MINISTERSTVO
PRŮMYSLU A OBCHODU

Assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling in the Czech Republic

2020

Contents

1 INTRODUCTION

Article 14 of Directive 2012/27/EU of the European Parliament and of the Council on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC requires each Member State to carry out and notify to the Commission a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling. The assessment should contain the information set out in Annex VIII of the Energy Efficiency Directive. The Directive required the Member States to submit the first assessment by 31 December 2015.

Based on this request, the Czech Republic submitted to the Commission the report 'Assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling in the Czech Republic' prepared in 2015.

The Commission subsequently analysed the first cycle of comprehensive assessments. The collection of new data, the identification of new possibilities and the exchange of best practices in energy efficiency for heating and cooling have confirmed the benefits of comprehensive assessments, as well as the need for Member States to update the document as of 2020, as was requested from the Member States.

Prior to the second cycle, the Commission updated the requirements for the contents of the comprehensive assessment to increase the usefulness of the information collected for Member States and the Commission, to simplify the information to be provided and to improve the relation to other Energy Union legislation, in particular Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action and Directive (EU) 2018/844 of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, Directive (EU) 2018/2002 of the European Parliament and of the Council amending Directive 2012/27/EU on energy efficiency and Directive (EU) 2018/2001 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources.

To this end, the Commission has issued Commission Delegated Regulation (EU) 2019/826 of 4 March 2019 amending Annexes VIII and IX to Directive 2012/27/EU of the European Parliament and of the Council on the contents of comprehensive assessments of the potential for efficient heating and cooling and 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.

The report was prepared on the basis of statistical data of the Ministry of Industry and Trade of the Czech Republic supplemented to include data of the Energy Regulatory Office and with regard to forecasts from the strategic documents of the Czech Republic – State Energy Policy of the Czech Republic, National Energy and Climate Plan and others.

2 HEATING AND COOLING – AN OVERVIEW

2.1 Demand for heating and cooling

The current demand for heat and the ways to meet the demand were analysed primarily using materials and statistical data of the Ministry of Industry and Trade. ERO, CZSO and CHMI statistics, IEA/Eurostat data and other additional materials were also used to supplement the data. Methodologies of data collection and their evaluation used for reporting heat production and consumption / combined heat and power (CHP) varies from entity to entity, which should be respected in particular when comparing the results in this material with other documents.

Summary data on thermal energy consumption and the development of useful energy for heating, broken down by sector in the period 2011 to 2019, are given in the following tables.

Table No 1: *Final consumption of energy for heating (including process and technological heat) in the period 2011 to 2019 (GWh)*

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Industry	**56 805**	**56 379**	**53 812**	**51 856**	**53 093**	**51 757**	**54 399**	**53 590**	**51 956**
Iron and steel	11 839	11302	10 849	9 769	9 377	9 070	9 563	9 696	7 624
Chemical and petrochemical	8 843	8 805	8 570	7 575	7 271	6 755	8 548	8 573	8 678
Non-ferrous metal industry	484	374	514	424	468	595	741	665	648
Non-metallic minerals	10 177	10 183	9 207	9 662	10 228	10 734	10 964	11 208	11 204
Transport equipment	2 657	2 671	2 432	2 205	2 144	2 424	2 505	2 401	2 813
Mechanical engineering	4 231	4 334	4 176	3 618	4 107	3 926	4 144	3 715	3 639
Mining and quarrying of non-energy raw materials	545	667	661	605	621	599	662	565	585
Food, beverages and tobacco	4 967	4 937	4 892	5 040	5 341	5 258	5 368	5 102	4 725
Paper, pulp and print	5 295	5 322	5 282	5 397	5 461	5 227	5 237	5 107	6 036
Wood and wooden products	1 748	1 933	1 997	1 962	2 190	2 241	2 007	1 969	1 908
Construction	1 527	1 546	1 616	1 535	1 742	1 842	1 683	1 618	1 407
Textiles and leather	852	812	786	772	743	736	776	727	731
Oher industry	3 640	3 495	2 830	3 292	3 400	2 350	2 201	2 244	1 958
Other	**95 441**	**97 588**	**98 868**	**90 239**	**92 823**	**96 907**	**99 111**	**95 409**	**95 308**
Commercial and public services	21 986	20 904	20 212	19 547	19 771	20 655	21 420	20 366	21 019
Households	66 954	69 878	71 468	63 606	66 087	69 226	70 390	68 304	67 406
Agriculture and forestry	5 518	5 738	6 301	6 242	6 120	6 527	6 486	6 269	6 431
Fisheries	0	0	0	2	1	1	2	2	3
Other	984	1 068	886	842	842	498	813	468	449
Total	**152 246**	**153 967**	**152 680**	**142 094**	**145 915**	**148 664**	**153 510**	**148 998**	**147 265**

Table No 2: *Useful energy for heating in the period 2011 to 2019 (GWh)*

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Industry	**46 966**	**46 604**	**44 441**	**42 742**	**43 744**	**42 705**	**44 865**	**44 200**	**42 905**
Iron and steel	9 759	9 331	8 914	7 989	7 661	7 423	7 832	7 920	6 271
Chemical and petrochemical	7 569	7 537	7 336	6 520	6 259	5 820	7 249	7 283	7 351
Non-ferrous metal industry	390	302	415	342	377	479	596	534	521
Non-metallic minerals	8 172	8 176	7 388	7 749	8 202	8 609	8 795	8 994	8 992
Transport equipment	2 242	2 241	2 048	1 856	1 807	2 039	2 106	2 019	2 361
Mechanical engineering	3 568	3 660	3 531	3 044	3 438	3 304	3 488	3 132	3 055
Mining and quarrying of non-energy raw materials	437	534	530	485	498	482	532	454	470
Food, beverages and tobacco	4 138	4 105	4 068	4 184	4 448	4 389	4 480	4 268	3 974
Paper, pulp and print	4 281	4 298	4 243	4 362	4 421	4 240	4 258	4 150	4 900
Wood and wooden products	1 405	1 553	1 605	1 575	1 766	1 811	1 631	1 605	1 563
Construction	1 239	1 252	1 307	1 241	1 410	1 489	1 363	1 313	1 144
Textiles and leather	718	680	653	638	615	610	642	605	608
Oher industry	3 047	2 934	2 403	2 755	2 840	2 010	1 894	1 922	1 694
Other	**80 153**	**81 971**	**83 011**	**75 609**	**77 712**	**81 123**	**82 918**	**79 814**	**79 627**
Commercial and public services	18 778	17 882	17 290	16 698	16 893	17 646	18 269	17 438	17 916
Households	56 145	58 624	59 953	53 225	55 233	57 840	58 791	56 965	56 184
Agriculture and forestry	4 442	4 610	5 059	5 011	4 911	5 238	5 206	5 034	5 166
Fisheries	0	0	0	1	1	1	1	2	2
Other	787	854	709	673	674	398	651	374	359
Total	**127 119**	**128 575**	**127 452**	**118 351**	**121 456**	**123 828**	**127 783**	**124 014**	**122 532**

Types of heat production

The types of heat production can be divided into two categories – centrally produced heat in connected sources and individually produced heat in local sources (e.g. households).

(A) Central heat production

Current situation in thermal energy supply systems:

Heat sold in the Czech Republic is currently (2018) produced primarily from brown and black coal. However, the share of coal in the production of heat sold has been consistently declining and, according to current statistics (2018) on holders of licence for the production of thermal energy, it reaches approximately 60% (56% in 2018). Fuel oil has been almost completely eliminated from the 'fuel base' for the production of heat sold, its share now being negligible, while the share of renewable energy sources and other fuels is increasing, including secondary energy sources such as industrial waste heat. Natural gas maintains a relatively stable share of about 25%.

In the last 15 years, the development of new thermal energy supply systems has not been extensive anymore. The main reason is that in Czech cities with more than 50 000 inhabitants the share of households connected to district heating is 65%, and usually even more in larger agglomerations. Further development thus has the form of increasing the density of already existing thermal energy supply systems. This is also due to the way in which new buildings are built (residential and non-residential housing), where the construction of entire new districts is rather exceptional and takes place within the existing development or as part of the revitalisation of former industrial areas.

- **An important role in the supply of heat to the public:** Approximately 1.7 million Czech households (i.e. approximately 4 million inhabitants) are connected to thermal energy supply systems.
- **The most common type of heating in households:** The last statistical survey in 2015 stated that the share of households connected to thermal energy supply systems stood at 40%, making it the most common type of heating.
- **Dominant role of coal**: Heat sold in the Czech Republic currently (2018) continues to be produced primarily from brown and black coal. However, the share of coal in the production of heat sold has been consistently declining and, according to current statistics on holders of licence for the production of thermal energy, it reaches approximately 56%.

(B) Individual heat production

Individual heat production takes place in individual sources, which include boilers burning solid, liquid or gaseous fuels, heat pumps, solar collectors and others. Only a small part of the individually produced heat is produced as CHP.

Concerning fuels used in households, the most used fuel is heat from RES, followed by natural gas. The following tables show the share of individual types of fuels used in households in 2015–2019 by type of use.

Table No 3: *Final energy consumption in households for heating (TJ)*

Heating		2015	2016	2017	2018	2019
ELECTRICITY		7 420	9 031	9 691	9 714	10 345
PURCHASED HEAT		26 439	29 718	30 241	27 832	27 421
NATURAL GAS		47 627	54 689	55 399	51 038	54 848
COAL AND COAL PRODUCTS		37 823	37 329	40 456	36 979	32 157
CRUDE OIL AND PETROLEUM PRODUCTS		1 312	1 500	1 506	1 648	1 495
Of which:	*LPG*	*1 312*	*1 500*	*1 506*	*1 648*	*1 495*
	Other kerosene	*0*	*0*	*0*	*0*	*0*
	Diesel/oil	*0*	*0*	*0*	*0*	*0*
RES		70 656	71 053	72 014	78 243	84 352
Of which:	*Solar thermal energy*	*69*	*61*	*66*	*72*	*83*
	Biomass	*70 587*	*70 992*	*71 949*	*74 609*	*80 090*
	Biogas	*0*	*0*	*0*	*0*	*0*
	Heat pumps	*0*	*0*	*0*	*3 562*	*4 179*
TOTAL		**191 276**	**203 320**	**209 307**	**205 454**	**210 618**

Table No 4: *Final energy consumption in households for cooling (TJ)*

Cooling		2015	2016	2017	2018	2019
ELECTRICITY		180	182	181	231	248
PURCHASED HEAT						
NATURAL GAS						
COAL AND COAL PRODUCTS						
CRUDE OIL AND PETROLEUM PRODUCTS						
Of which:	*LPG*					
	Other kerosene					
	Diesel/oil					
RES						
Of which:	*Solar thermal energy*					
	Biomass					
	Biogas					
	Heat pumps					
TOTAL		**180**	**182**	**181**	**231**	**248**

Table No 5: *Final energy consumption in households for water heating (TJ)*

Water heating		2015	2016	2017	2018	2019
ELECTRICITY		10 537	10 632	11 118	11 755	12 048
PURCHASED HEAT		16 106	14 535	14 386	13 966	13 243
NATURAL GAS		18 248	19 257	18 967	18 432	19 064
COAL AND COAL PRODUCTS		1 301	1 105	1 168	1 108	925
CRUDE OIL AND PETROLEUM PRODUCTS		0	0	0	0	0
Of which:	*LPG*	*0*	*0*	*0*	*0*	*0*
	Other kerosene	*0*	*0*	*0*	*0*	*0*

	Diesel/oil	*0*	*0*	*0*	*0*	*0*
RES		2 547	3 032	3 546	5 805	6 265
Of which:	*Solar thermal energy*	*399*	*431*	*451*	*454*	*447*
	Biomass	*2 148*	*2 601*	*3 095*	*3 373*	*3 496*
	Biogas	*0*	*0*	*0*	*0*	*0*
	Heat pumps	*0*	*0*	*0*	*1 979*	*2 322*
TOTAL		**48 739**	**48 562**	**49 185**	**51 066**	**51 544**

Table No 6: *Final energy consumption in households for cooking (TJ)*

Cooking		**2015**	**2016**	**2017**	**2018**	**2019**
ELECTRICITY		8 539	8 618	8 587	8 615	8 623
PURCHASED HEAT		0	0	0	0	0
NATURAL GAS		9 043	9 525	9 557	9 193	9 609
COAL AND COAL PRODUCTS		41	31	34	34	32
CRUDE OIL AND PETROLEUM PRODUCTS		569	381	375	451	385
Of which:	*LPG*	*569*	*381*	*375*	*451*	*385*
	Other kerosene	*0*	*0*	*0*	*0*	*0*
	Diesel/oil	*0*	*0*	*0*	*0*	*0*
RES		363	440	425	462	455
Of which:	*Solar thermal energy*	*0*	*0*	*0*	*0*	*0*
	Biomass	*363*	*440*	*425*	*462*	*455*
	Biogas	*0*	*0*	*0*	*0*	*0*
	Heat pumps	*0*	*0*	*0*	*0*	*0*
TOTAL		**18 555**	**18 994**	**18 977**	**18 756**	**19 103**

Table No 7: *Final energy consumption in households total (TJ)*

Residential premises / households, total		**2015**	**2016**	**2017**	**2018**	**2019**
ELECTRICITY		26 676	28 464	29 576	30 316	31 263
PURCHASED HEAT		42 545	44 253	44 627	41 798	40 664
NATURAL GAS		74 919	83 471	83 923	78 663	83 521
COAL AND COAL PRODUCTS		39 164	38 465	41 658	38 121	33 114
CRUDE OIL AND PETROLEUM PRODUCTS		1 881	1 881	1 881	2 099	1 881
Of which:	*LPG*	1 881	1 881	1 881	2 099	1 881
	Other kerosene	0	0	0	0	0
	Diesel/oil	0	0	0	0	0
RES		73 565	74 525	75 985	84 510	91 071
Of which:	*Solar thermal energy*	467	492	517	526	530
	Biomass	73 098	74 032	75 468	78 444	84 040
	Biogas	0	0	0	0	0
	Heat pumps	0	0	0	5 540	6 501
TOTAL		**258 750**	**271 058**	**277 650**	**275 507**	**281 514**

(C) Cogeneration

As the production of heat from cogeneration plants affects both central heat production and individual heat production, the part concerning production of heat from cogeneration has been included under this special chapter.

The following table shows the structure of CHP plants as of 31 December 2019. The table shows that most of the installed capacity (10 082.0 MWe) falls on thermal power plants with an installed capacity of more than 5 MWe. The thermal installed capacity of these sources makes up more than 88% of the total thermal installed capacity of CHP plants.

Table No 8: *Electricity generation and supply of useful heat from CHP in 2019*

	CHP up to 1 MWe		**CHP over 1 MWe up to 5 MWe**		**CHP over 5 MWe**		**CHP total**	
	Gross electricity production	Supply of useful heat	Gross electricity production	Supply of useful heat	Gross electricity production	Supply of useful heat	Gross electricity production	Supply of useful heat
	(GWh)	(TJ)	(GWh)	(TJ)	(GWh)	(TJ)	(GWh)	(TJ)
CHP	**1 604.8**	**4 974.0**	**1 303.5**	**7 153.4**	**6 990.2**	**87 161.9**	**9 898.5**	**99 289.3**
Biomass	12.1	353.7	91.9	1 053.9	1 049.8	11 373.1	1 153.9	12 780.7
Biogas	1 140.4	1 308.4	574.6	572.8	34.0	90.8	1 749.0	1 972.0
Black coal	0.1	2.5	27.8	985.5	761.8	10 117.7	789.7	11 105.7
Brown coal	11.2	1 047.4	25.7	825.2	3 965.1	52 653.7	4 002.0	54 526.2
Coke	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste heat	0.0	0.0	17.3	541.7	14.4	156.0	31.7	697.7
Other liquid fuels	0.0	0.0	11.5	184.7	4.3	43.3	15.8	228.0
Other solid fuels	2.0	8.6	9.1	372.0	86.8	1 643.3	97.9	2 023.9
Other gases	4.4	31.1	58.4	215.9	277.0	4 204.3	339.8	4 451.3
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel oils	5.3	4.6	0.4	0.4	1.3	19.5	7.6	24.4
Natural gas	429.4	2 217.8	486.1	2 401.5	795.6	6 860.2	1 711.2	11 479.5
Total installed power capacity (MWe)	**425.6**		**399.4**		**10 082.0**		**10 907.0**	
Total installed heat capacity (MWt)		**1 013.8**		**1 365.0**		**18 903.1**		**21 281.8**

Source: ERO, Annual Report on the Operation of the Energy System of the Czech Republic, 2019

The following table shows installed power capacity in 2014–2019, broken down by capacity. In this period, installed capacity increased by 360 MWe.

Table No 9: *Installed capacity in 2014–2019 (MWe)*

	CHP up to 1 MWe	CHP over 1 MWe up to 5 MWe	CHP over 5 MWe	CHP total
2014	309.6	321.8	9 915.6	10 547.0
2015	320.2	347.3	10 032.0	10 699.5
2016	339.3	356.6	10 019.9	10 715.8
2017	396.4	389.1	10 392.1	11 177.6
2018	411.9	390.7	10 806.7	11 609.4
2019	425.6	399.4	10 082.0	10 907.0
difference 2014–2019	116.0	77.6	166.4	360.0

Source: ERO, Annual Report on the Operation of the Energy System of the Czech Republic, 2014–2019

The following table shows the most important cogeneration sources in the Czech Republic.

Table No 10: *A list of large cogeneration sources*

Kladno power plant	Přerov heating plant	Doubravecká heating plant
Zlín heating plant	Přívoz heating plant	Vřesová CCGT plant
ArcelorMittal power plant	ČSM heating plant	Vřesová heating plant
Planá heating plant	Kolín power plant	Synthesia ZL 1 heating plant
Hodonín power plant	Opatovice power plant	Synthesia ZL 2 heating plant
Poříčí power plant	Třinec E 3 heating plant	Ško-Energo heating plant
Tisová II power plant	Mělník I power plant	České Budějovice heating plant
Dětmarovice power plant	ENERGY Ústí nad Labem	Otrokovice heating plant
Dvůr Králové heating plant	Sokolov heating plant	Písek heating plant
Trmice heating plant	Tatra Kopřivnice heating plant	Strakonice heating plant
Třebovice power plant	Mondi Štětí	České Meziříčí sugar refinery
Frýdek-Místek heating plant	Lovochemie power plant	T-700 heating plant
Karviná heating plant	Opava branch	Komořany heating plant
Krnov heating plant	Ostrov heating plant	Příbram heating plant
Olomouc heating plant	Plzeňská energetika – ELÚ III	ŽĎAS heating plant

2.2 Current supply of heating and cooling

The tables below show the amount of energy supply for heating provided on site in 2010–2019 by its production technology broken down into households and services and others. The vast majority of energy is produced in heat boilers; the share of energy supplied by heat pumps is slowly increasing.

Table No 11: *Energy provided on site – households and services (GWh)*

year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
boilers producing only heat	74 716	69 470	70 644	71 328	65 161	67 531	70 663	72 211	69 524	69 502
high-efficiency cogeneration	–	–	–	–	–	–	–	–	–	–
heat pumps	501	610	734	862	989	1 130	1 314	1 538	1 809	2 122
other technology	–	–	–	–	–	–	–	–	–	–
total	**75 217**	**70 080**	**71 378**	**72 190**	**66 150**	**68 662**	**71 977**	**73 748**	**71 333**	**71 624**

Table No 12: *Energy provided on-site – others (GWh)*

year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
boilers producing only heat	57 580	55 510	55 524	53 873	52 479	53 526	52 072	54 741	53 416	51 832
high-efficiency cogeneration	–	–	–	–	–	–	–	–	–	–
heat pumps	30	46	59	77	89	107	129	146	175	205
other technology	–	–	–	–	–	–	–	–	–	–
total	**57 610**	**55 557**	**55 583**	**53 950**	**52 567**	**53 633**	**52 202**	**54 888**	**53 591**	**52 038**

This table shows the supply of energy for heating provided remotely in 2010–2019 by its production technology. Here, the largest share of energy is supplied from cogeneration plants.

Table No 13: *Energy provided remotely (GWh)*

year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Heat supply	**28 211**	**26 609**	**27 006**	**26 540**	**23 378**	**23 620**	**24 484**	**24 874**	**24 075**	**23 603**
high-efficiency cogeneration	21 384	20 507	21 257	20 882	18 640	18 872	19 346	19 449	18 670	18 089
waste heat	–	–	–	–	–	–	–	–	–	–
other technology (heat-only plants)	6 827	6 103	5 749	5 658	4 738	4 748	5 139	5 425	5 405	5 514
Waste heat	**456**	**465**	**501**	**507**	**525**	**519**	**516**	**387**	**511**	**471**
Heat from chemical processes	25	34	37	57	61	45	90	89	196	186
Other sources	431	431	464	450	464	473	426	297	315	285
Total	**28 667**	**27 074**	**27 507**	**27 047**	**23 903**	**24 139**	**25 000**	**25 261**	**24 586**	**24 074**

Sources in district heating systems

Sources supplying heat to district heating systems in the Czech Republic can be broadly divided into several groups:

- Large cogeneration sources using solid fossil fuels – brown and black coal, possibly in combination with other fuels (sources with steam boilers and back-pressure or condensing extraction turbines);
- Large cogeneration sources with using gaseous or liquid fossil fuels – natural gas and process gases, or fuel oil (sources with steam boilers and back-pressure or condensing extraction turbines or combined cycle gas turbines with heat recovery)
- Smaller cogeneration sources using natural gas (cogeneration units with internal combustion engines)
- Smaller cogeneration sources using biomass and alternative fuels (biomass sources with steam turbines or with ORC cycle, biogas stations with internal combustion engines, waste incinerators with steam turbines)
- Nuclear power plants
- Sources using chemical and waste heat
- Heat-only sources using fossil or other fuels

Sources in individual heating systems

Sources supplying heat from individual heating in the Czech Republic can be broadly divided into several groups:

- Gas boilers (esp. natural gas)
- Boilers burning solid fossil fuels (brown and black coal, coke, briquettes)
- Biomass boilers
- Electric boilers and heat pumps
- Micro-cogeneration

2.2.1 Technology distinguishing between energy obtained from fossil and renewable sources and equipment that produces waste heat or cold

Technology for the recovery of heat from RES

Sources supplying heat from RES in the Czech Republic can be broadly divided into several groups:

- Heat pumps
- Municipal waste (RES)
- Biomass
- Biogas
- Geothermal energy

Technology for the recovery of waste heat

Sources supplying waste heat in the Czech Republic can be broadly divided into several groups:

- Heat from chemical processes
- Other sources

2.2.2 Share of energy from renewable sources and from waste heat or cold in final energy consumption in district heating and cooling

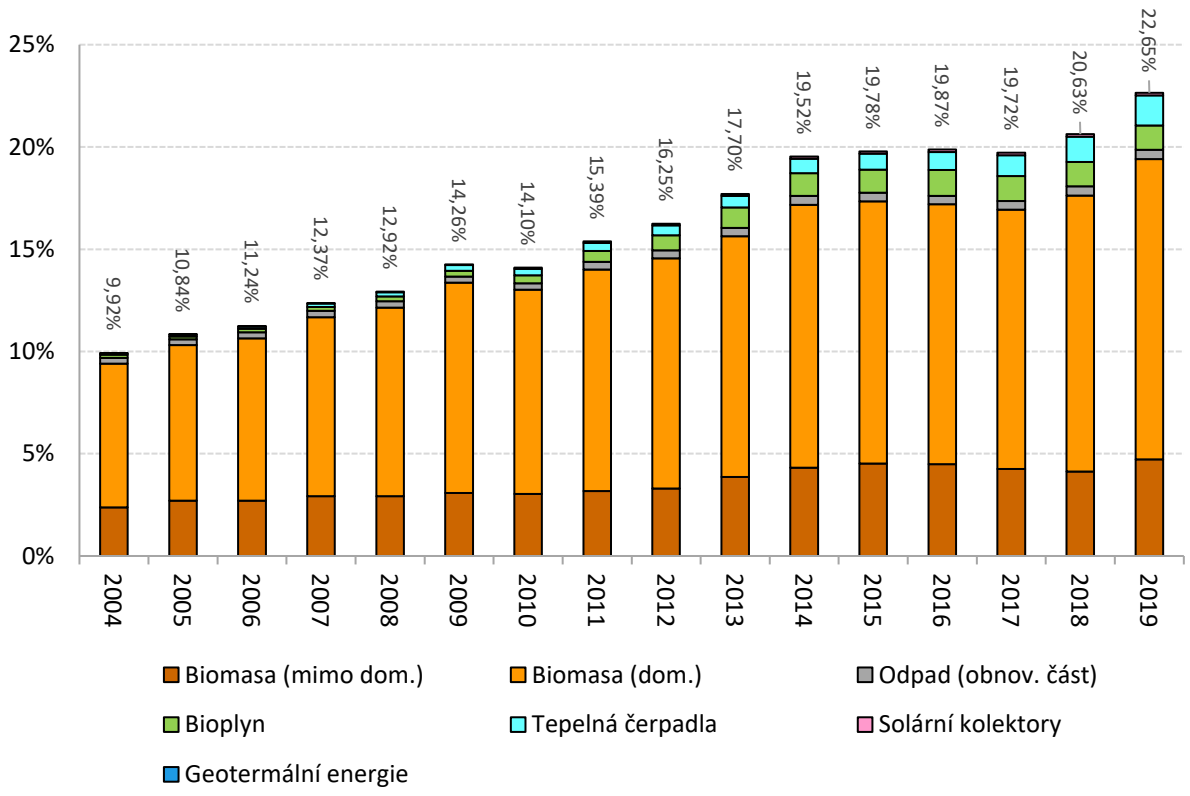
The share of energy from renewable sources in the heating and cooling sectors is constantly growing. In 2010–2019, the share of RES increased from 14.1% to 22.6%, i.e. an increase of 8.5 pp (seeTable No 14). Chart No 1 then shows the contribution of individual fuels to the share of RES in each year. It is clear that the most important role is played by biomass, which accounts for about 85% of renewable sources in the heating and cooling sectors. If we consider the contribution of bioenergy (i.e. biomass, waste and biogas) to the share of RES in the heating and cooling sectors, this contribution is approximately 93%. For now, other renewable sources (heat pumps, solar collectors, etc.) make up only a very small part of the total contribution to the share of RES compared to bioenergy.

Table No 14: *Share of RES in final energy consumption for heating and cooling (%)*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RES share	14.10	15.39	16.25	17.70	19.52	19.78	19.87	19.72	20.63	22.65

Source: The share of RES in the EUROSTAT methodology

Chart No 1: *Historical development of the contribution of individual fuels to the share of RES in the heating and cooling sectors (%)*



Key to graphic	
Original text	Translation
Biomasa (mimo dom.)	Biomass (excl. households)
Bioplyn	Biogas

Geotermální energie	Geothermal energy
Biomasa (dom.)	Biomass (households)
Tepelná čerpadla	Heat pumps
Odpad (obnov. část)	Waste (renewable)
Solární kolektory	Solar collectors

Source: The share of RES in the EUROSTAT methodology

Gross heat production from RES in 2019 stood at 2 820 GWh, i.e. an increase in heat production from RES by 1 746 GWh compared to 2010. Biomass again has the largest share, accounting for about 75% of total heat production from RES (seeTable No 15). Table No 16 then shows the development of gross heat production in district heating by individual sectors in 2010–2019.Table No 17 then shows the development of the share of RES in district heating in 2010–2019. It is evident from the above values that the share of gross heat production from RES in district heating in 2010–2019 increased from 2.82% to 9.21%, i.e. an increase of 6.39 pp. Chart No 2 then shows the development of the share of heat production from RES in district heating and the contribution of individual RES as a graph.

Table No 15: *Gross heat production from RES in district heating (GWh)*

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Heat pumps	26	21	22	19	21	19	17	25	26	30
Municipal waste (RES)	294	393	418	413	436	434	417	472	467	458
Biomass	683	830	818	1 390	1 617	1 782	1 869	1 989	1 883	2 134
Biogas	71	84	101	135	157	173	167	200	203	198
Geothermal energy										
Total	**1 074**	**1 328**	**1 359**	**1 957**	**2 231**	**2 408**	**2 469**	**2 685**	**2 580**	**2 820**

Table No 16: *Gross heat production in district heating (GWh)*

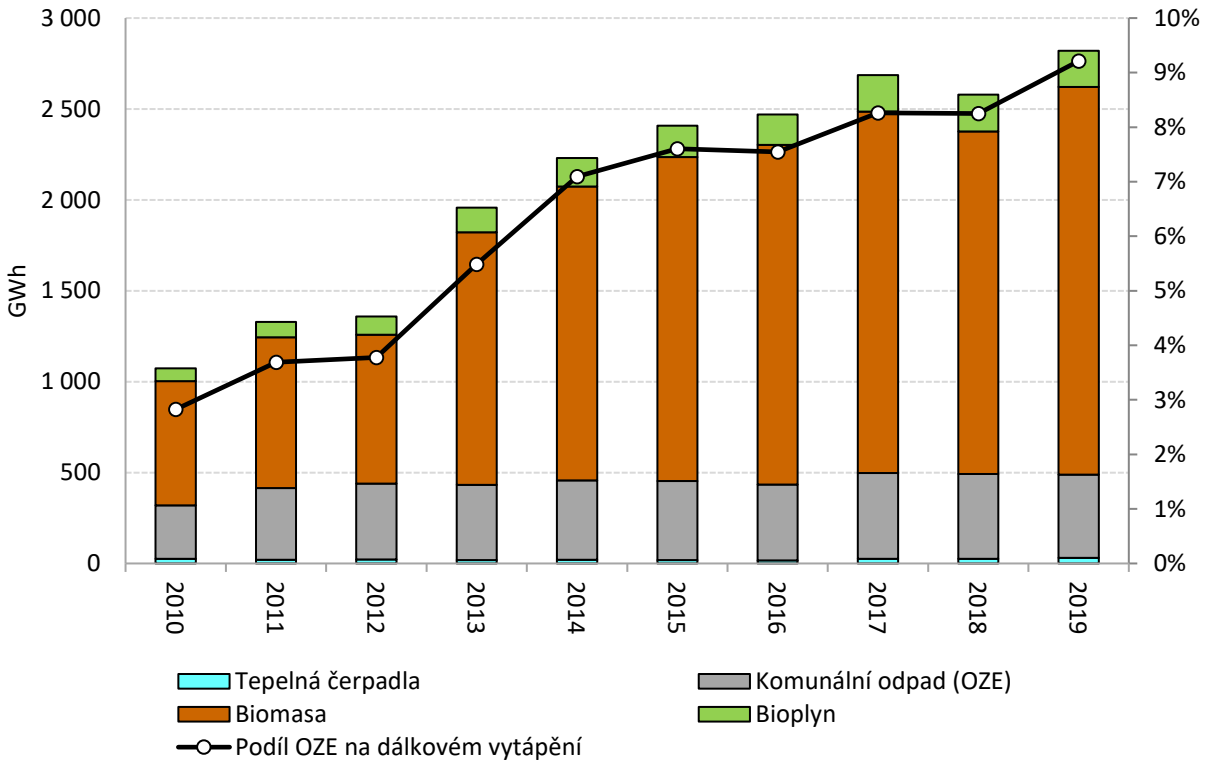
year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Own consumption	7 808	7 597	7 146	7 311	6 300	6 179	6 278	5 711	5 562	5 294
Distribution losses	2 006	1 810	1 838	1 836	1 784	1 865	1 975	1 920	1 628	1 712
Industry	**7 367**	**7 609**	**7 504**	**6 956**	**6 287**	**6 351**	**6 497**	**6 729**	**6 641**	**6 700**
Iron and steel	1 018	1 441	1 446	1 172	873	797	838	908	815	859
Chemical and petrochemical	2 461	2 472	2 466	2 399	2 298	2 212	2 080	2 054	2 123	2 043
Non-ferrous metal industry	22	14	16	17	13	14	16	14	12	12
Non-metallic minerals	192	152	148	114	99	101	107	122	138	147
Transport equipment	646	582	522	511	461	461	499	510	495	555
Mechanical engineering	1 051	916	965	952	748	763	815	861	797	718
Mining and quarrying of non-energy raw materials	8	6	5	7	7	7	12	12	11	11
Food, beverages and tobacco	709	822	781	773	759	879	914	925	931	971
Paper, pulp and print	199	228	202	88	224	259	291	341	326	353
Wood and wooden products	54	34	33	38	29	73	93	126	149	183
Construction	111	86	80	71	66	81	79	83	93	96
Textiles and leather	196	178	153	121	103	103	105	106	118	117

Oher industry	701	677	688	693	606	603	649	667	634	635
Households	**14 387**	**12 912**	**13 607**	**13 889**	**11 700**	**11 818**	**12 293**	**12 396**	**11 610**	**11 295**
Commercial and public services	**6 306**	**5 948**	**5 797**	**5 602**	**5 303**	**5 379**	**5 611**	**5 665**	**5 727**	**5 505**
Agriculture and forestry	**151**	**141**	**98**	**93**	**87**	**73**	**83**	**84**	**97**	**102**
Fisheries	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	**38 025**	**36 016**	**35 990**	**35 687**	**31 461**	**31 664**	**32 738**	**32 505**	**31 265**	**30 610**

Table No 17: *Share of RES in district heating in 2010–2019 (%)*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RES share in district heating	2.82	3.69	3.78	5.48	7.09	7.60	7.54	8.26	8.25	9.21

Chart No 2: *The share of RES in district heating and the contribution of individual renewable sources*



Key to graphic	
Original text	Translation
Tepelná čerpadla	Heat pumps
Biomasa	Biomass
Podíl OZE na dálkovém vytápění	RES share in district heating
Komunální odpad (OZE)	Municipal waste (RES)
Bioplyn	Biogas
GWh	GWh

The total amount of waste heat produced in 2010–2019 did not change much. There have been changes in the way this heat is obtained. The use of heat from chemical processes increases and the share of heat from other sources decreases (seeTable No 18).

Table No 18: *Gross waste heat production (GWh)*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Heat from chemical processes	25	34	37	57	61	45	90	89	196	186
Other sources	431	431	464	450	464	473	426	297	315	285
Total	**456**	**465**	**501**	**507**	**525**	**519**	**516**	**387**	**511**	**471**

Table No 19 then shows statistics on gross heat production in district heating by individual sectors in 2010–2019. The share of the gross production of waste heat in the final consumption of district heating in 2010–2019 did not change significantly (seeTable No 20). From 1.20% in 2010, the share of waste increased by 2019 ‘only’ to 1.54%, i.e. the share increased by 0.34 pp. Chart No 3 then shows the share of gross production of waste heat in the final consumption of district heating also as a graph.

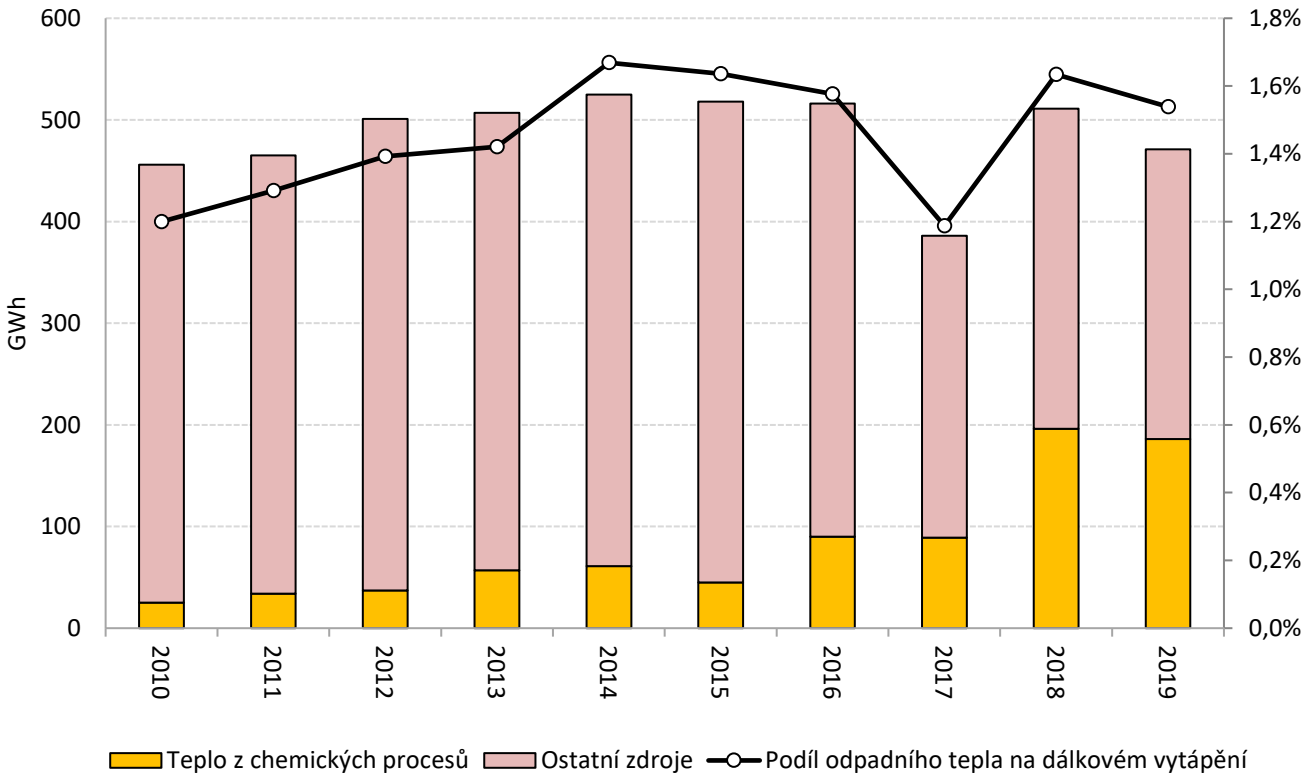
Table No 19: *Gross heat production in district heating (GWh)*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Own consumption	7 808	7 597	7 146	7 311	6 300	6 179	6 278	5 711	5 562	5 294
Distribution losses	2 006	1 810	1 838	1 836	1 784	1 865	1 975	1 920	1 628	1 712
Industry	**7 367**	**7 609**	**7 504**	**6 956**	**6 287**	**6 351**	**6 497**	**6 729**	**6 641**	**6 700**
Iron and steel	1 018	1 441	1 446	1 172	873	797	838	908	815	859
Chemical and petrochemical	2 461	2 472	2 466	2 399	2 298	2 212	2 080	2 054	2 123	2 043
Non-ferrous metal industry	22	14	16	17	13	14	16	14	12	12
Non-metallic minerals	192	152	148	114	99	101	107	122	138	147
Transport equipment	646	582	522	511	461	461	499	510	495	555
Mechanical engineering	1 051	916	965	952	748	763	815	861	797	718
Mining and quarrying of non-energy raw materials	8	6	5	7	7	7	12	12	11	11
Food, beverages and tobacco	709	822	781	773	759	879	914	925	931	971
Paper, pulp and print	199	228	202	88	224	259	291	341	326	353
Wood and wooden products	54	34	33	38	29	73	93	126	149	183
Construction	111	86	80	71	66	81	79	83	93	96
Textiles and leather	196	178	153	121	103	103	105	106	118	117
Oher industry	701	677	688	693	606	603	649	667	634	635
Households	**14 387**	**12 912**	**13 607**	**13 889**	**11 700**	**11 818**	**12 293**	**12 396**	**11 610**	**11 295**
Commercial and public services	**6 306**	**5 948**	**5 797**	**5 602**	**5 303**	**5 379**	**5 611**	**5 665**	**5 727**	**5 505**
Agriculture and forestry	**151**	**141**	**98**	**93**	**87**	**73**	**83**	**84**	**97**	**102**
Fisheries	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	**38 025**	**36 016**	**35 990**	**35 687**	**31 461**	**31 664**	**32 738**	**32 505**	**31 265**	**30 610**

Table No 20: *Share of waste heat in district heating (%)*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Share of waste heat in dist. heating	1.20	1.29	1.39	1.42	1.67	1.64	1.58	1.19	1.64	1.54

Chart No 3: *Share of gross waste heat production in final consumption of district heating*



Key to graphic	
Original text	Translation
Teplo z chemických procesů	Heat from chemical processes
Ostatní zdroje	Other sources
Podíl OZE na dálkovém vytápění	RES share in district heating
GWh	GWh

2.3 Maps

This part of the document aims to present maps of the Czech Republic which, while preserving confidentiality of commercially sensitive information, would show the following:

- points of demand for heating and cooling;
  - cities and suburban areas;
  - industrial zones;
- existing and planned district heating and cooling infrastructure;
- potential heating and cooling supply points;
  - installations for the production of electricity;
  - waste incineration plants;
  - existing and planned cogeneration and district heating plants;

2.3.1 Areas of demand for heating and cooling;

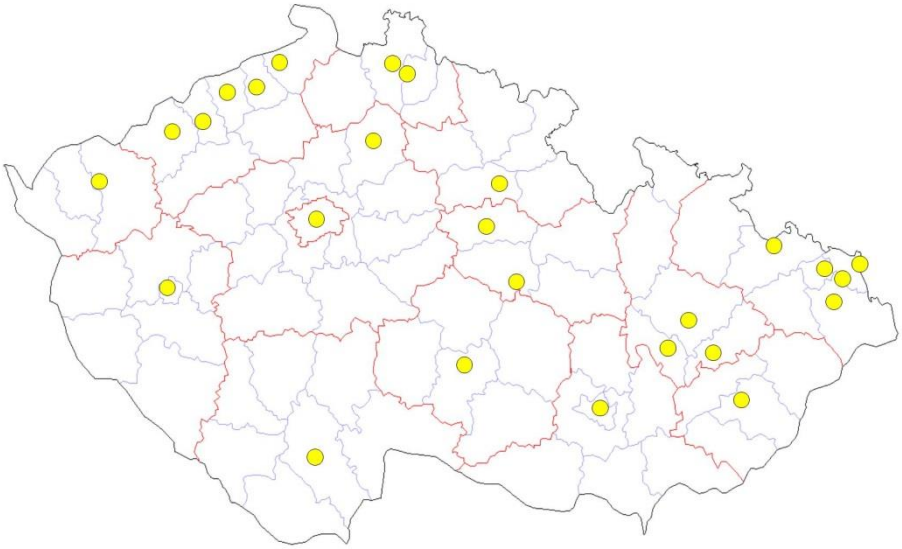
Points of demand for heating and cooling

- **Cities and suburban areas**

There are about 6 250 municipalities in the Czech Republic. Therefore, only residential units that have the status of a city were selected from the complete overview. Cities account for about one tenth of the total – a total of 606. Further selection can narrow down the data to cities with a population of 10 000 or more. Of the 606 cities, this selection brings us to the number of 126 cities.

The following map shows the most significant municipalities in the Czech Republic – the so-called 'statutory cities' (Prague, Plzeň, Liberec, Brno, Ostrava, České Budějovice, Havířov, Hradec Králové, Karlovy Vary, Olomouc, Opava, Pardubice, Ústí nad Labem, Zlín, Jihlava, Kladno, Most, Karviná, Mladá Boleslav, Teplice, Děčín, Frýdek-Místek, Chomutov, Přerov, Jablonec nad Nisou, Prostějov).

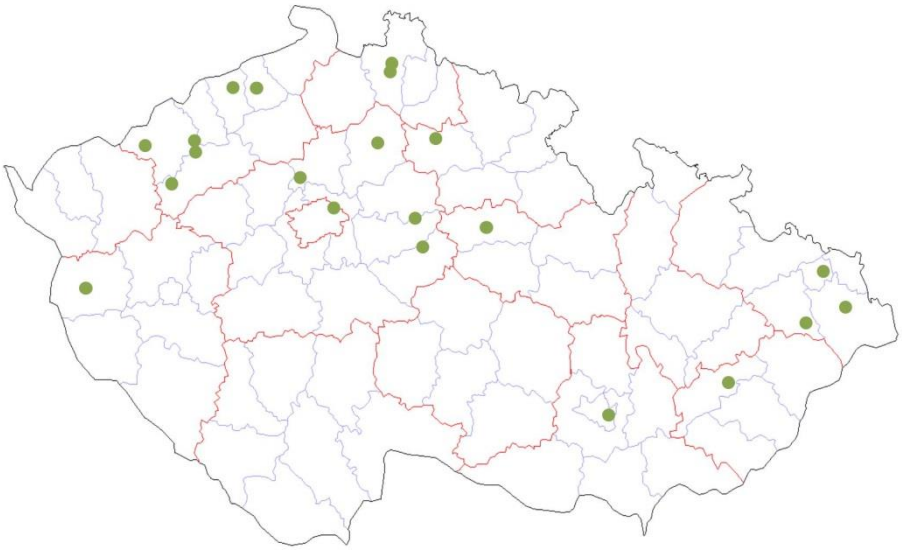
Figure No 1: *Map of 'statutory' cities in the Czech Republic*



Industrial zones

The breakdown of industrial zones by heat consumption is not available in the Czech Republic. The following map shows industrial zones with a used area of more than 50 ha (Kolín-Ovčáry, Ostrava – Mošnov, Most – Joseph, Holešov, Žatec – Triangle, Nošovice, Kutná Hora – Na Rovinách, Liberec Jih-Doubí, Logistický park Bor, Mladá Boleslav – východ, Kozomín – Úžice, Klášterec n.O. ind. park VERNE, Jičín – Průmyslová zóna I, II, III, Černovická terasa, Industriální park Krupka, Obchodní a průmyslová zóna Liberec Sever – Růžodol, Ostrava – Hrabová, Pardubice – Free zone + Staré Čívice, Podbořany – Alpka, Podnikatelský areál Vlčovice, Ústí nad Labem – Severní Předlice, VGP Park Horní Počernice).

Figure No 2: *Map of industrial zones*

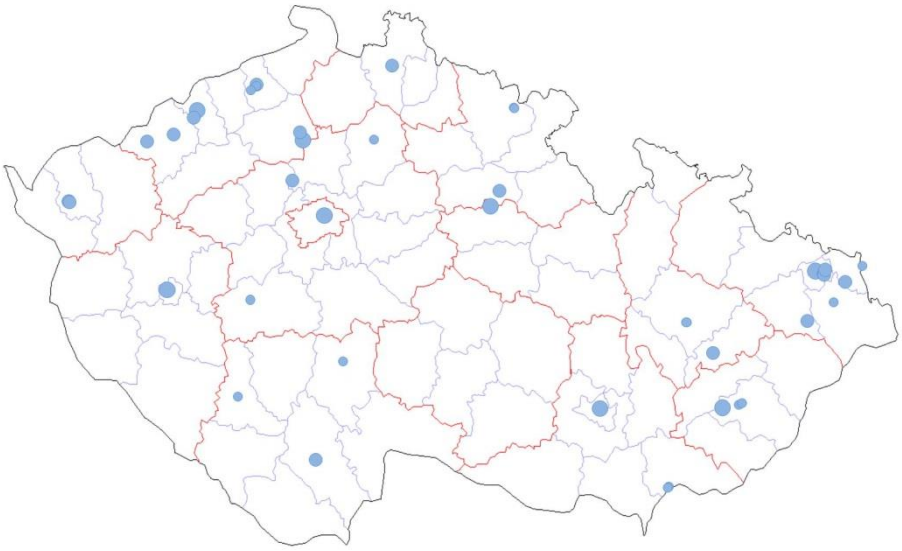


- **Infrastructure for district heating and cooling**

It is evident that heating systems are not present in all localities with the status of a city. By contrast, there may be a heating system in cities with less than 10 000 inhabitants. It is therefore likely that we will work with a dataset with more than 126 but less than 606 localities.

The following map shows the most important thermal energy supply systems in the Czech Republic; for illustration, systems with a transmission capacity of over 200 MWt are provided (Hodonín, Trutnov, Tisová, Prunéřov, Ostrava Vítkovice, Plzeň, České Budějovice, power supply from Mělník distribution systems in Prague, Strakonice, Ústí nad Labem, Ostrava, Karviná, Havířov, Olomouc, Přerov, Frýdek Místek, Ústí nad Labem, Zlín, Liberec, Brno, Hradec Králové, Mladá Boleslav, Příbram, Ostrava, Tábor, Olomouc, Štětí, Chomutov, Hodonín, Vítkovice, Ústí nad Labem, Litvínov, Zlín, Plzeň, Opatovice, Kralupy nad Vltavou, Most – Komořany, Kopřivnice, Otrokovice). At present, only heat distribution from the Temelín nuclear power plant can be considered as a more extensive planned district heating infrastructure. Given that the planned development of high-efficiency cogeneration involves primarily smaller plants, it will not be necessary to build large-scale infrastructure projects for district heating.

Figure No 3: *Map of district heating infrastructure*



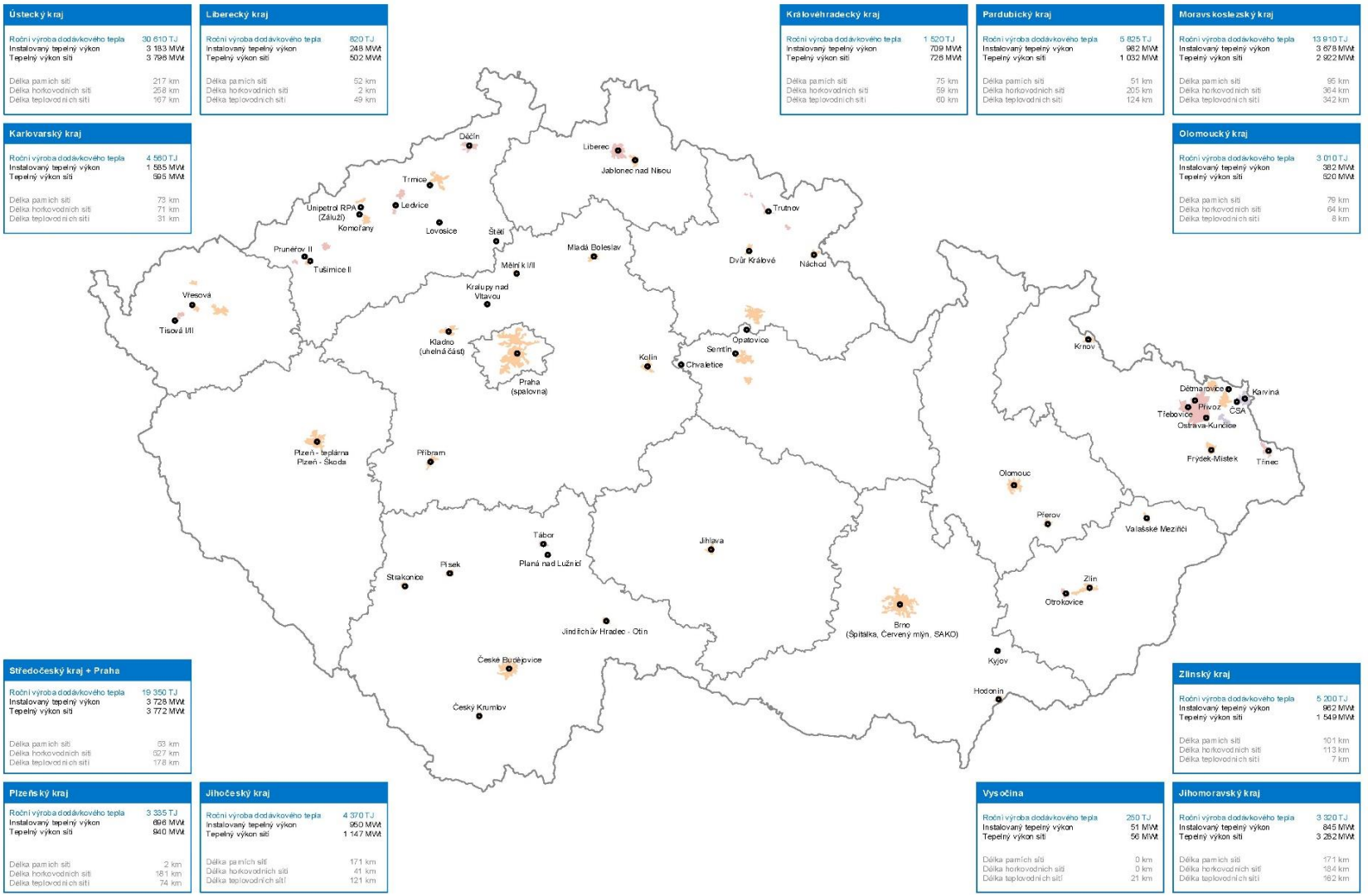
The following table shows the range of district heating in individual regions of the Czech Republic in terms of installed capacity and the amount of heat supply. Also shown is the scope of heat distribution networks by heat transfer medium. The decisive fuels are brown coal in 10 regions, black coal in 2 regions and natural gas in two regions.

Table No 21: *Summary data on decisive DH systems broken down by region*

region	installed heat output	annual heat supply	length of steam networks	length of high-temperature water networks	length of hot water networks	main fuel
	MWt	TJ	km	km	km	brown coal
Central Bohemia Region + Prague	3 728	19 350	53	527	178	brown coal
South Bohemian Region	950	4 370	171	41	121	brown coal
Plzeň Region	696	3 335	2	181	74	brown coal
Karlovy Vary Region	1 585	4 560	73	71	31	brown coal
Ústí nad Labem Region	3 183	30 610	217	258	167	brown coal
Liberec Region	248	820	52	2	49	natural gas
Hradec Králové Region	709	1 520	75	59	60	brown coal
Pardubice Region	982	5 825	51	205	124	brown coal
Vysočina Region	51	250	0	0	21	natural gas
South Moravian Region	845	3 320	171	184	162	brown coal
Zlín Region	962	5 200	101	113	7	brown coal
Olomouc Region	382	3 010	79	64	8	black coal
Moravian-Silesian Region	3 678	13 910	95	364	342	black coal
Czechia total	**18 001**	**96 080**	**1 140**	**2 070**	**1 344**	

Figure No 4: *Basic overview of the locations and main parameters of large heating systems in the Czech Republic*

Základní přehled rozmístění a hlavních parametrů velkých teplárenských systémů v ČR

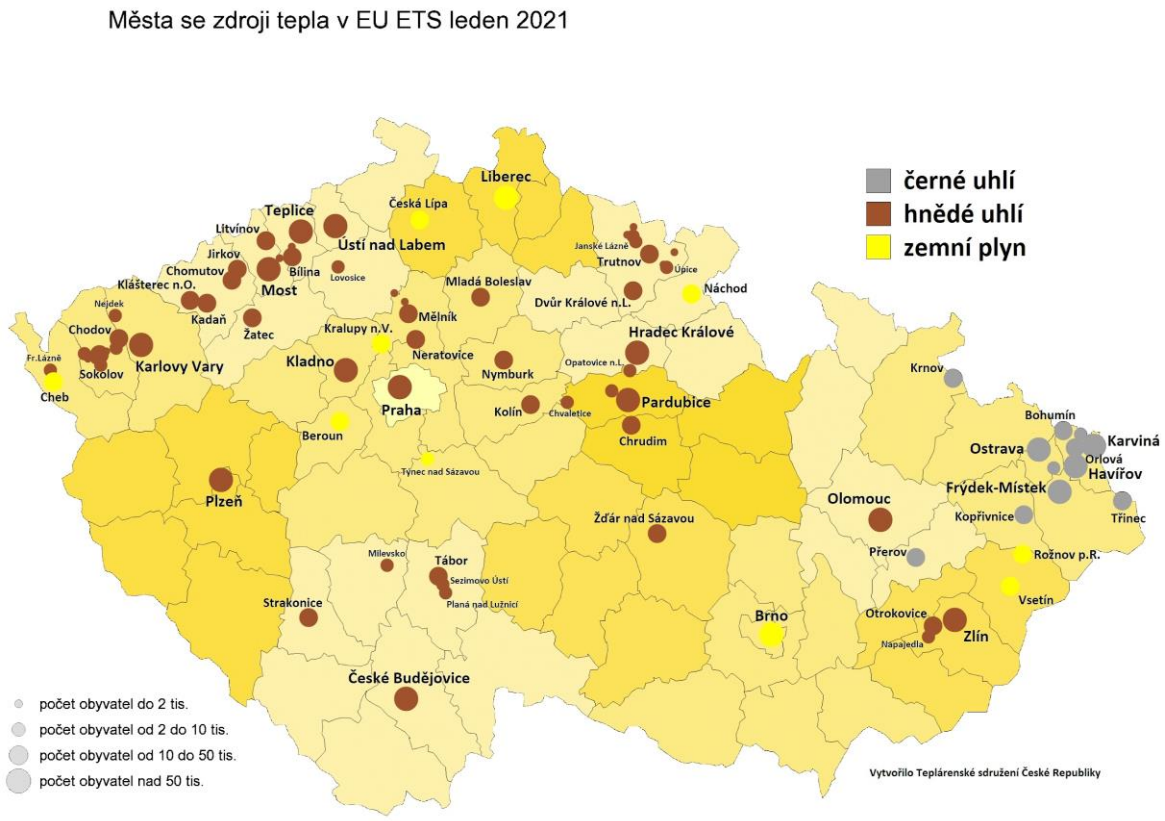


Key to graphic	
Original text	Translation
Základní přehled rozmístění a hlavních parametrů velkých teplárenských systémů v ČR	Basic overview of the locations and main parameters of large heating systems in the Czech Republic
Ústecký kraj	Ústí nad Labem Region
Roční výroba dodávkového tepla	Annual production of supply heat
Instalovaný tepelný výkon	Installed heat output
Tepelný výkon sítí	Thermal output of networks
Délka parních sítí	Length of steam networks
Délka horkovodních sítí	Length of high-temperature hot water networks
Délka teplovodních sítí	Length of hot water networks
Liberecký kraj	Liberec Region
Královéhradecký kraj	Hradec Králové Region
Pardubický kraj	Pardubice Region
Moravskoslezský kraj	Moravian-Silesian Region
Karlovarský kraj	Karlovy Vary Region
Olomoucký kraj	Olomouc Region
Středočeský kraj	Central Bohemian Region
Plzeňský kraj	Plzeň Region
Jihočeský kraj	South Bohemian Region
Zlínský kraj	Zlín Region
Vysočina	Vysočina Region
Jihomoravský kraj	South Moravian Region

281.1.1 Existing heating and cooling supply points

Heating and cooling supply points

Figure No 5: *Fossil fuel heating plants included in the EU ETS in 2020*



Key to graphic	
Original text	Translation
Města se zdroji tepla v EU ETS leden 2021	Cities with heat sources in the EU ETS January 2021
černé uhlí	black coal
hnědé uhlí	brown coal
zemní plyn	natural gas
počet obyvatel do 2 tis	population up to 2 thousand
počet obyvatel od 2 do 10 tis	population from 2 to 10 thousand
počet obyvatel od 10 do 50 tis.	population from 10 to 50 thousand
počet obyvatel nad 50 tis.	population above 50 thousand
Vytvořilo Teplárenská sdružení České republiky	Created by Association for District Heating of the Czech Republic (ADH CR)

Source: Association for District Heating of the Czech Republic

Waste incineration plants

The following map shows 4 existing municipal waste incineration plants in the Czech Republic (Prague, Brno, Liberec, Plzeň with a total annual consumption of about 750 thousand tons of waste) and the most important industrial waste incineration plant in Ostrava (consumption of about 20 thousand tons of waste).

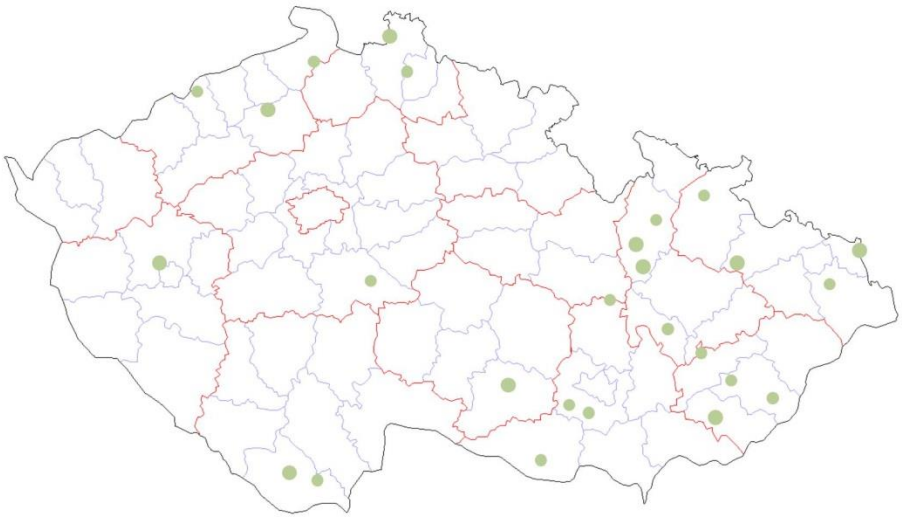
In the Czech Republic, there are another 23 smaller incineration plants for industrial/hazardous/medical waste with minimal potential for energy recovery of waste.

2.3.3 Planned heating and cooling supply points

Planned cogeneration plants and heat-only plants

The following map is based on authorisations issued for the construction of power generation plants and shows the planned power generation plants with cogeneration-enabling technology (sources with a planned power output of over 2 MWe were selected for illustration).

Figure No 6: *Planned cogeneration plants*

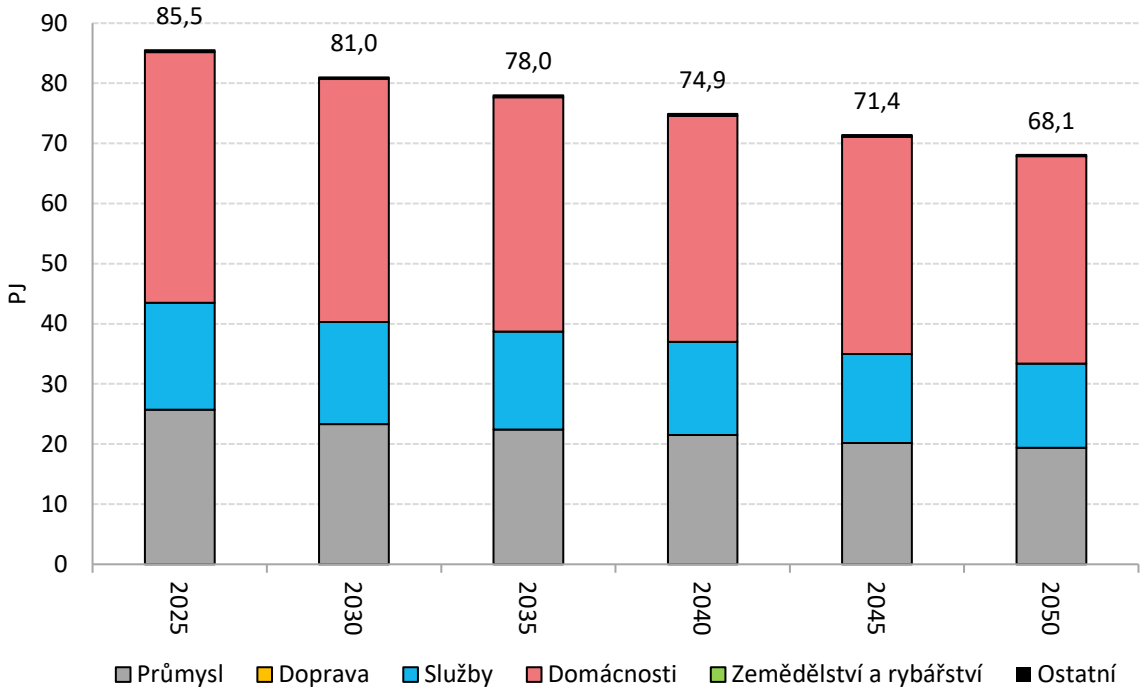


2.4 Forecast of the development of demand for heating and cooling with a view to the next 30 years

Table No 22: *Expected development of final heat consumption (PJ)*

year	2025	2030	2035	2040	2045	2050
Industry	25.7	23.3	22.4	21.5	20.2	19.4
Transport						
Services	17.8	17.0	16.3	15.5	14.8	14.0
Households	41.7	40.4	39.0	37.6	36.1	34.5
Agr. and fisheries	0.3	0.3	0.3	0.3	0.3	0.2
Other						
Total	**85.5**	**80.9**	**78.0**	**75.0**	**71.4**	**68.1**

Chart No 4: *Expected development of final heat consumption (PJ)*



Key to graphic	
Original text	Translation
Průmysl	Industry
Doprava	Transport
Služby	Services
Domácnosti	Households
Zemědělství a rybářství	Agriculture and fisheries
Ostatní	Other
PJ	PJ

The above prediction of the development of final heat consumption is given in the National Energy and Climate Plan of the Czech Republic, which was prepared on the basis of and in accordance with EU Regulation 2018/1999.[1]

In the future, the share of energy from renewable sources in the production of heat sold should be expected to continue to increase, especially at the expense of coal, and at least in the transitional period, the share of natural gas will also increase. However, there will also be an increase in the recovery of heat from nuclear power plants in connection with the project to connect the thermal energy supply system in České Budějovice to the Temelín nuclear power plant. Thermal energy supply systems are seen as an

[1] The National Energy and Climate Plan of the Czech Republic is available here. The national plans of individual Member States, including the Czech Republic, are available in English here.

important element for reducing greenhouse gas emissions and the use and development of renewable energy sources or high-efficiency cogeneration, which is also confirmed by the European Commission's heating and cooling strategy. The National Energy Policy also requires the long-term maintenance of the largest possible extent of economically sustainable thermal energy supply systems.

Concerning the heat sector (centralised and decentralised heat supply), the following can be considered as the main objectives of the Czech Republic:

- **Emphasis on the maintenance and development of 'efficient thermal energy supply systems'** (which make extensive use of renewables, secondary sources and high-efficiency cogeneration), which is prioritised by EU legislation.
- **At least 60% of the thermal energy supply** from thermal energy supply systems **should be covered by high-efficiency cogeneration.**
- **Renovation, transformation and stabilisation of thermal energy supply systems based preferentially on national sources** (nuclear, renewable sources, waste recovery, secondary sources), ideally available at regional and local levels. These fuels and sources will be further supplemented to include natural gas.

At present, the basic strategies of the heating industry (centralised heat supply and decentralised (individual) thermal energy supply), including the balance model, are laid down in the National Energy Policy and the National Energy and Climate Plan of the Czech Republic.

The National Energy and Climate Plan lays down the requirements of Article 23 of Directive 2018/2001 to mainstream renewable energy in heating and cooling.

For the stabilisation and development of thermal energy supply systems, it will be crucial for thermal energy supply systems that currently use coal to ensure, in accordance with the decision of the Government of the Czech Republic in connection with the recommendation of the Coal Commission, the transition to another (less emission-intensive) fuel (biomass, waste or natural gas).

This issue will mainly concern 45 heating plants and company power plants connected to thermal energy supply systems that currently use coal. In the period 2021–2030, a change in the fuel base of these heating plants should be made or started in order to use different, less emission-intensive types of fuels (biomass, waste or natural gas). Some sources will be shut down and the heat will be supplied by other heat sources.

The remaining heat supply from current coal-fired thermal energy systems, which will not be provided through heat production in cogeneration plants, will be provided by small heat-only plants and small decentralised cogeneration sources.

Electric boilers may also play a certain role in the heating sector and in the stabilisation and development of heat supply systems in the future.

(A) Predicted development of the final energy consumption and useful energy for heating and the share of RES in district heating

Table No 23: *Predicted final consumption of energy for heating – including process and technological heat*

year	2025	2030	2035	2040	2045	2050
Industry	**52 370.8**	**50 631.2**	**49 997.2**	**49 225.9**	**48 074.5**	**47 506.6**
Other	**87 211.7**	**83 281.4**	**79 626.5**	**75 364.6**	**70 620.0**	**65 600.7**
Commercial and public services	18 207.8	16 950.7	15 727.0	14 581.3	13 508.9	12 603.0
Households	62 386.7	59 670.9	56 956.2	53 951.4	50 774.1	47 433.4
Agr., forestry and fisheries	6 126.8	6 169.6	6 453.1	6 341.7	5 846.7	5 074.0
Other	490.3	490.3	490.3	490.3	490.3	490.3
Total	**139 582.5**	**133 912.7**	**129 623.7**	**124 590.5**	**118 694.5**	**113 107.2**

Table No 24: *Prediction of the development of useful energy for heating*

year	2025	2030	2035	2040	2045	2050
Industry	**43 323.2**	**41 797.0**	**41 241.6**	**40 577.2**	**39 583.5**	**39 083.0**
Other	**73 090.7**	**69 830.3**	**66 790.5**	**63 260.6**	**59 337.0**	**55 186.6**
Commercial and public services	15 553.9	14 506.2	13 485.3	12 526.7	11 626.9	10 860.2
Households	52 227.5	49 980.4	47 734.0	45 252.0	42 625.6	39 862.0
Agr., forestry and fisheries	4 917.2	4 951.5	5 179.0	5 089.6	4 692.3	4 072.2
Other	392.2	392.2	392.2	392.2	392.2	392.2
Total	**116 413.9**	**111 627.3**	**108 032.1**	**103 837.7**	**98 920.4**	**94 269.6**

Table No 25: *Prediction of the development of gross heat production from RES (GWh)*

year	2025	2030	2035	2040	2045	2050
Heat pumps						
Municipal waste (RES)	1 425.5	1 674.9	1 674.9	1 674.9	1 674.9	1 674.9
Biomass	3 201.5	3 617.8	4 592.4	5 047.2	4 810.8	4 699.9
Biogas	365.7	503.0	505.4	718.1	764.7	785.1
Geothermal energy	86.1	447.2	627.8	808.3	988.9	1 169.4
Total	**5 078.8**	**6 242.9**	**7 400.5**	**8 248.6**	**8 239.2**	**8 329.3**

Table No 26: *Predicted share of gross heat production from RES in final consumption of district heating (GWh)*

year	2025	2030	2035	2040	2045	2050
Gross heat generation	31 335.1	30 075.0	29 249.2	28 289.6	27 167.0	26 141.2

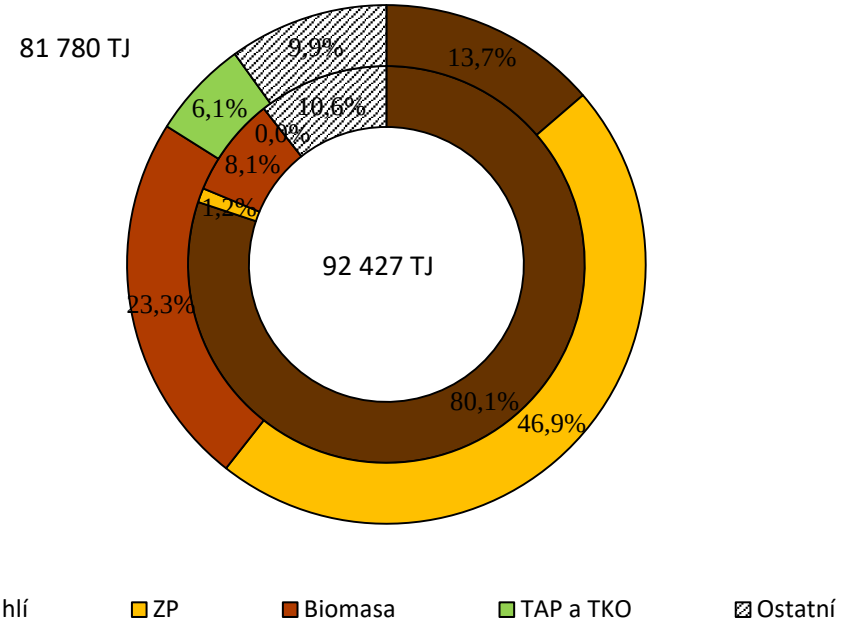
Table No 27: *Outlook for the share of RES in district heating (%)*

year	2025	2030	2035	2040	2045	2050
RES share in district heating	16.21	20.76	25.30	29.16	30.33	31.86

(B) Expected transformation of existing coal sources by 2030

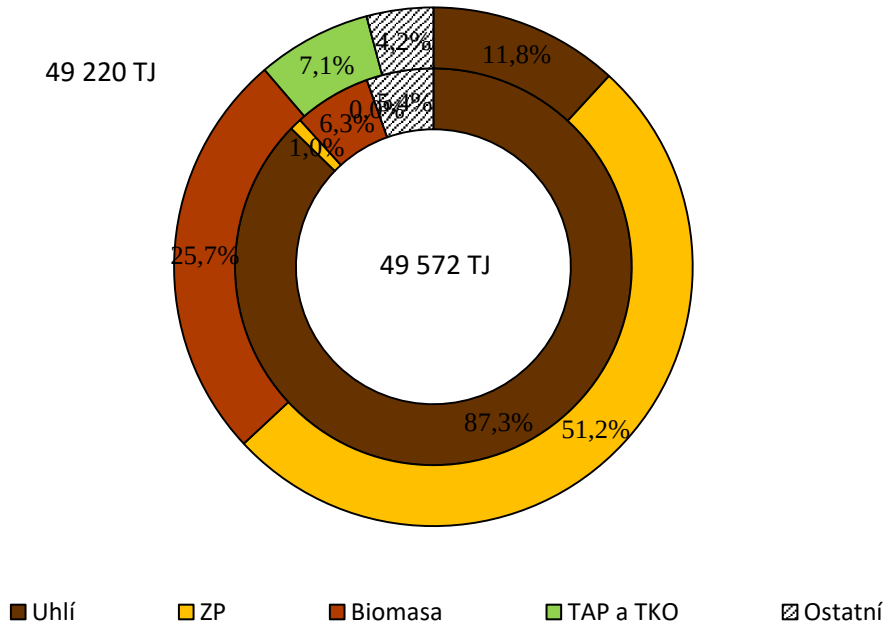
In the preparation of this document, the authors analysed all large sources supplying heat to thermal energy supply systems, from which they selected 'large' public and industrial heating plants and power plants currently burning brown or black coal (45 sources), which are expected to undergo transformation. They analysed their current fuel mix and planned changes of this fuel mix. In particular, this concerns a transition from coal to natural gas, biomass and waste. It is evident that there is a relatively significant substitution of coal in the production of heat as well as electricity. Not all transformations will involve cogeneration; part of the heat will involve heat-only production.

Chart No 5: *Gross heat production in existing coal-fired heating sources in 2018 (inner circle) and after transformation in 2030 (outer circle)*



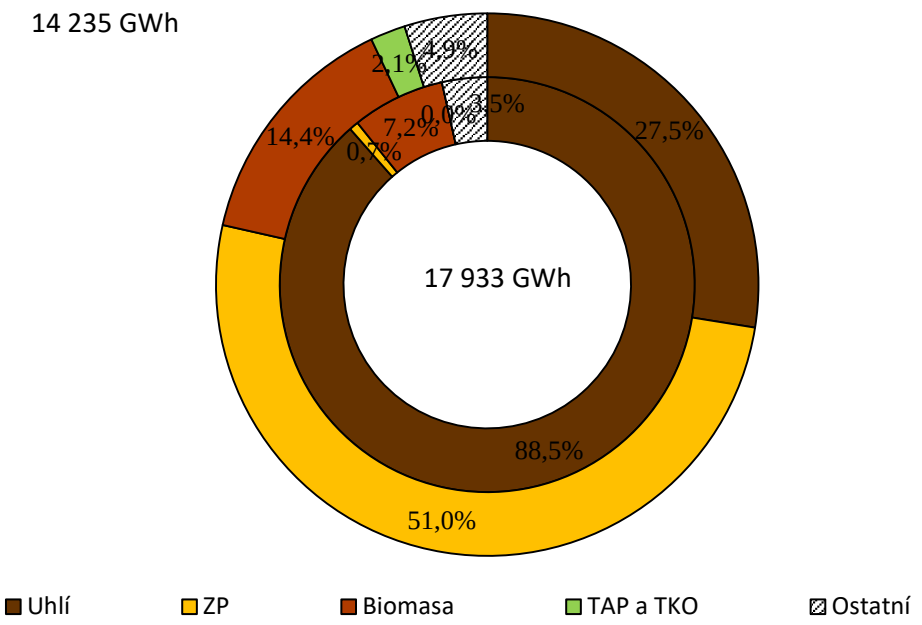
Key to graphic	
Original text	Translation
Uhlí	Coal
ZP	NG
Biomasa	Biomass
TAP a TKO	SAF and MSW
Ostatní	Other
81 780 TJ	81 780 TJ
92 427 TJ	92 427 TJ

Chart No 6: *Heat sold in existing coal-fired district heating sources in 2018 (inner circle) and after transformation in 2030 (outer circle)*



Key to graphic	
Original text	Translation
Uhlí	Coal
ZP	NG
Biomasa	Biomass
TAP a TKO	SAF and MSW
Ostatní	Other
49 220 TJ	49 220 TJ
49 572 TJ	49 572 TJ

Chart No 7: *Gross electricity production in existing coal-fired heating sources in 2018 (inner circle) and after transformation in 2030 (outer circle)*



Key to graphic	
Original text	Translation
Uhlí	Coal
ZP	NG
Biomasa	Biomass
TAP a TKO	SAF and MSW
Ostatní	Other
14 235 GWh	14 235 GWh
17 933 GWh	17 933 GWh

(C) Expected development in cogeneration

Table No 28 shows the expected and estimated development of the installed cogeneration capacity required for the transformation of the heating industry in the period 2021–2030. This capacity is based on the analysis of existing coal-fired sources (electricity and heat production plants) connected to thermal energy supply systems and their transformation into low-emission heat sources as part of the decarbonisation of heat supply systems and also the expected construction of new sources (electricity and heat production plants) installed primarily outside the thermal energy supply system, such as small 'community' and industrial cogeneration sources. Because there is a relatively large number of variables with respect to the exact year of the transition, the installed capacity in the given time period is distributed in linear (uniform) fashion.

Table No 28: *Development of the installed cogeneration capacity required for the transformation of the heating industry (MWe)*

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Transformation of existing (especially coal-fired) cogeneration sources within thermal energy supply systems	248	248	248	248	248	248	248	248	248	248	**2 480**
a. Natural gas	210	210	210	210	210	210	210	210	210	210	**2 100**
b. Biomass	25	25	25	25	25	25	25	25	25	25	**250**
c. WtE plants + SAF	13	13	13	13	13	13	13	13	13	13	**130**
New cogeneration plants (engine-based) installed mainly outside thermal energy supply systems	42	42	43	43	43	43	43	43	43	43	**428**
a. Biogass	5	5	5	5	5	5	5	5	5	5	**50**
b. Natural gas	35	35	35	35	35	35	35	35	35	35	**350**
c. Micro-cogeneration	2	2	3	3	3	3	3	3	3	3	**28**
Total	290	290	291	291	291	291	291	291	291	291	**2 908**

3 OBJECTIVES, STRATEGIES AND POLICY MEASURES

The planned contribution of the Member State to its national projects, objectives and contributions related to the five dimensions of the Energy Union

The planned contribution of the Member State to national plans, objectives and contributions related to the five dimensions of the Energy Union is detailed in the Czech Republic's National Energy and Climate Plan, which was prepared on the basis of and in accordance with EU Regulation 2018/1999.[2]

3.2 Overview of existing policies and measures

(A) Strategic Framework for Sustainable Development of the Czech Republic 2030

The basic document in the field of sustainable development is the Strategic Framework for Sustainable Development of the Czech Republic 2030. Chapter 2.3: Infrastructure specifies objective 10.4 Thermal energy infrastructure:

- Creating conditions for the approach 'municipal waste that cannot be recycled will be advantageous to use for heat production' in the new Waste Act.
- Support for cogeneration from renewable sources.
- Levelling the conditions for different types of heat producers and suppliers by charging the emissions produced.

[2] The National Energy and Climate Plan of the Czech Republic is available here. The national plans of individual Member States, including the Czech Republic, are available in English here.

This document is followed by the State Environmental Policy of the Czech Republic 2012–2020 from 2012 and the State Energy Policy from 2015, which lays down more specific objectives and measures.

(B) State Environmental Policy of the Czech Republic 2012–2020

Within the thematic area Climate protection and improvement of air quality, priority 2.1 Reducing greenhouse gas emissions and reducing the negative effects of climate change sets the following objective 2.3.3: Fulfilling the commitment to increase energy efficiency by 2020. Measures to achieve this objective include: 'Support the increase in the share of combined heat and power.'

(C) State Energy Policy of the Czech Republic

The State Energy Policy of the Czech Republic (SEP) is a top strategic document in the field of energy[3]. The current State Energy Policy of the Czech Republic was approved in March 2015. In early 2021, the Evaluation of the progress towards the SEP and the preparation of an update of this strategic document were approved.

The SEP contains a number of objectives and measures relating to cogeneration. In particular, it is a strategic goal to achieve/maintain 60% of heat supply from thermal energy supply systems from cogeneration and 20% of heat supply from renewable energy sources.

The State Energy Policy of the Czech Republic also contains a number of specific priorities related to the heating/CHP sector. This is, for example, a strategy in the sense of: the transition of most heating plants to high-efficiency cogeneration where economically viable (PII5); ensuring a gradual transition to cogeneration combined with the efficient use of heat pumps in all heating plants (D.3); Transition to high-efficiency cogeneration in all heat supply systems (Fb.3-); creation of conditions for the development of micro-cogeneration sources and their reasonable integration into networks with preferential use of electricity for own consumption (Ae.2.);. long-term maintenance of the largest possible economically sustainable scope of heat supply systems with regard to their competitiveness and ensuring comparison of economic conditions of centralised and decentralised heat sources in the payment of emissions and other externalities (carbon tax, allowances, emissions) (D.1) and Fb.4. Reduction of losses in distribution systems of heating equipment (Fb.4.). Optimised scenario of energy sector development until 2040 provided in the State Energy Policy assumes a substantial increase in the share of heat from RES in heat supplies from heat supply systems.

(D) National Action Plan for Smart Grids

The National Action Plan for Smart Grids (NAP SG) is a key strategic and planning document concerning smart grids. This document is prepared by the Ministry of Industry and Trade as envisioned in the State Energy Policy. The NAP SG then contains measures to increase the flexibility of the energy system and was approved by Government Resolution No 149 of 4 March 2015. The NAP SG characterises the period until 2019 as preparatory; in this period, the aim was to prepare the necessary analyses, design and agree on a target model for the deployment of smart grids in the Czech Republic, complete and evaluate pilot projects and develop an implementation process for smart metering (AMM).

[3] The State Energy Policy of the Czech Republic is available here.

On 16 September 2019, the Government of the Czech Republic approved the Update of the NAP SG – the National Action Plan for Smart Grids 2019–2030 (NAP SG 2019–2030)[4]. At the same time, the NAP SG Evaluation Report was prepared, providing details on the progress towards individual cards/policies and measures in this national action plan.

The relevant areas under the Updated NAP SG include the following: (i) legislation (EU legislation – network regulations, winter legislative package, new technologies); (ii) use of aggregation, flexibility for electricity systems (decentralised energy sources, consumption); (iii) electromobility (integration and use for the operation of the electrical grid); (vi) digitisation and its use (automation, communication); (v) decentralised energy sources (integration and use for the operation of the electrical grid); (vi) dispatching (including operational measurement); (vii) accumulation (integration and use for the operation of the electrical grid); (viii) smart metering (AMM).

[4] The National Action Plan for Smart Grids 2019–2030 is available here. For more details click here.

(E) Legislative and investment measures

Table No 29: *Existing legislative and investment measures to support cogeneration and efficient heat supply systems*

Measures	Detailed description
Investment and operating aid for cogeneration	The Czech Republic has introduced investment and operating aid for the production of electricity from high-efficiency cogeneration.
Preferential connection to the electrical grid	In accordance with Act No 165/2012, the distribution system operators and the transmission system operator are obliged to give priority to connecting plants producing electricity from high-efficiency cogeneration in their defined territory.
Tax exemption	In accordance with Act No 261/2007, as amended, the fuel used for cogeneration is exempt from gas tax and solid fuel tax in accordance with Directive 2003/96/EC.
Obligation to assess the use of cogeneration	In accordance with Act No 406/2000, on energy management, a builder or owner of an energy management system must, from 1 July 2015, provide an energy assessment to assess the costs and benefits of providing for high-efficiency cogeneration in the case of construction of a new electricity generation plant or substantial renovation of an existing electricity generation plant with a total heat input of more than 20 MW.
Obligation to assess the recovery of waste heat	In accordance with Act No 406/2000, a builder or owner of an energy management system must, from 1 July 2015, provide an energy assessment to assess the costs and benefits of waste heat recovery to meet economically justified heat demand, including cogeneration, and connecting the plant to at least the thermal energy supply system (at least 1 000 meters from the source) and to assess the costs and benefits of the recovery of waste heat from at least industrial plants (at least 500 meters from the source).
Obligation to assess the usability of heat supply systems	In accordance with Act No 406/2000, when constructing new buildings or when major alterations are made to an existing building with an energy source with an installed thermal capacity of more than 200 kW, the builder, unit owners' association or building owner is obliged to provide an energy assessment to assess the technical, economic and environmental

	feasibility of alternative energy supply systems, including thermal energy supply systems.
Considering the potential use of cogeneration and heat supply systems in territorial energy strategies	In accordance with Act No 406/2000 the regions and the city of Prague are obliged to develop a territorial energy strategy, which sets out the objectives and principles of energy management within the territory of the region, the city of Prague, its city districts or municipalities. When developing the territorial energy strategy, they must take into account the potential of using efficient heating and cooling systems, especially if they use high-efficiency cogeneration, and heating and cooling using renewable energy sources, where appropriate. The territorial energy strategy then forms the basis for the development of the land-use development principles or the land-use plan.
Investment aid for the renovation and development of heat supply system infrastructure.	In the Czech Republic, investment aid for the renovation and development of heat supply system infrastructure has been introduced.
Inclusion of heat supply system renovations in the National Investment Plan	Heat supply system renovations have also been included in the National Investment Plan under Article 10c of Directive 2009/29/EC amending Directive 2003/87/EC in order to improve and extend the scheme for greenhouse gas emission allowance trading within the Community. Operators of heat supply systems with cogeneration sources can thus obtain an allocation of free allowances in exchange for investments in heat supply system renovations. However, the investments included in the National Investment Plan are not eligible for concurrent support with subsidy programs.
Reduced VAT rate	In accordance with Act No 235/2004 on value added tax, as amended, heat is subject to reduced VAT rate, which is 10%.
Priority use of heat supply systems	In accordance with Act No 201/2012 on air protection, as amended, legal and natural persons are obliged, if it is technically possible and economically acceptable for them, to use heat from thermal energy supply systems or a source that is not a stationary source of air pollution in new buildings or in the case of alterations to existing buildings.

4 ANALYSIS OF THE ECONOMIC POTENTIAL OF HEATING AND COOLING EFFICIENCY

4.1 Analysis of the economic potential of different heating and cooling technologies

Within the monitored capacity categories, the following modernisation methods are assumed in the category up to 50 MW and the category from 50 to 300 MWt, as shown in the tables below.

The estimate is based on the method of representatives, the data are taken from a survey conducted by the heating sector, implemented investment projects from the period 2010–2020, and bids in tenders for 2020. The data collected in this way are adjusted by expert estimates.

Data in individual capacity categories and methods of modernisation have a relatively high variability; the typical value according to expert estimate (within the variation range of the category) was chosen as the representative value rather than automatically choosing the average value. To test the impact of the choice of these representative values on the estimate of total investment needs by 2030, two basic scenarios of values of specific investment costs were developed, namely:

- a conservative scenario, which reflects the upper cost estimate by 2030
- an optimistic scenario, which conversely defines the lower cost estimate by 2030

The results of the modelling of investment costs in both scenarios at 2020 prices are summarised in the following tables for the conservative and optimistic scenarios.

Table No 30: *Results of modelling investment costs of modernisation of the heating industry by 2030 in CZK millions, conservative scenario, 2020 prices (CZK millions)*

	up to 50 MWt	50–300 MWt	Total
Cost of new cogeneration sources	43 459	13 745	57 204
Cost of the renovation of cogeneration sources	15 521	8 025	23 545
Cost of new heat-only sources	4 711	1 527	6 238
Cost of the renovation of heat-only sources	2 092	872	2 965
HESS renovation costs	-	-	6 220
Total model costs			**96 172**

Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

Table No 31: *Results of modelling investment costs of modernisation of the heating industry by 2030 in CZK millions, optimistic scenario, 2020 prices (CZK millions)*

	up to 50 MWt	50–300 MWt	Total
Cost of new cogeneration sources	39 689	13 745	53 434
Cost of the renovation of cogeneration sources	11 552	7 608	19 160

Cost of new heat-only sources	4 711	1 527	6 238
Cost of the renovation of heat-only sources	2 092	872	2 965
HESS renovation costs	-	-	5 040
Total model costs			**86 837**

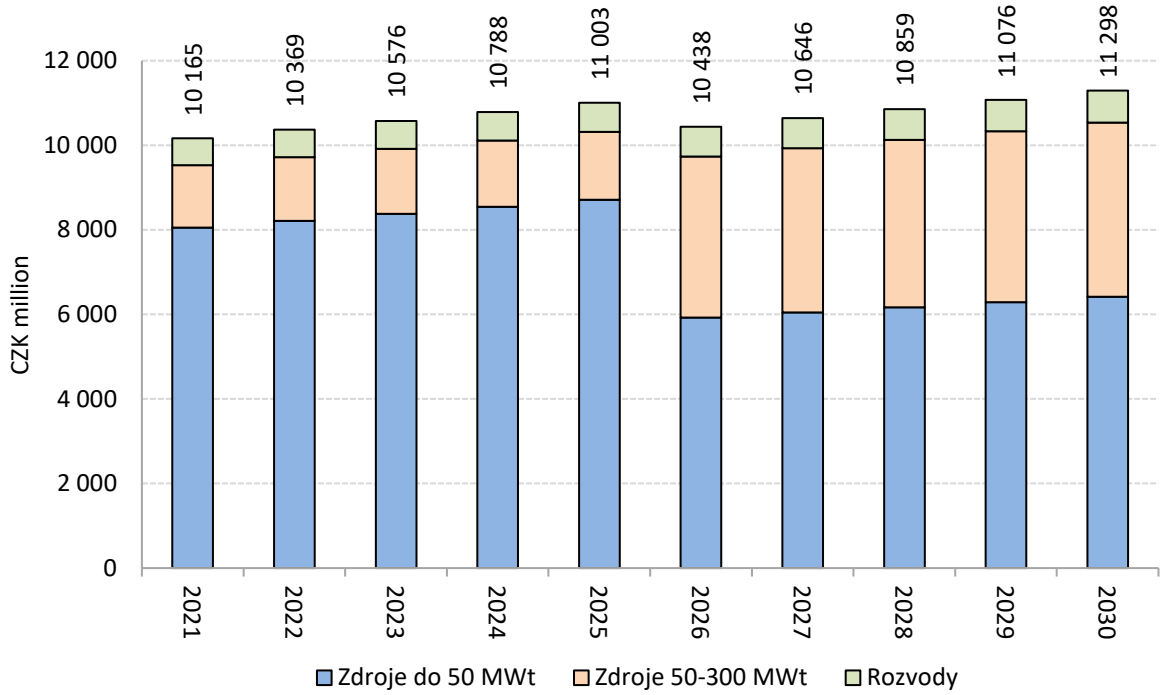
Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

After taking into account the increase in prices of construction works and technology according to the above assumptions, the accumulated values of costs in current prices of the given year by 2030 are as follows:

- **Conservative scenario: CZK 107.2 billion**
- **Best case scenario: CZK 98.3 billion**

The following figures show the distribution of costs over time (in current prices of a given year) for both scenarios.

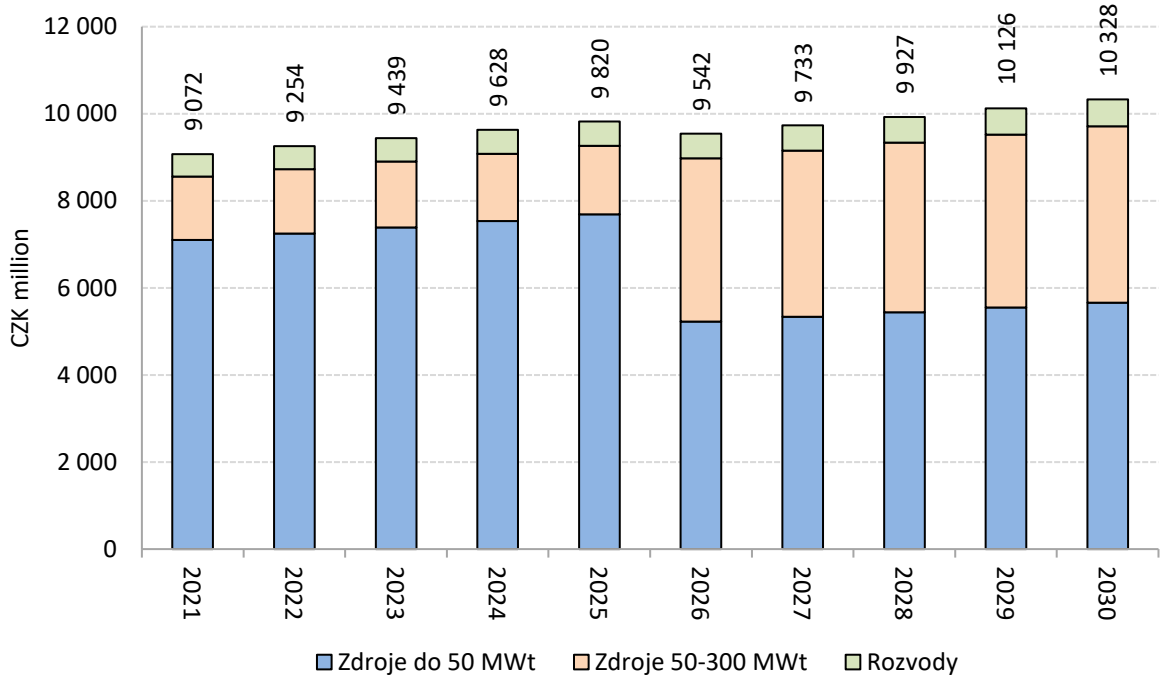
Chart No 8: *Distribution of costs in current year prices for modernisation of heating industry, conservative scenario (CZK millions)*



Key to graphic	
Original text	Translation
Zdroje do 50 MWt	Sources up to 50 MWt
Zdroje 50-300 MWt	Sources 50–300 MWt
Rozvody	Distribution systems
mil. Kč	CZK million

Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

Chart No 9: *Distribution of costs in current year prices for the modernisation of the heating industry, optimistic scenario (CZK millions)*



Key to graphic	
Original text	Translation
Zdroje do 50 MWt	Sources up to 50 MWt
Zdroje 50-300 MWt	Sources 50–300 MWt
Rozvody	Distribution systems
mil. Kč	CZK million

Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

The following figures and tables provide more details on the distribution of investment funds at current prices of the given year.

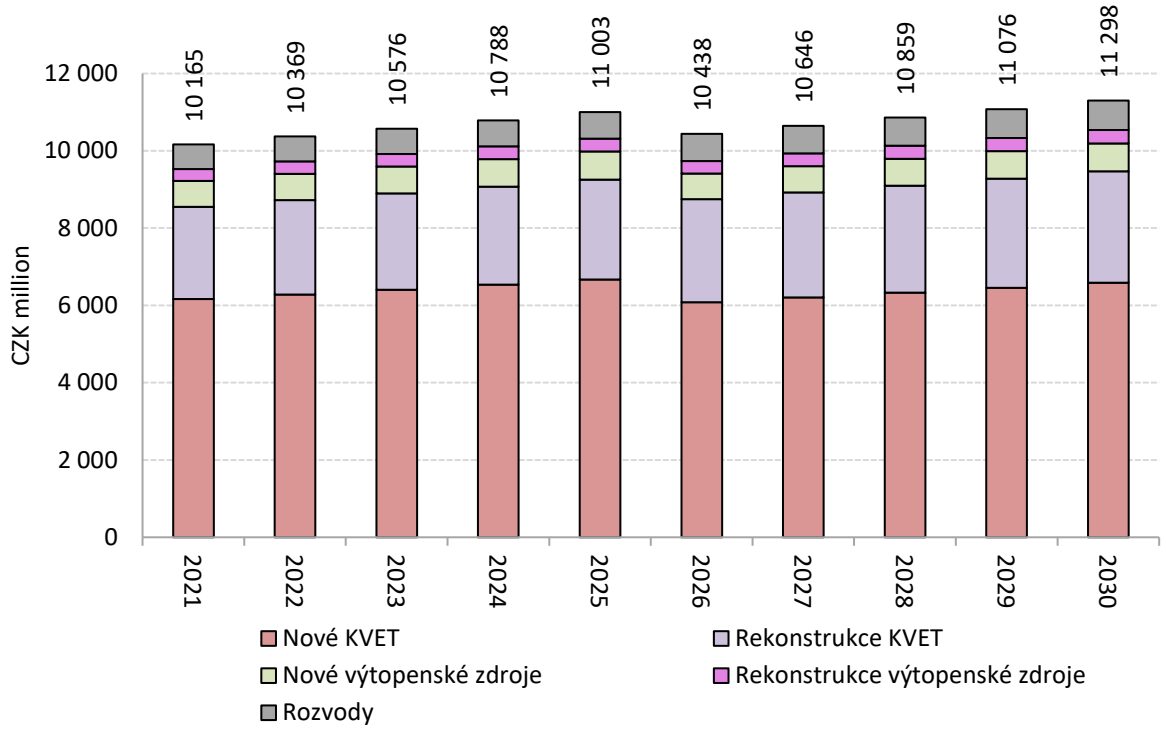
Table No 32: *Distribution of costs for the modernisation of heating industry by groups of sources and stages of modernisation, conservative scenario, current prices of the given year (CZK millions)*

	by 2025	**2026–2030**
New CHP	32 060	31 653
Renovated CHP	12 442	13 861
New heat-only sources	3 487	3 462
Renovated heat-only sources	1 611	1 697
Distribution systems	3 302	3 645

Total	**52 901**	**54 318**

Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

Chart No 10: *Distribution of costs for the modernisation of the heating industry in years in current year prices by type of source and project, current prices of the given year, conservative scenario (CZK millions)*



Key to graphic	
Original text	Translation
Nové KVET	New CHP
Nové výtopenské zdroje	New heat-only sources
Rozvody	Distribution systems
Rekonstrukce KVET	Renovated CHP
Rekonstrukce výtopenské zdroje	Renovated heat-only sources
mil. Kč	CZK million

Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

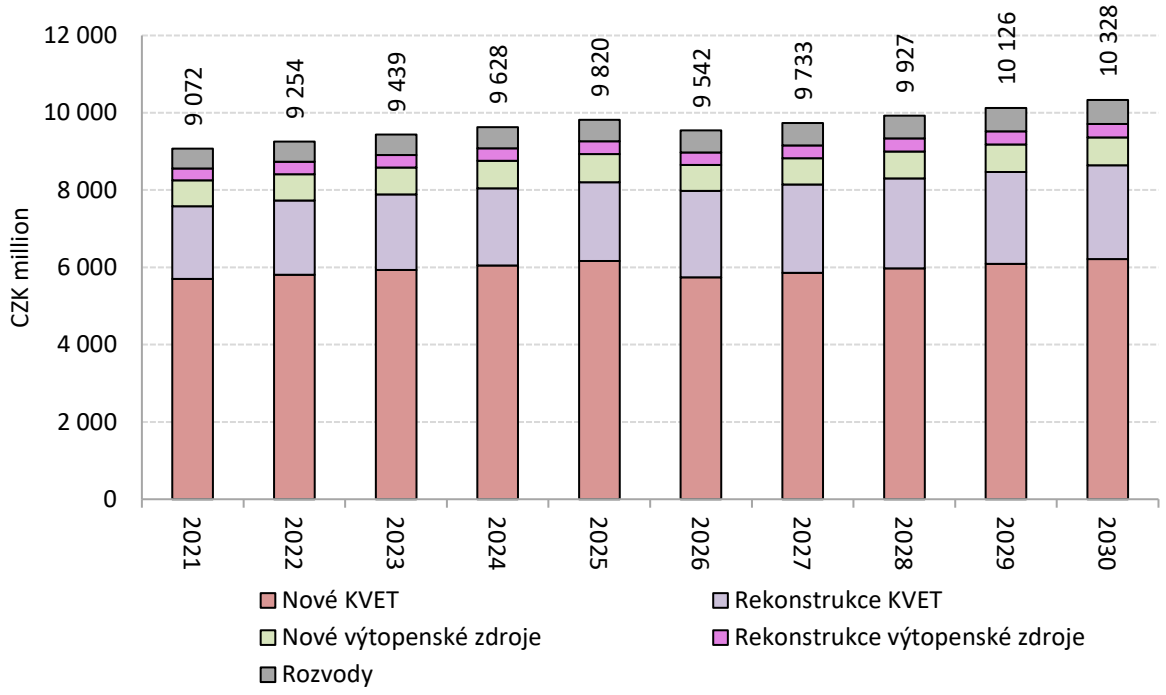
Table No 33: *Distribution of costs for the modernisation of the heating industry by groups of sources and stages of modernisation, optimistic scenario, current prices of the given year (CZK millions)*

	by 2025	**2026–2030**
New CHP	29 658	29 885
Renovated CHP	9 781	11 658

New heat-only sources	3 487	3 462
Renovated heat-only sources	1 611	1 697
Distribution systems	2 675	2 954
TOTAL	**47 213**	**49 656**

Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

Chart No 11: *Distribution of costs for the modernisation of the heating industry in years in current year prices by type of source and project, optimistic scenario, current prices of the given year (CZK millions)*



Key to graphic	
Original text	Translation
Nové KVET	New CHP
Nové výtopenské zdroje	New heat-only sources
Rozvody	Distribution systems
Rekonstrukce KVET	Renovated CHP
Rekonstrukce výtopenské zdroje	Renovated heat-only sources
mil. Kč	CZK million

Source: Climate-energy investments in heating industry 2014–2030 (Czech Technical University in Prague)

5 POTENTIAL NEW STRATEGIES AND POLICY MEASURES

5.1 Overview of new legislative and non-legislative policy measures to achieve economic potential

5.1.1 Basic strategies for stabilisation and development of high-efficiency cogeneration and efficient thermal energy supply systems have been set

At present, the basic strategies of the heating industry (centralised heat supply and decentralised thermal energy supply), including the balance model, are laid down in the National Energy Policy and the National Energy and Climate Plan of the Czech Republic.

The National Energy and Climate Plan lays down the requirements of Article 23 of Directive 2018/2001 to mainstream renewable energy in heating and cooling. The plan also includes the expected development in the field of cogeneration, which will be further updated as required by European legislation (Directive 2012/27/EU of the European Parliament and of the Council on energy efficiency).

For the stabilisation and development of thermal energy supply systems, it will be crucial for thermal energy supply systems that currently use coal to ensure, in accordance with the decision of the Government of the Czech Republic in connection with the recommendation of the Coal Commission, the transition to another (less emission-intensive) fuel (biomass, waste or natural gas).

This issue will mainly concern 45 heating plants and company power plants connected to thermal energy supply systems that currently use coal. In the period 2021–2030, a change in the fuel base of these heating plants should be made or started in order to use different, less emission-intensive types of fuels (biomass, waste or natural gas). Some sources will be shut down and the heat will be supplied by other heat sources.

The remaining heat supply from current coal-fired thermal energy systems, which will not be provided through heat production in cogeneration plants, will be provided by small heat-only plants and small decentralised cogeneration sources.

Electric boilers may also play a certain role in the heating sector and in the stabilisation and development of heat supply systems in the future.

5.1.2 New systems of operating aid after 2020

The draft amendment to Act No 165/2012 on supported energy sources and amending certain acts proposes a range of operating aid measures, both for energy production plants to be newly commissioned and those that are already in operation. The new system of operating aid, which should be applied after the approval and effective date of the said draft Act (the expected effective date is 1 January 2022), introduces several types of operating aid, which can be used and are also intended for the support and development of the heating industry. For example, operating aid for electricity from high-efficiency cogeneration and aid for heat from renewable sources can be considered an important measure for the heating industry.

These operating aids are systemic measures to support thermal energy supply systems following from the EU legislation. The Czech Republic has long had a system of aid for electricity from high-efficiency cogeneration and other operating aids, and it is appropriate for the stabilisation and development of

thermal energy supply systems to maintain and further develop this system in the next period 2021–2030.

One of the other operating aids for the stabilisation of thermal energy supply systems is also the aid for electricity for the modernisation of electricity production. Due to the set strategy and direction in the heating sector, however, we do not anticipate the use of this aid for energy production using coal.

The new system of operating aid should also allow for the concurrence of investment grants and operating aid, a measure which will lead to a reduction in the financial requirements for operating aid.

The approval/decision of the European Commission to extend the already notified operating aid schemes for electricity and heat production plants commissioned in the period from 1 January 2016 to 31 December 2020 also to electricity and heat production plants commissioned by 31 December 2021 should be seen as an important stabilising element. Extended aid schemes also include aid for electricity from high-efficiency cogeneration for installations commissioned from 1 January 2016 or aid for electricity from high-efficiency cogeneration for installations commissioned from 1 January 2013 to 31 December 2015 and aid for heat from renewable sources. The extension of these aids will make it possible to also announce operating aid for sources entering these schemes in 2021, and this setting will thus ensure continuity and follow after the effective date of the amendment to Act No 165/2012, which is currently going through the legislative process.

5.1.3 New systems of investment subsidies after 2020

A fundamental measure for the stabilisation and development of thermal energy supply systems is to enable the allocation of investment subsidies for the change of the fuel base, for the modernisation of thermal energy distribution, and also for the possible construction of new thermal energy supply systems or their modernisation. For the use of investment subsidies for the stabilisation and development of thermal energy supply systems, the most important investment subsidy programs will include the Modernisation Fund, the Just Transition Fund, RRF, OP TAC and OPE.

Of the proposed subsidy programmes, the most important for thermal energy supply systems is primarily the Modernisation Fund, which could finance the modernisation of heating plants and their transition to low-emission fuels and aid for heat from renewable energy sources. These investments should cover, for example, the transition of heat networks from steam to hot water and the further modernisation of heat networks, which will reduce losses and increase the efficiency of heat distribution. In addition, the replacement of coal-fired heat sources with heat sources using natural gas, waste or renewables should be encouraged in order to reduce the emission intensity of heat production and thus the cost of purchasing emission allowances.

Within the Modernisation Fund, a total of nine sub-programmes are gradually being created, where the most important for the heating industry is sub-programme No 1 called Modernisation of Thermal Energy Supply Systems (TEPLO). The focus of the programme is primarily to support projects for the use of RES and low-emission sources primarily intended for heating, such as changing the fuel base and modernising the distribution of thermal energy.

It will also be important to obtain investment subsidies from the Just Transition Fund, where it will be possible to finance/provide subsidies in a total of 11 areas. In the district heating sector/overall, energy savings, renewable energy and transport will be particularly important. This programme will be crucial

for the three regions of the Czech Republic which will be the recipients of the aid (Moravian-Silesian Region, Ústí nad Labem Region and Karlovy Vary Region).

The Recovery and Resilience Facility is another of the programmes to provide subsidies for projects, especially with regard to the modernisation of heat distribution within heat supply systems.

In the case of operational programmes, the production of heat from biomass, the 'new green field sources', could be supported from the OP TAC, which will replace the current OP EIC from 2021. In the case of new electricity/heat production plants from biogas, the OPE should allow aid for biogas plants using waste or the change from biogas plants using agricultural biomass to biogas plants using plant waste, and the OP TAC should support the conversion of existing biogas plants producing electricity (and heat) to biomethane production plants or the recovery of heat from a biogas plant through, for example, remote cogeneration. New biogas plants using agricultural biomass should not be supported (neither from the Modernisation Fund, nor from the OPE nor from the OP TAC), as they lack synergistic effect towards the RES target in transport or in heating and cooling.

5.1.4 Other financial and economic forms of aid

Reduction of value added tax for heat and cold

From 1 January 2020, the value added tax rate for the supply of heat and cold was reduced from 15% to 10%.

5.1.5 A new model of price regulation of the heating industry

The Energy Regulatory Office is currently preparing a new model of regulation in the heating industry, which should in some cases lead to deregulation of the heating market.

In general, the intended deregulation of the heating market should respect the division of the heating market under competition law into decentralised (local) heating and district heating (thermal energy supply systems). The basic considerations in the new regulation model are as follows:

Decentralised heat production

The production of thermal energy in decentralised heat production is the production of heat in a fully competitive thermal energy market, and therefore deregulation of the price of thermal energy should be considered.

Central heat production (thermal energy supply systems):

Central production of heat (the supply of heat from the thermal energy supply system) continues to be, as a rule (or in some cases), a non-competitive market and maintaining a certain regulation of the price of heat still makes sense.

5.1.6 Effective protection of efficient thermal energy supply systems

As part of meeting the requirements for the support of efficient thermal energy supply systems arising from Article 24 of Directive 2018/2001 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, a requirement was introduced in the draft legislation not to impair the energy performance of a building when disconnected from a thermal energy supply

system. This legislative requirement is proposed in the amendment to the legislation which is part of the draft of the new Construction Code (see the legislative draft amending certain acts in connection with the adoption of the Construction Code), which will also include an amendment to Act No 406/2000 on energy management, where the said provision will be specifically located. With regard to the fulfilment of the Czech Republic's climate and energy obligations, a building should be disconnected from the energy supply system only where its energy performance is not impaired. This would create more stable conditions for investment in the use of low-carbon energy sources in thermal energy supply systems.

5.1.7 Introducing verification of correctness of billing of costs separately for heating and hot water, adjusting the rules for heat measurement, readings and requirements for billing and guarantees of origin for heat from RES according to the requirements of the new EU legislation

A specification of legislative regulations is being prepared, which will govern:

Introduction of verifying the correctness of the billing of costs separately for heating and hot water for the supply of thermal energy from the thermal energy supply system among individual users of apartments and non-residential premises and the associated designation of the responsible control body. This is a key point for maintaining thermal energy supply systems resulting from gaining credibility and transparency of thermal energy supply costs for users of apartments and non-residential premises.

Requirements for the heating industry resulting from new EU legislation:

Introduction of measures and requirements for the heating industry resulting from the new EU regulations (requirements from Directive No 2018/2001 of the European Parliament and of the Council on the promotion of energy production from renewable sources and Directive No 2018/2002 of the European Parliament and of the Council, revision of the Energy Efficiency Directive), namely:

(a) requirements for remotely readable meters and devices recording the supply of thermal energy to end-users, the distinction between the terms 'end-customer' and 'end-user' and the related requirements for the content of billing / billing information and the frequency of their provision.

(b) requirements for the introduction of guarantees of origin for heat from RES (and it is also possible to use guarantees of origin for electricity from cogeneration)

5.1.8 Levelling the playing field in the taxation of CO_2 emissions

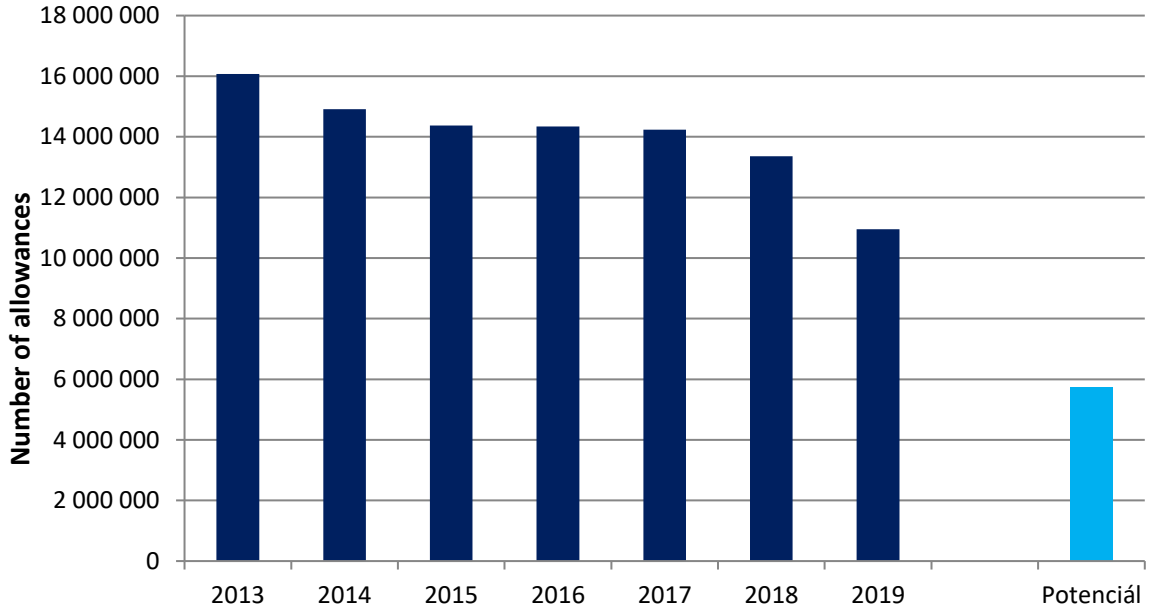
In the context of the forthcoming revision of the EU-ETS, there will be a discussion on the conditions for appropriate taxation of heat produced and the possibility of including smaller installations through energy suppliers in the EU-ETS greenhouse gas emissions trading scheme, and potentially on the introduction of a 'carbon tax' for fossil fuel sources that do not fall under the EU-ETS and are therefore not required to pay emission allowances for CO_2 emissions.

5.2 Reduction of greenhouse gas emissions

A major current problem in thermal energy supply systems is a significant increase in the price of emission allowances, which affects especially heating plants that produce heat from brown and black coal. At the same time, the amount of free allocation of allowances for heat production is rapidly decreasing. The cost of purchasing allowances is reflected in the price of heat and threatens the economic viability of many thermal energy supply systems.

The EU and Czech air protection legislation has also significant impact on thermal energy supply systems, as the compliance with this legislation required more than CZK 21 billion between 2013 and 2018, and further significant investments will still be needed after 2021. These are, in particular, the requirements arising from Directive 2015/2193 on the limitation of emissions of certain pollutants into the air from medium combustion plants (the MCPD), Act No 201/2012 on air protection and the related Implementing Decree No 415/2012 on the permissible level of pollution, Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) and related documents, in particular the BAT Conclusions for Large Combustion Plants.

Chart No 12: *Heating plants – development of verified greenhouse gas emissions in 2013–2019 and gasification potential*[5]



Key to graphic	
Original text	Translation
Počet povolenek	Number of allowances
Potenciál	Potential

Source – ADH CR, calculation from EUTL data

5.3 Primary energy savings

This section provides partial details on primary energy savings.Table No 34 presents summary information on cogeneration in 2016–2018 based on reporting under Directive 2012/27/EC, including primary energy savings in those years. Based on the above data, which were quantified in accordance with the relevant methodology, it can be noted that the current primary energy savings associated with the use of CHP are around 34.57 PJ.Table No 35 then presents a comparison of current electricity production in CHP and the estimated state in 2030, which is consistent with other estimates provided in

[5] Note: Emissions in the case of gasification of coal-fired heating plants (gas and biomass heating plants without changes)

this document. An increase in electricity produced from CHP by almost 4 TWh can be assumed based on these estimates. This estimate is based on the best available information on future developments, and if it is met, primary energy savings should increase from the current 34.57 PJ to approximately 41.89 PJ in 2030 (see Chart No 13).

Table No 34: *Information on CHP based on reporting to the EU under Directive 2012/27/EC*[6]

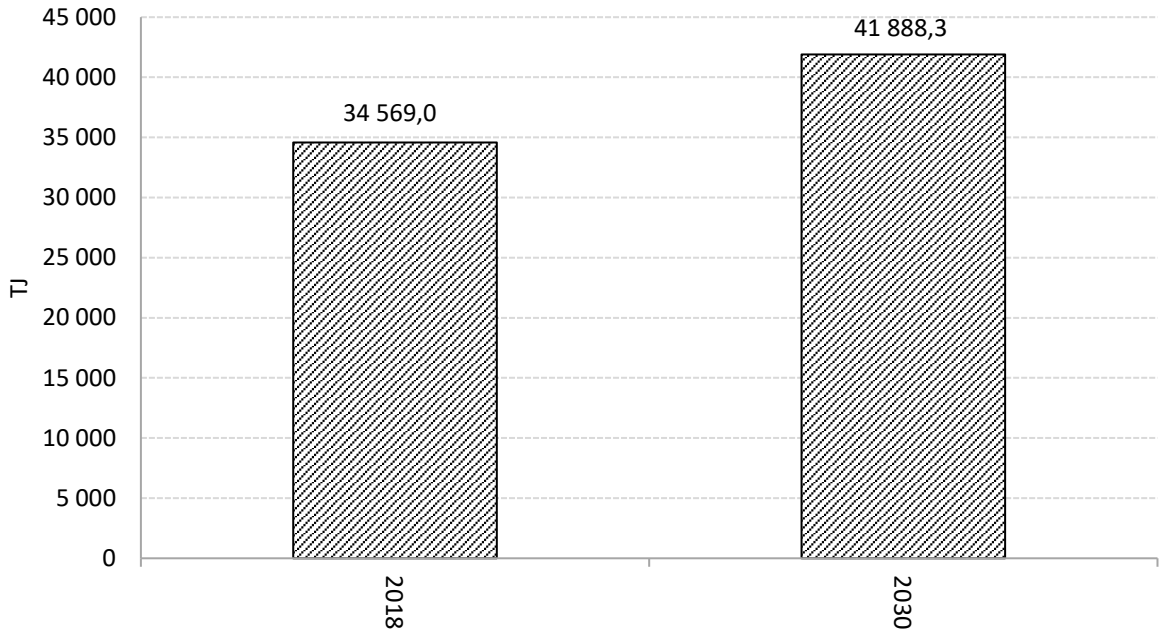
	Maximum capacity			Generation			Fuel consumption		Primary energy savings	Number of units
	Power		Heat from CHP	Power		Heat from CHP	Total	CHP		
	CHP	Total		CHP	Total					
	MWe	MWe	MWt	GWh	GWh	TJ	TJ (NCV)	TJ (NCV)	TJ	number
2016	8 812	9 707	20 446	10 862	38 004	101 607	506 795	192 309	**38 300**	944
2017	8 028	9 262	22 071	10 221	38 476	103 517	502 022	190 166	**34 274**	1 030
2018	8 510	9 271	21 697	10 020	38 079	102 064	492 797	184 471	**34 569**	1 092

Table No 35: *Comparison of current electricity production in CHP and estimated state in 2030 (MWh)*

	2018	2030
Coal	4 980 935	1 123 714
Renewable sources	2 907 322	2 949 961
Natural gas	1 674 587	8 303 958
Other	475 939	728 930
Total	10 038 783	13 106 563

[6] For the above table, we also refer to the reports annexed to this report, which provide detailed data on the production of electricity and heat from cogeneration. These are the following reports: CHP_Reporting_Template_CZ_new_2016; CHP_Reporting_Template_CZ_new_2017 a CHP_Reporting_Template_CZ_new_2018

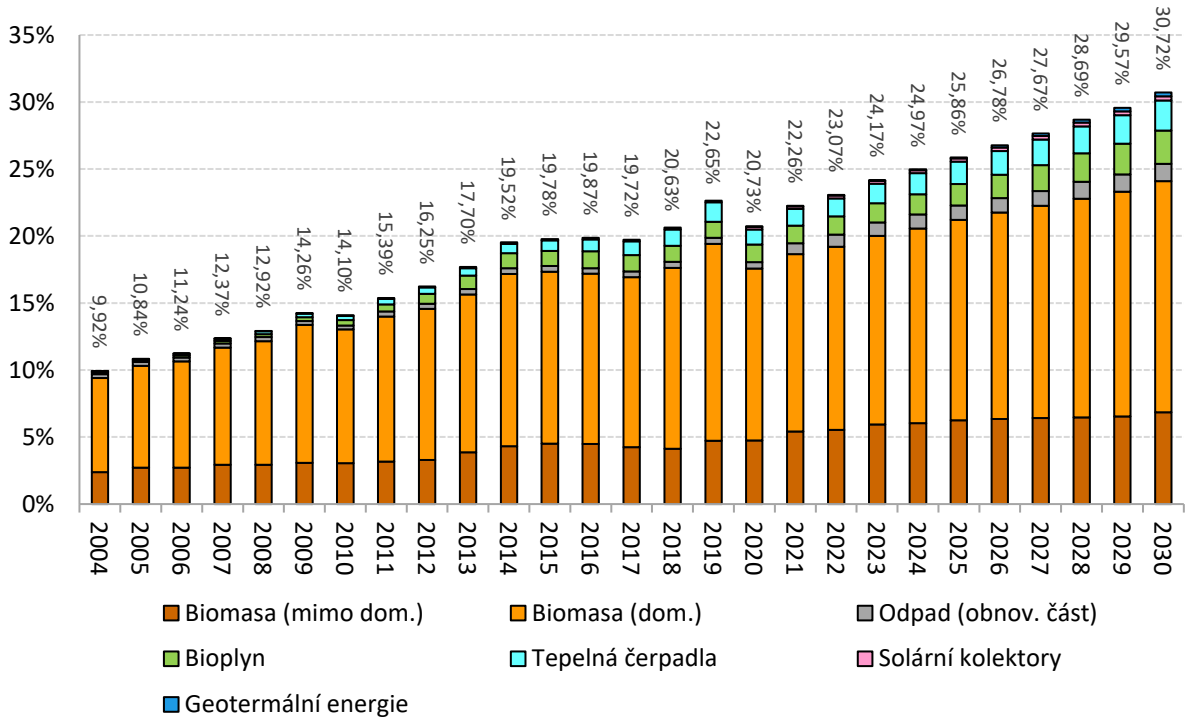
Chart No 13: *Comparison of current primary energy savings and estimated state in 2030 (TJ)*



5.4 Impact on the share of renewable energy in the heating and cooling sectors

The historical development of the share of RES in the heating and cooling sectors (according to the EUROSTAT methodology) and the expected development are provided in relative detail in the National Energy and Climate Plan of the Czech Republic, specifically in section 2.1.2 thereof. The Czech Republic tried to take into account the indicative target of the year-on-year growth of the share of RES in the heating and cooling sectors by 1.1 pp. (excluding waste heat) as much as possible. This target follows from Directive 2018/2001 on the promotion of the use of energy from renewable sources. Taking into account all factors (details are provided in the National Plan of the Czech Republic), the share of RES in the heating and cooling sectors should reach 30.7% in 2030, which corresponds to an average year-on-year increase in the share of RES by 1%. Of course, the share of RES is significantly affected by the total energy consumption in the heating and cooling sectors. A decrease in consumption in the heating and cooling sectors is expected as a result of measures aimed at energy savings in buildings, as well as other factors. However, if this decline were to not occur, then, of course, a larger amount of renewable resources will be needed to reach a 30% share of RES in 2030.

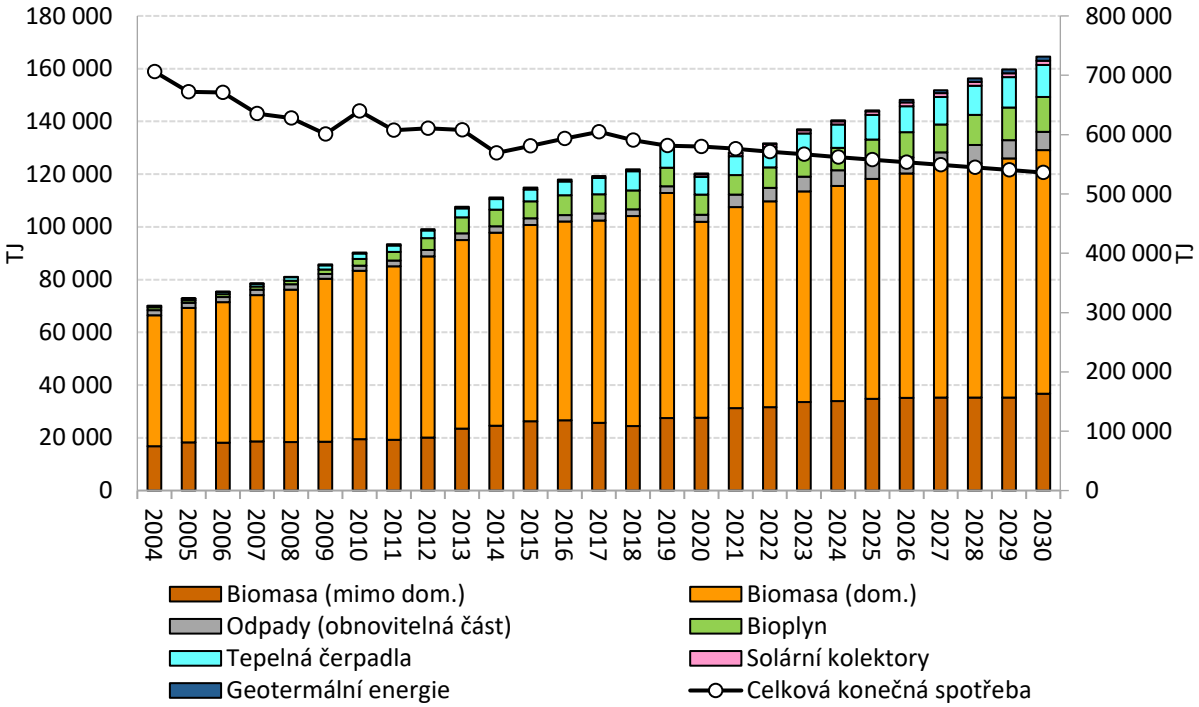
Chart No 14: *Historical development (2004–2019) and outlook (2020–2030) of the contribution of individual fuels to the share of RES in the heating and cooling sectors (%)*[7]



Key to graphic	
Original text	Translation
Biomasa (mimo dom.)	Biomass (excl. households)
Bioplyn	Biogas
Geotermální energie	Geothermal energy
Biomasa (dom.)	Biomass (households)
Tepelná čerpadla	Heat pumps
Odpad (obnov. část)	Waste (renewable)
Solar collectors	Solar collectors

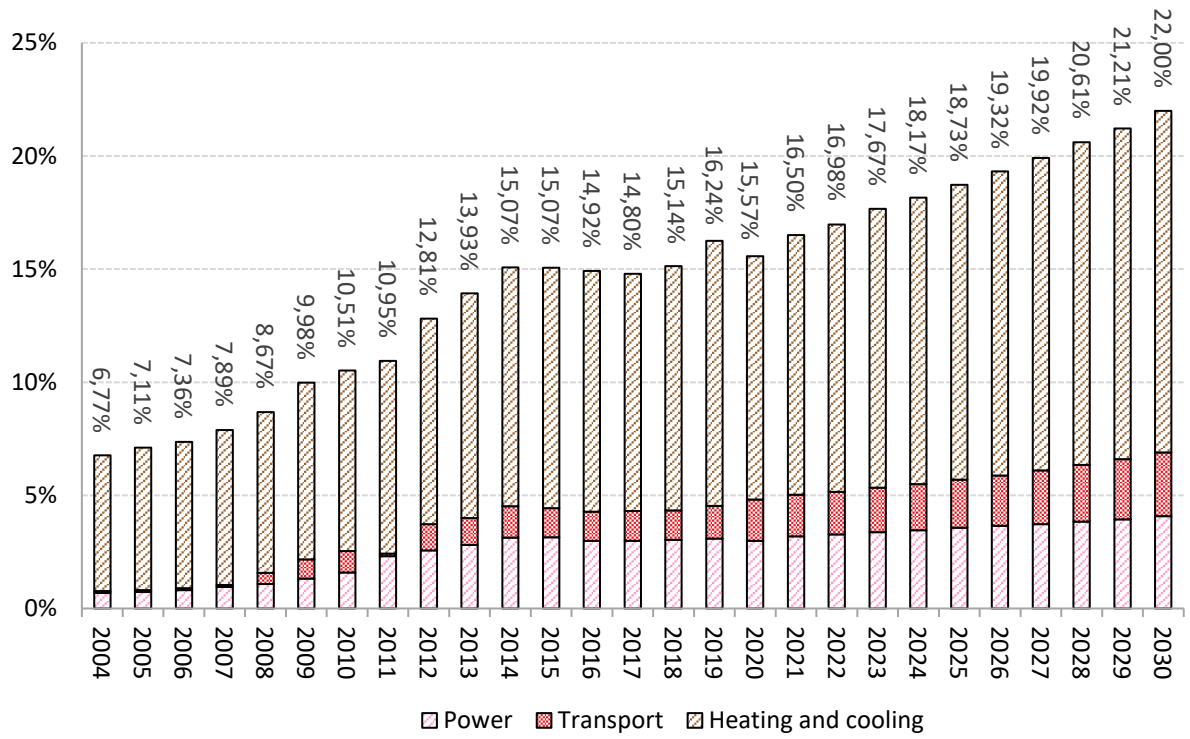
[7] The outlooks are based on the National Plan of the Czech Republic. The historical reference year in the National Plan was 2016. The data were updated on the basis of the latest available data, so the development in the 2016–2019 period could not have been fully taken into account.

Chart No 15: *Historical development (2004–2019) and outlook (2020–2030) of the contribution of individual fuels to the share of RES in the heating and cooling sectors (TJ)*



Key to graphic	
Original text	Translation
TJ	TJ
Biomasa (mimo dom.)	Biomass (excl. households)
Odpady (obnovitelná část)	Waste (renewable)
Tepelná čerpadla	Heat pumps
Geotermální energie	Geothermal energy
Biomasa (dom.)	Biomass (households)
Bioplyn	Biogas
Solární kolektory	Solar collectors
Celková konečná spotřeba	Total final consumption

Chart No 16: *Historical development (2004–2019) and outlook (2020–2030) of the contribution of individual sectors to the total share of RES*



5.5 Links to national financial planning and cost savings for the public budget and market participants and estimate of possible state aid measures

Investment need to meet the 2030 targets

The Member States of the European Union have set themselves an objective to achieve climate neutrality by 2050. This end is also pursued by the updated target of reducing greenhouse gas emissions by 55% by 2030 (compared to the original 40%) compared to 1990[8]. Although the final form of the new EU energy legislation (revision of the Directive on the promotion of the use of energy from renewable sources, revision of the Energy Efficiency Directive, revision of the EU-ETS Directive and others) and the deadline for the phase-out of mining and use of brown coal in the Czech Republic were not known at the time of making this document, the transformation of the heating industry from a significant use of coal to other, low-carbon sources is already clear and inevitable.

Compared to 2018 (and previous years), the situation changes dramatically in 2020; until 2018, the year 2040 was considered to be the horizon for the end of coal use in the heating industry, therefore, the vast majority of projects for the reconstruction of thermal energy supply systems focus on heat distribution or on control and regulation systems.

Investment needs were modelled according to the above distribution in categories up to 50, between 50 and 300 and over 300 MWt. This distribution is not applied to the entire organisational unit (e.g. heating plant), but to individual production blocks/units (complete parts of technology including its own

[8] https://ec.europa.eu/clima/policies/eu-climate-action/law_en

combustion equipment – boiler or gas engines, etc.), which will undergo reconstruction. This distribution was chosen due to the structure of available data and at the same time due to the logic of the equipment modernisation itself. In some cases, only some production units located in a given organisational unit at a given location will be modernised, not all of them. Furthermore, the manner of their modernisation may vary as well. In other cases, the modernisation will take place by the construction of a new facility in the existing locality, i.e. there will be no reconstruction of the existing facility; only the existing infrastructure of the given locality will be used.

Resources included in individual categories will differ within the given category by their specific indicators – investment costs. This is given by the specific conditions of each locality (e.g. what can be used from the existing equipment for modernisation), as well as by the relatively large range of heat output in individual categories. Furthermore, the up to 50 MWt category is specific in that a number of existing units have been transformed so that they are below the limit input of 20 MWt thanks to the EU ETS rules, and they were thus not included in the EU ETS.

The WtE plants and SAF sources burning waste and alternative fuels are also specific in a similar manner. These sources are not expected to exceed 50 MWt due to the nature of the fuel, the limitations of its availability and realistic transport distances. At the same time, not only the heating regime is considered, but cogeneration as well, due to legislation requirement. Simultaneously, the possibility of reconstruction of existing facilities is not considered for WtE plants and SAF sources, only the construction of new facilities. In the case of WtE plants, the technology uses the incineration of mixed municipal waste and multi-stage purification of flue gases, including heavy metals and dioxins. In the case of SAF, the technology uses pelletised (or otherwise treated) fuel from waste; the technology is similar to biomass combustion plants; projects usually involve co-incineration of SAF with biomass; the use of fluidised bed combustion is suitable for SAF.

In the above 300 MWt category, it is practically possible to consider modernisation only through natural gas; biomass is not considered for these large sources (e.g. due to large transport distances or its required amount). When estimating the investment needs of the heating industry, this category is not considered due to its size with regard to the categorisation according to individual production units (not according to entire production – see methodology description above).

Individual types of modernisations can be characterised as follows:

Table No 36: *Expected methods of modernisation of heating plants in the category up to 50 MWt*

	Biomass	Gas	WtE plants	SAF
Modernisation – heat-only plant	X	X	-	-
Modernisation – cogeneration	X	X	-	-
New source – heat-only plant	X	X	-	-
New source – cogeneration	X	X	X	X

Table No 37: *Expected methods of modernisation of heating plants in the category from 50 to 300 MWt*

	Biomass	Gas	WtE plants	SAF
Modernisation – heat-only plant	X	X	-	-
Modernisation – cogeneration	X	X	-	-
New source – heat-only plant	X	X	-	-
New source – cogeneration	X	X	-	-

The estimate is based on the method of representatives, the data are taken from a survey conducted by the ADH CR within the membership basis, implemented investment projects from the period 2010–2020, or bids in tenders for 2020. The data collected in this way are adjusted by expert estimates.

Data in individual capacity categories and methods of modernisation have a relatively high variability; the typical value according to expert estimate (within the variation range of the category) was chosen as the representative value rather than automatically choosing the average value. To test the impact of the choice of these representative values on the estimate of total investment needs by 2030, two basic scenarios of values of specific investment costs were developed, namely:

- a conservative scenario, which reflects the upper cost estimate by 2030
- an optimistic scenario, which conversely defines the lower cost estimate by 2030

Structure of the model for estimating investment costs for 2030

The model is based on the analysis of the MoIT mapping the method of modernisation of the 45 largest district heating sources in the Czech Republic. This strategy captures the existing 'large' public and industrial heating plants; in 2018, these sources provided about 92 PJ of gross heat production and the sale of heat from these sources in 2018 was about 49.5 PJ of heat (gross electricity production was about 18 TWh).

Estimates of the use of individual types of fuels were used for the presented model, as well as estimates of the share of heating and cogeneration plants in the production and supply of heat – see the following table.

Table No 38: Estimate of the structure of new sources replacing existing district heating sources (MoIT)

	NG	BIOM	MSW and SAF
Production of heat (TJ)	37 298	11 486	7 100
Cogeneration (TJ)	23 165	9 082	7 100
Single-energy production (TJ)	14 133	2 404	0
Cogeneration of electricity (GWh)	7 078	858	454
Installed capacity (MWe)	2 022	245	130
Consumption (m^3 million, tonne thousand)	1 945	2 132	1 270

Investments have already been implemented in the category of sources with a total installed capacity of up to 50 MWt due to new legislation concerning emission limits for pollutants and due to the pressure

to leave the EU ETS (20 MWt limit). These sources will not see any more fundamental investments in the resource base by 2030. Investments in heating systems can be expected in the vast majority of cases in the up to 50MWt and over 50 MWt categories at the level of individual production facilities. The resource-oriented solution at the level of individual production facilities can be considered especially in the up to 300 MWt category. The installation of individual production facilities over 300 MWt will be rather exceptional even in the case of natural gas; in the case of biomass and waste, it cannot be expected at all with regard to the availability of fuel.

Table No 39: *Distribution of the share of modernisation of existing equipment and construction of new equipment according to types of fuels, cogeneration*

	Modernisation	**New plant**
Biomass	50%	50%
Natural gas	50%	50%
WtE plant waste	0%	100%
SAF waste	0%	100%

The share of cogeneration in the modernisation and construction of new sources by types of fuels is defined by the following table compiled according to a questionnaire survey among members of the ADH CR from January 2021.

Table No 40: *Share of cogeneration in modernisation and construction of new facilities by types of fuels, cogeneration*

	up to 50 MWt	**50–300 MWt**
Biomass	90%	10%
Natural gas	50%	50%
WtE plant waste	100%	0%
SAF waste	100%	0%

Estimate of the power structure in CHP for 2030 according to power categories and types of fuels, table compiled according to a questionnaire survey among members of the ADH CR from January 2021.

Table No 41: *Estimate of installed capacity in cogeneration by 2030 according to the ADH CR survey*

	up to 50 MWt		50–300 MWt		Total
	modernisation	new	modernisation	new	
Biomass	110	110	12	12	245
Natural gas	506	506	506	506	2022
WtE plant waste	-	65	-	0	65
SAF waste	-	65	-	0	65

The estimate of the share of individual fuels according to power categories for heating plants is defined in the following table

Table No 42: *Estimate of the share of individual fuels according to the power categories of heating plants*

	up to 50 MWt	50–300 MWt
Biomass	100%	0%
Natural gas	50%	50%
WtE plant waste	0%	0%
SAF waste	0%	0%

The estimate of the share of modernisations of existing sources (heating plants) and construction of new sources (heating plants) according to fuels is defined by the following table compiled according to a questionnaire survey among members of the ADH CR from January 2021.

Table No 43: *Estimate of the share of modernisation of existing facilities and construction of new facilities by individual fuels, heating plants*

	Modernisation	New
Biomass	50%	50%
Natural gas	50%	50%
WtE plant waste	0%	0%
SAF waste	0%	0%

Table No 44: *Estimate of installed capacity in heating plants by 2030 according to the ADH CR survey*

	up to 50 MWt		50–300 MWt		Total
	modernisation	new	modernisation	new	
Biomass	119	119	0	0	238.5
Natural gas	727	727	727	727	2 908
WtE plant waste	0	0	0	0	
SAF waste	0	0	0	0	

For network reconstructions, the following assumptions about specific reconstruction costs were used in a conservative scenario. The data are taken from a survey among members of the ADH CR for the purposes of determining the absorption potential of the use of funds from the Recovery and Resilience Facility (RRF), January 2021.

Table No 45: *Estimate of specific costs of network reconstruction (CZK million per km)*

	Urban development	Extra-urban	Mixed use development
Heat distribution networks	42–55.5	12.6–19.7	25.2–31.1
Model value – conservative scenario	31.1		
Model value – optimistic scenario	25.2		

At the same time, the pace of reconstructions is assumed to be approximately 20 km per year in both scenarios. The estimate of the speed of network reconstruction is based on the statistics of reconstructions for the last decade.

The same methodology was used for modelling the amount of investment costs in nominal prices (after including price growth) as in estimating the amount of investment costs for meeting the RES targets. This methodological approach is based on the division of the investment into two basic parts: the construction part and the technology itself. The estimate of the share of the construction and technology part was performed for two basic methods of modernisation – reconstruction of the existing source and construction of a new source in the existing locality – and in a breakdown by heat output. These are expert estimates based on information on the planned methods of modernisation of sources (according to the ADH CR questionnaire survey from January 2021 and other information on district heating sources). Type of fuel was not included in this estimate due to a lack of information sources. Estimates of the share of the construction and technology part are summarised in the following table.

Table No 46: *Estimate of the distribution of investment costs for the construction and technology part*

Type of modernisation	Reconstruction of the source		New source	
	up to 50 MWt	50–300 MWt	up to 50 MWt	50–300 MWt
Technology	85%	90%	70%	75%
Construction part	15%	10%	30%	25%

At the same time, an assumption was made about the distribution of investments in the modernisation of district heating sources in time periods up to and including 2025 and between 2026 and 2030. These estimates are summarised in the following table.

Table No 47: *Estimate of the distribution of investments into time periods in the monitored categories according to output*

	up to 50 MWt	50–300 MWt
by 2025	60%	30%
2026–2030	40%	70%

Note: This is based on the assumption of significantly faster design preparation, permitting procedures and implementation of smaller sources up to 50 MWt in comparison with sources between 50 and 300 MWt. Investments after 2030 are not included here.

The study mapping the amount of investment costs in 2030 in the field of RES and buildings[9] discusses the issue of price increase coefficients for technology and construction works in detail. A coefficient of

[9] Ibid.

2% per year was used in all categories of RES for the increase of construction work prices. For the technology part, the influence of the learning curve effect was significantly reflected in some categories of RES, and the increases ranged between 0% and 2% in individual categories of RES. Even in the case of modernisation of the heating industry, certain differences can be expected in the increase of prices of technology according to the type of fuel used. However, a sufficient database is lacking to assess this impact. Given the extent of the necessary modernisation of the heating industry (e.g. compared to the amount of investment between 2016–2019) and thus the increase in demand for specialised supplies of technology, a lower rate of increase than in the case of construction work is unlikely. Therefore, the value of 2% was chosen as the lower boundary of the price increase estimate even for the technology part.

Modelling results

The results of the modelling of investment costs in both scenarios at 2020 prices are summarised in the following tables for the conservative and optimistic scenarios.

Table No 48: *Results of modelling investment costs of modernisation of the heating industry by 2030 in CZK millions, conservative scenario, 2020 prices (CZK millions)*

	up to 50 MWt	**50–300 MWt**	**Total**
Cost of new cogeneration sources	43 459	13 745	57 204
Cost of the renovation of cogeneration sources	15 521	8 025	23 545
Cost of new heat-only sources	4 711	1 527	6 238
Cost of the renovation of heat-only sources	2 092	872	2 965
HESS renovation costs	-	-	6 220
Total model costs			**96 172**

Table No 49: *Results of modelling investment costs of modernisation of the heating industry by 2030 in CZK millions, optimistic scenario, 2020 prices (CZK millions)*

	up to 50 MWt	**50–300 MWt**	**Total**
Cost of new cogeneration sources	39 689	13 745	53 434
Cost of the renovation of cogeneration sources	11 552	7 608	19 160
Cost of new heat-only sources	4 711	1 527	6 238
Cost of the renovation of heat-only sources	2 092	872	2 965
HESS renovation costs	-	-	5 040
Total model costs			**86 837**

After taking into account the increase in prices of construction works and technology according to the above assumptions, the accumulated values of costs in current prices of the given year by 2030 are as follows:

- **Conservative scenario: CZK 107.2 billion**
- **Best case scenario: CZK 98.3 billion**

The following figures and tables provide more details on the distribution of investment funds at current prices of the given year.

Table No 50: *Distribution of costs for the modernisation of heating industry by groups of sources and stages of modernisation, conservative scenario, current prices of the given year, CZK millions*

	by 2025	**2026–2030**
New CHP	32 060	31 653
Renovated CHP	12 442	13 861
New heat-only sources	3 487	3 462
Renovated heat-only sources	1 611	1 697
Distribution systems	3 302	3 645
TOTAL	**52 901**	**54 318**

Table No 51: *Distribution of costs for the modernisation of the heating industry by groups of sources and stages of modernisation, optimistic scenario, current prices of the given year, CZK millions*

	by 2025	**2026–2030**
New CHP	29 658	29 885
Renovated CHP	9 781	11 658
New heat-only sources	3 487	3 462
Renovated heat-only sources	1 611	1 697
Distribution systems	2 675	2 954
TOTAL	**47 213**	**49 656**

Annex 1: List of Tables, Charts and Figures

List of Tables

List of Charts

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Annex 2: List of Abbreviations

BAT	Best available techniques
BAU	Business as usual
BPS	Biogas plant
CAPEX	Investment costs
CBA	Cost benefit analysis
CHMI	Czech Hydrometeorological Institute
CNB	Czech National Bank
WWTP	Waste water treatment plant
CR	Czech Republic
CSO	Czech Statistical Office
BlC	Black coal
DS	Distribution system
SecS	Secondary sources
EEX	European Energy Exchange
ERDF	European Regional Development Fund
ERO	Energy Regulatory Office
EU ETS	EU Emissions Trading System
EUA	European Union Allowance
BrC	Brown coal
IEA	International Energy Agency
IPS	Individual power supply
CGU	Cogeneration unit (in Czechia, CHP with the combustion engine technology)
CHP	Cogeneration
MoIT	Ministry of Industry and Trade
NPV	Net present value
OPEX	Operating Costs
OP EIC	Operational Programme Enterprise and Innovations for Competitiveness
OPE	Operational Program Environment
ORC	Organic Rankine cycle
RES	Renewable energy sources
CC	Combined cycle
RESAP	Register of Emissions and Sources of Air Pollution
HESS	Heat/energy supply system
TA CR	Technology Agency of the Czech Republic
ADH CR	Association for District Heating of the Czech Republic
HV	Hot water
PM	Particulate matter
PES	Primary energy savings
WEP	Waste-to-Energy plants

Energy Management Act .....Act No 406/2000, on energy management