.00	1023.00	1023.00
wastewater treatment biogas, CHP	627.75	627.75	627.75
landfill biogas, CHP	372.00	372.00	372.00
solid biomass, CHP	558.00	558.00	558.00
hard coal, CHP	223.20	223.20	223.20
district heating boiler, coal	4.65	4.65	4.65
district heating boiler, natural gas	4.65	4.65	4.65
district heating boiler, fuel oil	4.65	4.65	4.65
RES, district heating boiler, biomass, collectors, geothermal energy	4.65	4.65	4.65
heat pumps, electricity	4.65	4.65	4.65
waste heat*	4.65	4.65	4.65

Source: own study, based on: Ministry of Climate and Environment, 2021. *Energy Policy of Poland until 2040, Annex 2 – Conclusions drawn from forecast analysis for the energy sector, pp. 7-8*

** values as for a biomass-fired district heating boiler were adopted.*

Table 100 Variable OPEX assumptions

Variable OPEX	PLN thousand / MWh		
	2020	2035	2050
GT, CHP	0.00651	0.00651	0.00651
agricultural biogas, CHP	0	0	0
wastewater treatment biogas, CHP	0	0	0
landfill biogas, CHP	0	0	0
solid biomass, CHP	0	0	0
hard coal, CHP	0.01488	0.01488	0.01488
district heating boiler, coal	0.00651	0.00651	0.00651
district heating boiler, natural gas	0.00186	0.00186	0.00186
district heating boiler, fuel oil	0.002325	0.002325	0.002325
RES, district heating boiler, biomass, collectors, geothermal energy	0.00651	0.00651	0.00651
heat pumps, electricity	0	0	0
district heating boiler, RDF*	0.00651	0.00651	0.00651

Source: own study, based on: Ministry of Climate and Environment, 2021. *Energy Policy of Poland until 2040, Annex 2 – Conclusions drawn from forecast analysis for the energy sector, pp. 7-8*

** values as for a biomass-fired district heating boiler were adopted.*

Table 101 Forecast fuel prices

Fuel price	PLN/MWh		
	2020	2035*	2050
natural gas	118.08	172.8	202.32
agricultural biogas	150.12	162	162
wastewater treatment biogas	0	0	0
landfill biogas	0	0	0
solid biomass	54.72	97.2	108
hard coal	126	61.92	57.24
coal	126	61.92	57.24
natural gas	118.08	172.8	202.32
fuel oil	54.72	97.2	108
solid biomass	54.72	97.2	108
electricity	199.44	336.88	389.97
waste heat*	0	0	0
*The forecast value for 2035 has been calculated as the arithmetic mean of the 2030 and 2040 forecast values given in the reference document			

Source: own study based on: Ministry of Climate and Environment, 2022. *Heating Sector Strategy for 2030 with an outlook for 2040 – Analytical Annex. Draft*. [online] Warsaw: Ministry of Climate and Environment. Available at: <https://bip.mos.gov.pl/strategie-plany-programy/strategia-dla-cieplownictwa-do-2030-r-z-perspektywa-do-2040-r/>*.; str. 29*

In the case of prices given in EUR, exchange rates recommended in the official guidelines of the Ministry of Finance (Ministry of Finance, 2022) were used.

Table 102 Forecast quota prices

	2020	2025	2030	2035	2040	2045	2050
€/t CO_2	25	62.5	100	150	200	300	400
PLN 2020/t CO_2	112	280	448	672	896	1344	1792

Source: Ministry of Climate and Environment, 2022. *Heating Sector Strategy for 2030 with an outlook for 2040 – Analytical Annex. Draft*. [online] Warsaw: Ministry of Climate and Environment. Available at: <https://bip.mos.gov.pl/strategie-plany-programy/strategia-dla-cieplownictwa-do-2030-r-z-perspektywa-do-2040-r/>*.; str. 29-30*

Table 103 Forecast heat and electricity prices

Selling price	PLN thousand/MWh		
	2020	**2035**	**2050**
heat	0.18	0.216	0.252
electricity*	0.72	1.21	1.40

*Source: * Ministry of Climate and Environment, 2021. Energy Policy of Poland until 2040, Annex 2 – Conclusions drawn from forecast analysis for the energy sector, p. 27.*

Table 104 Energy efficiency of technologies

	efficiency, %	
	electric	**total**
CHP	36%	84%
CHP (agricultural biogas)	36%	85%
CHP (wastewater treatment biogas)	34%	85%
CHP (landfill biogas)	40%	85%
CHP (solid biomass)	30%	80%
CHP (coal)	30%	80%
district heating boiler		90%
district heating boiler		96%
district heating boiler		95%
district heating boiler		90%

Source: Ministry of Climate and Environment, 2021. Energy Policy of Poland until 2040, Annex 2 – Conclusions drawn from forecast analysis for the energy sector, pp. 7-8.

Acceptable (maximum) share of technology for the analysed scenarios

Table 105. Restrictions on the allowable (maximum) share of technology for the S0 Scenario

	Residential sector			Service sector			Industry sector		
	2020	2035	2050	2020	2035	2050	2020	2035	2050
Gas turbine, natural gas, CHP	60%	50%	40%	60%	50%	40%	60%	50%	40%
agricultural biogas, CHP	2%	5%	10%	2%	5%	10%	2%	5%	10%
wastewater treatment biogas, CHP	1%	3%	5%	1%	3%	5%	1%	3%	5%
landfill biogas, CHP	1%	5%	10%	1%	5%	10%	1%	5%	10%
solid biomass, CHP	10%	20%	30%	10%	20%	30%	10%	20%	30%
hard coal, CHP	70%	50%	30%	70%	50%	30%	70%	50%	30%
district heating boiler, coal	70%	40%	10%	70%	40%	10%	70%	40%	10%
district heating boiler, natural gas	50%	40%	30%	50%	40%	30%	50%	40%	30%
waste incineration plants	5%	3%	2%	5%	3%	2%	5%	3%	2%
district heating boiler, biomass	5%	10%	15%	5%	10%	15%	5%	10%	15%
heat pumps, electricity	5%	15%	25%	5%	15%	25%	5%	15%	25%
waste heat	1%	5%	10%	1%	5%	10%	1%	5%	10%

Table 106 Restrictions on the allowable (maximum) share of technology for the S1 Scenario

	Residential sector			**Service sector**			**Industry sector**		
	2020	**2035**	**2050**	**2020**	**2035**	**2050**	**2020**	**2035**	**2050**
Gas turbine, natural gas, CHP	60%	55%	50%	60%	55%	50%	60%	55%	50%
agricultural biogas, CHP	2%	5%	10%	2%	5%	10%	2%	5%	10%
wastewater treatment biogas, CHP	1%	2%	4%	1%	2%	4%	1%	2%	4%
landfill biogas, CHP	1%	3%	8%	1%	3%	8%	1%	3%	8%
solid biomass, CHP	10%	15%	20%	10%	15%	20%	10%	15%	20%
hard coal, CHP	70%	60%	50%	70%	60%	50%	70%	60%	50%
district heating boiler, coal	70%	50%	30%	70%	50%	30%	70%	50%	30%
district heating boiler, natural gas	50%	45%	40%	50%	45%	40%	50%	45%	40%
waste incineration plants	5%	3%	2%	5%	3%	2%	5%	3%	2%
district heating boiler, biomass	5%	8%	13%	5%	8%	13%	5%	8%	13%
heat pumps, electricity	5%	10%	20%	5%	10%	20%	5%	10%	20%
waste heat	1%	8%	10%	1%	8%	10%	1%	8%	10%

Table 107 Restrictions on the allowable (maximum) share of technology for the S2 Scenario

	Residential sector			Service sector			Industry sector		
	2020	**2035**	**2050**	**2020**	**2035**	**2050**	**2020**	**2035**	**2050**
Gas turbine, natural gas, CHP	60%	40%	20%	60%	40%	20%	60%	40%	20%
agricultural biogas, CHP	5%	10%	15%	5%	10%	15%	5%	10%	15%
wastewater treatment biogas, CHP	1%	4%	8%	1%	4%	8%	1%	4%	8%
landfill biogas, CHP	1%	5%	10%	1%	5%	10%	1%	5%	10%
solid biomass, CHP	10%	20%	30%	10%	20%	30%	10%	20%	30%
hard coal, CHP	70%	40%	10%	70%	40%	10%	70%	40%	10%
district heating boiler, coal	70%	30%	0%	70%	30%	0%	70%	30%	0%
district heating boiler, natural gas	50%	35%	20%	50%	35%	20%	50%	35%	20%
waste incineration plants	5%	3%	2%	5%	3%	2%	5%	3%	2%
district heating boiler, biomass	5%	15%	25%	5%	15%	25%	5%	15%	25%
heat pumps, electricity	5%	15%	30%	5%	15%	30%	5%	15%	30%
waste heat	1%	10%	13%	1%	10%	13%	1%	10%	13%

Table 108 Restrictions on the allowable (maximum) share of technology for the S3 Scenario

	Residential sector			Service sector			Industry sector		
	2020	**2035**	**2050**	**2020**	**2035**	**2050**	**2020**	**2035**	**2050**
Gas turbine, natural gas, CHP	60%	45%	30%	60%	45%	30%	60%	45%	30%
agricultural biogas, CHP	5%	8%	13%	5%	8%	13%	5%	8%	13%
wastewater treatment biogas, CHP	1%	3%	6%	1%	3%	6%	1%	3%	6%
landfill biogas, CHP	1%	4%	9%	1%	4%	9%	1%	4%	9%
solid biomass, CHP	10%	13%	25%	10%	13%	25%	10%	13%	25%
hard coal, CHP	70%	50%	30%	70%	50%	30%	70%	50%	30%
district heating boiler, coal	70%	40%	0%	70%	40%	0%	70%	40%	0%
district heating boiler, natural gas	50%	40%	30%	50%	40%	30%	50%	40%	30%
waste incineration plants	5%	3%	2%	5%	3%	2%	5%	3%	2%
district heating boiler, biomass	5%	12%	22%	5%	12%	22%	5%	12%	22%
heat pumps, electricity	5%	12%	25%	5%	12%	25%	5%	12%	25%
waste heat	1%	9%	12%	1%	9%	12%	1%	9%	12%

ANNEX 3 – SCOPE OF THE SENSITIVITY ANALYSIS CARRIED OUT WITHIN THE CBA

Table 109 Scope of sensitivity analysis

	V2	V1	V3
Parameter changed	**decrease**	**baseline**	**increase**
Capital expenditure	-30%	0%	30%
Costs of emission quotas	-30%	0%	30%
Heat prices	-30%	0%	30%
Electricity prices	-30%	0%	30%
Fuels for individual technologies			
natural gas	-30%	0%	100%
agricultural biogas	-50%	0%	40%
wastewater treatment biogas	-30%	0%	30%
landfill biogas	-50%	0%	30%
solid biomass	-30%	0%	80%
coal	-10%	0%	150%
fuel oil	-10%	0%	50%
RDF	-30%	0%	30%

ANNEX 4 – CLASSIFICATION OF THE TECHNOLOGY SOLUTIONS ANALYSED IN THE CBA

Table 110 Classification of the technology solutions included in the CBA

Description			cogeneration						district heating plants				other	district heating plants
			GT, CHP	agricultural biogas, CHP	wastewater treatment biogas, CHP	landfill biogas, CHP	solid biomass, CHP	hard coal, CHP	district heating boiler, coal	district heating boiler, natural gas	district heating boiler, fuel oil	district heating boiler, biomass	heat pumps, electricity	Waste heat
Category /Fuel			t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11	t12
Generation	on-site								X	X	X	X	X	X
	supplied		X				X	X	X	X	X	X		X
Sector	residential		X				X	X	X	X	X	X	X	X
	services		X				X	X	X	X	X	X	X	X
	industry		X	X	X	X	X	X	X	X	X			X
	other		X	X	X	X	X	X	X	X	X	X	X	X
Place of generation	on-site												X	
	off-site		X	X	X	X	X	X	X	X	X	X		X
Fuels	fossil	coal						X	X					
		gas	X							X				
		fuel oil									X			
	RES	biomass					X					X		
		agricultural biogas		X										
		wastewater treatment biogas			X									
		landfill biogas				X								

Description			cogeneration						district heating plants				other	district heating plants
			GT, CHP	agricultural biogas, CHP	wastewater treatment biogas, CHP	landfill biogas, CHP	solid biomass, CHP	hard coal, CHP	district heating boiler, coal	district heating boiler, natural gas	district heating boiler, fuel oil	district heating boiler, biomass	heat pumps, electricity	Waste heat
Category /Fuel			t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11	t12
		electricity, heat pumps											X	
		RDF												X
	other							X	X	X	X			
Technologies	district heating plants								X	X	X	X		X
	high-efficiency cogeneration		X	X	X	X	X	X						
	heat pumps												X	

ANNEX 5 – CBA SENSITIVITY ANALYSIS FOR POLAND

Table 111. CBA sensitivity analysis for Poland

Scenario	Variant	Sector	CAPEX (PLN thousand) 2035	NPV (PLN thousand)	RES share (%) 2020	RES share (%) 2035	RES share (%) 2050	CO_2 emissions (thousand tonnes) 2020	CO_2 emissions (thousand tonnes) 2035	CO_2 emissions (thousand tonnes) 2050	heat cost (PLN/GJ) 2020	heat cost (PLN/GJ) 2035	heat cost (PLN/GJ) 2050	Heat production (GWh) 2020	Heat production (GWh) 2035	Heat production (GWh) 2050	Primary energy (TJ) 2020	Primary energy (TJ) 2035	Primary energy (TJ) 2050
S0	V1	Other sectors	9 426 710.19	-43 729 636.16	5.25%	5.25%	5.25%	4 986.48	4 601.73	4 769.07	118.6	241.48	209.07	7 518.63	6 938.51	7 190.82	68 127.95	62 871.35	65 157.64
		Residential sector	52 676 189.36	-238 343 190.79	9.23%	9.23%	9.23%	27 512.81	23 396.97	21 344.14	116.45	237.36	231.31	42 932.57	36 509.97	33 306.61	392 365.44	333 668.64	304 392.79
		Industry sector	4 693 741.49	-21 427 311.25	4.72%	4.72%	4.72%	2 510.97	2 336.42	2 461.78	113.63	231.44	197.41	3 931.34	3 658.05	3 854.33	34 225.72	31 846.49	33 555.26
		Service sector	8 295 925.25	-37 008 445.75	5.50%	5.50%	5.50%	4 217.81	4 057.64	4 347.12	115.58	235.32	197.14	6 529.48	6 281.52	6 729.66	57 805.12	55 609.96	59 577.30
	V2	Other sectors	6 598 697.13	-39 460 481.32	5.25%	5.25%	5.25%	4 986.48	4 601.73	4 769.07	117.9	178.71	155.68	7 518.63	6 938.51	7 190.82	68 127.95	62 871.35	65 157.64
		Residential sector	36 873 332.55	-216 246 586.88	9.23%	9.23%	9.23%	27 512.81	23 396.97	21 344.14	115.77	176.08	172.8	42 932.57	36 509.97	33 306.61	392 365.44	333 668.64	304 392.79
		Industry sector	3 285 619.04	-19 391 007.18	4.72%	4.72%	4.72%	2 510.97	2 336.42	2 461.78	112.94	171.45	147.15	3 931.34	3 658.05	3 854.33	34 225.72	31 846.49	33 555.26
		Service sector	5 807 147.67	-33 377 569.01	5.50%	5.50%	5.50%	4 217.81	4 057.64	4 347.12	114.89	174.3	146.94	6 529.48	6 281.52	6 729.66	57 805.12	55 609.96	59 577.30
	V3	Other sectors	14 140 065.29	-57 446 313.07	5.25%	5.25%	5.25%	4 986.48	4 601.73	4 769.07	119.31	379.9	330.66	7 518.63	6 938.51	7 190.82	68 127.95	62 871.35	65 157.64
		Residential sector	79 014 284.04	-308 832 616.16	9.23%	9.23%	9.23%	27 512.81	23 396.97	21 344.14	117.13	371.93	364.38	42 932.57	36 509.97	33 306.61	392 365.44	333 668.64	304 392.79
		Industry sector	7 040 612.23	-28 261 431.76	4.72%	4.72%	4.72%	2 510.97	2 336.42	2 461.78	114.31	364.36	312.45	3 931.34	3 658.05	3 854.33	34 225.72	31 846.49	33 555.26
		Service sector	12 443 887.87	-48 999 629.06	5.50%	5.50%	5.50%	4 217.81	4 057.64	4 347.12	116.27	370.29	311.87	6 529.48	6 281.52	6 729.66	57 805.12	55 609.96	59 577.30
S1	V1	Other sectors	8 261 607.30	-32 783 344.92	5.25%	57.82%	57.82%	4 986.48	1 039.07	1 002.61	118.6	143.56	96.56	7 518.63	6 938.51	7 190.82	68 127.95	40 233.74	38 822.00
		Residential sector	42 624 561.87	-177 318 548.04	9.23%	60.85%	60.85%	27 512.81	4 650.34	4 242.32	116.45	135.99	102.33	42 932.57	36 509.97	33 306.61	392 365.44	201 199.18	183 546.11
		Industry sector	4 382 243.67	-16 635 485.77	4.72%	56.22%	56.22%	2 510.97	592.95	562.76	113.63	147.1	98.08	3 931.34	3 658.05	3 854.33	34 225.72	21 695.24	20 590.44
		Service sector	7 639 424.78	-28 805 888.36	5.50%	55.08%	55.08%	4 217.81	1 090.93	1 018.28	115.58	151.19	99.67	6 529.48	6 281.52	6 729.66	57 805.12	38 239.50	35 693.08
	V2	Other sectors	5 783 125.11	-31 688 848.73	5.25%	57.82%	57.82%	4 986.48	1 039.07	1 002.61	117.9	109.1	75.9	7 518.63	6 938.51	7 190.82	68 127.95	40 233.74	38 822.00
		Residential sector	29 837 193.31	-172 454 344.14	9.23%	60.85%	60.85%	27 512.81	4 650.34	4 242.32	115.77	103.3	80.52	42 932.57	36 509.97	33 306.61	392 365.44	201 199.18	183 546.11
		Industry sector	3 067 570.57	-16 008 518.15	4.72%	56.22%	56.22%	2 510.97	592.95	562.76	112.94	111.79	77.03	3 931.34	3 658.05	3 854.33	34 225.72	21 695.24	20 590.44
		Service sector	5 347 597.35	-27 594 235.10	5.50%	55.08%	55.08%	4 217.81	1 090.93	1 018.28	114.89	114.87	78.2	6 529.48	6 281.52	6 729.66	57 805.12	38 239.50	35 693.08

Scenario	Variant	Sector	CAPEX (PLN thousand) 2035	NPV (PLN thousand)	RES share (%) 2020	RES share (%) 2035	RES share (%) 2050	CO_2 emissions (thousand tonnes) 2020	CO_2 emissions (thousand tonnes) 2035	CO_2 emissions (thousand tonnes) 2050	heat cost (PLN/GJ) 2020	heat cost (PLN/GJ) 2035	heat cost (PLN/GJ) 2050	Heat production (GWh) 2020	Heat production (GWh) 2035	Heat production (GWh) 2050	Primary energy (TJ) 2020	Primary energy (TJ) 2035	Primary energy (TJ) 2050
	V3	Other sectors	12 392 410.94	-39 763 260.75	5.25%	57.82%	57.82%	4 986.48	1 039.07	1 002.61	119.31	220.74	150.05	7 518.63	6 938.51	7 190.82	68 127.95	40 233.74	38 822.00
		Residential sector	63 936 842.80	-211 374 333.90	9.23%	60.85%	60.85%	27 512.81	4 650.34	4 242.32	117.13	208.68	158.64	42 932.57	36 509.97	33 306.61	392 365.44	201 199.18	183 546.11
		Industry sector	6 573 365.50	-20 446 980.83	4.72%	56.22%	56.22%	2 510.97	592.95	562.76	114.31	226.38	152.57	3 931.34	3 658.05	3 854.33	34 225.72	21 695.24	20 590.44
		Service sector	11 459 137.18	-35 634 094.15	5.50%	55.08%	55.08%	4 217.81	1 090.93	1 018.28	116.27	232.77	155.08	6 529.48	6 281.52	6 729.66	57 805.12	38 239.50	35 693.08
S2	W1	Other sectors	12 161 852.14	-38 687 551.48	5.25%	73.69%	73.69%	4 986.48	674.46	650.8	118.6	176.99	109.01	7 518.63	6 938.51	7 190.82	68 127.95	49 603.08	47 862.59
		Residential sector	62 634 251.85	-202 011 056.25	9.23%	80.82%	80.82%	27 512.81	2 221.29	2 026.39	116.45	159.91	106.61	42 932.57	36 509.97	33 306.61	392 365.44	237 984.40	217 103.82
		Industry sector	6 456 155.14	-20 108 165.26	4.72%	70.07%	70.07%	2 510.97	431.1	409.15	113.63	185.96	115.32	3 931.34	3 658.05	3 854.33	34 225.72	27 350.65	25 957.85
		Service sector	11 243 350.16	-35 221 582.24	5.50%	67.74%	67.74%	4 217.81	838.01	782.21	115.58	193.98	120.05	6 529.48	6 281.52	6 729.66	57 805.12	48 849.98	45 596.99
	W2	Other sectors	8 513 296.50	-35 737 109.60	5.25%	73.69%	73.69%	4 986.48	674.46	650.8	117.9	131.45	83.6	7 518.63	6 938.51	7 190.82	68 127.95	49 603.08	47 862.59
		Residential sector	43 843 976.30	-189 406 904.63	9.23%	80.82%	80.82%	27 512.81	2 221.29	2 026.39	115.77	119.2	82.59	42 932.57	36 509.97	33 306.61	392 365.44	237 984.40	217 103.82
		Industry sector	4 519 308.60	-18 388 918.63	4.72%	70.07%	70.07%	2 510.97	431.1	409.15	112.94	137.86	88.01	3 931.34	3 658.05	3 854.33	34 225.72	27 350.65	25 957.85
		Service sector	7 870 345.11	-31 995 672.86	5.50%	67.74%	67.74%	4 217.81	838.01	782.21	114.89	143.65	91.37	6 529.48	6 281.52	6 729.66	57 805.12	48 849.98	45 596.99
	W3	Other sectors	18 242 778.21	-48 016 645.56	5.25%	73.69%	73.69%	4 986.48	674.46	650.8	119.31	266.16	164.17	7 518.63	6 938.51	7 190.82	68 127.95	49 603.08	47 862.59
		Residential sector	93 951 377.78	-244 120 201.32	9.23%	80.82%	80.82%	27 512.81	2 221.29	2 026.39	117.13	237.99	157.86	42 932.57	36 509.97	33 306.61	392 365.44	237 984.40	217 103.82
		Industry sector	9 684 232.72	-25 407 948.35	4.72%	70.07%	70.07%	2 510.97	431.1	409.15	114.31	281.12	175.05	3 931.34	3 658.05	3 854.33	34 225.72	27 350.65	25 957.85
		Service sector	16 865 025.23	-44 917 427.14	5.50%	67.74%	67.74%	4 217.81	838.01	782.21	116.27	294.21	183.1	6 529.48	6 281.52	6 729.66	57 805.12	48 849.98	45 596.99
S3	W1	Other sectors	9 421 501.21	-36 646 522.34	5.25%	56.28%	56.28%	4 986.48	1 114.30	1 075.20	118.6	170.67	116.84	7 518.63	6 938.51	7 190.82	68 127.95	46 879.16	45 234.24
		Residential sector	48 337 571.84	-192 247 262.80	9.23%	61.57%	61.57%	27 512.81	4 642.87	4 235.51	116.45	155.01	116.91	42 932.57	36 509.97	33 306.61	392 365.44	225 477.54	205 694.30
		Industry sector	5 013 408.49	-18 990 591.18	4.72%	53.55%	53.55%	2 510.97	656.5	623.07	113.63	179.01	122.39	3 931.34	3 658.05	3 854.33	34 225.72	25 833.69	24 518.14
		Service sector	8 741 427.25	-33 206 649.58	5.50%	51.84%	51.84%	4 217.81	1 217.84	1 136.75	115.58	186.27	126.43	6 529.48	6 281.52	6 729.66	57 805.12	46 071.19	43 003.24
	V2	Other sectors	6 595 050.85	-34 254 290.49	5.25%	56.28%	56.28%	4 986.48	1 114.30	1 075.20	117.9	126.79	88.84	7 518.63	6 938.51	7 190.82	68 127.95	46 879.16	45 234.24
		Residential sector	33 836 300.29	-182 249 353.51	9.23%	61.57%	61.57%	27 512.81	4 642.87	4 235.51	115.77	115.45	89.46	42 932.57	36 509.97	33 306.61	392 365.44	225 477.54	205 694.30
		Industry sector	3 509 385.94	-17 580 111.78	4.72%	53.55%	53.55%	2 510.97	656.5	623.07	112.94	132.77	92.76	3 931.34	3 658.05	3 854.33	34 225.72	25 833.69	24 518.14
		Service sector	6 118 999.07	-30 542 791.86	5.50%	51.84%	51.84%	4 217.81	1 217.84	1 136.75	114.89	138.07	95.67	6 529.48	6 281.52	6 729.66	57 805.12	46 071.19	43 003.24
	W3	Other sectors	14 132 251.81	-45 685 995.57	5.25%	56.28%	56.28%	4 986.48	1 114.30	1 075.20	119.31	262.73	181.74	7 518.63	6 938.51	7 190.82	68 127.95	46 879.16	45 234.24
		Residential sector	72 506 357.76	-233 432 861.71	9.23%	61.57%	61.57%	27 512.81	4 642.87	4 235.51	117.13	236.86	180.14	42 932.57	36 509.97	33 306.61	392 365.44	225 477.54	205 694.30

Scenario	Variant	Sector	CAPEX (PLN thousand) 2035	NPV (PLN thousand)	RES share (%) 2020	RES share (%) 2035	RES share (%) 2050	CO_2 emissions (thousand tonnes) 2020	CO_2 emissions (thousand tonnes) 2035	CO_2 emissions (thousand tonnes) 2050	heat cost (PLN/GJ) 2020	heat cost (PLN/GJ) 2035	heat cost (PLN/GJ) 2050	Heat production (GWh) 2020	Heat production (GWh) 2035	Heat production (GWh) 2050	Primary energy (TJ) 2020	Primary energy (TJ) 2035	Primary energy (TJ) 2050
		Industry sector	7 520 112.73	-24 109 329.06	4.72%	53.55%	53.55%	2 510.97	656.5	623.07	114.31	276.6	191.26	3 931.34	3 658.05	3 854.33	34 225.72	25 833.69	24 518.14
		Service sector	13 112 140.87	-42 537 459.10	5.50%	51.84%	51.84%	4 217.81	1 217.84	1 136.75	116.27	288.49	198.13	6 529.48	6 281.52	6 729.66	57 805.12	46 071.19	43 003.24

List of tables