DECARBONIZING DISTRICT HEATING: A COMPARISON OF AUSTRIA AND THE CZECH REPUBLIC

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ABSTRACT

This paper provides an analysis of the district heating (DH) sector in Austria and the Czech Republic, focusing on their transition towards carbon neutrality. The study examines the current state of the DH sector in both countries, including the installed capacities, energy sources, and the share of buildings/population connected to DH. The decarbonization targets and strategies set by the governments are evaluated, considering the challenges posed by the current energy crisis. The comparison highlights differences and similarities in the strategies and goals of each country, primarily influenced by the European Union's initiatives. The European DH sector has gained traction as a reliable and efficient method of supplying heat, contributing to greenhouse gas reduction, improved energy efficiency, and enhanced energy security. However, the DH supply in Europe still relies heavily on fossil fuels, necessitating a challenging transformation to meet climate goals. The paper also discusses the European Union's legislation on DH and emphasizes the importance of sustainable heating and cooling in the decarbonization process. In Austria, DH plays a significant role in reducing CO2 emissions, with biomass being the largest heat source. The country aims to achieve carbon-neutral heat supply by 2040, with subsidies available for DH expansion projects. The city of Vienna is leading the transition, focusing on geothermal energy and large-scale heat pumps. In the Czech Republic, DH serves as the primary heat source for a significant portion of the population, with a considerable focus on households. Unlike Austria, the Czech Republic has coal as the largest share of energy for heat production. The expected phase out of coal use fo energy and heat production is planned by 2033. The findings of this paper contribute to the understanding of the DH sector's current state and its prospects for decarbonization in Austria and the Czech Republic, highlighting the role of the European Union in driving sustainable heating solutions.

1 INTRODUCTION

District heating (DH) is an efficient way of supplying the space heating and hot water needs of buildings and industry. DH allows the use of diverse heat sources and technologies into a single network. This makes DH a good option for decarbonization of the heating sector, especially highly populated urban areas where the heat density is high.

The European Union's Green Deal and Climate Law aims to achieve carbon neutrality by 2050. Heating and cooling are crucial in this target as they constitute nearly half of the EU's final energy consumption [1]. DH has a significant potential for integrating low-carbon energy sources into the heating energy mix on a large scale [2]. Therefore, it can contribute significantly to the decarbonization of the heating sector. In this paper, the current state of the DH heating sector, transformation towards low carbon systems, and the challenges ahead for Austria and Czech Republic will be analyzed. Conclusion will also be derived for the role EU DH sector and role of Austria's and Czech Republic's DH sector in it.

The core objective of this paper is to analyze the current state of the DH sector and its transition to carbon neutrality in Austria and the Czech Republic. The analysis is focused on the existing decarbonization targets set by the governments through national energy and climate plans of each country. These targets are evaluated by considering the decarbonization strategies in place and the possible challenges in reaching these targets because of the current energy crisis. This comparison demonstrates differences and similarities in each country's strategies and goals, which come mainly from the European Union.

2 METHODOLOGY AND MAIN DATA SOURCES

Our work provides a review and comparative analysis for the DH sectors of Austria and the Czech Republic. The paper will start with an overview of the European DH sector. Then, the status quo of DH sector in Austria and the Czech Republic will be separately presented. The main indicators to be presented in the status quo consist of:

- DH demand,
- technology mix (installed capacities),
- fuel mix (energy use),
- DH connection rate (share of buildings/population connected to DH),

These indicators are the basis to compare the status quo in both countries. The targets sets by the governments and the transformation strategies are presented for both countries. A review of the current approach to the transformation towards the net-zero emission system and the challenges ahead will be done.

As the main data sources, we use the overviews, information and legislation provided by the European Commission, the Council of the European Union, and the European Parliament. Analysis of national policy is necessary in the case of both countries. Therefore, national overviews and legislations published by the states are other main data sources. In the case of the Czech Republic the main source of national overview is provided by the Ministry of Industry and Trade of the Czech Republic which is responsible for energy policy in the Czech Republic and also by Energy Regulatory Office. In case of Austria, the main data source for the decarbonization targets and strategies are the reports published by the Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology and the Association of Gas and Heat Supply Companies (FGW). The main data source for decarbonization strategies for DH sector in Austria is the regional DH utility of Vienna, Wien Energie.

3 OVERVIEW OF DISTRICT HEATING IN EUROPE

DH is a method of generating and distribution of heat to buildings and households using insulated pipes. With DH, it is possible to regulate the temperature in a building and provide water heating. Coal, natural gas, but also biomass, solar energy or nuclear energy can be used as primary sources for heat production. Such heat is most often generated during cogeneration, e.g. the production of electricity and heat simultaneously in power plants. Thanks to this process, DH is considered an efficient and effective way of producing heat. It is also a suitable method of distributing heat to buildings in larger cities [3].

District heating has gained considerable traction in Europe as a reliable and efficient method of supplying heat to residential, commercial, and industrial buildings. District heating networks have become increasingly prevalent across Europe due to their ability to reduce greenhouse gas emissions, improve energy efficiency, and enhance energy security. The European Union has actively promoted district heating as a key component of its decarbonization and energy transition strategies, aiming to replace fossil fuel-based heating systems with low-carbon alternatives. As a result, district heating infrastructure has expanded significantly in many European countries, fostering the integration of renewable energy sources, waste heat recovery,

and innovative technologies to create sustainable, resilient, and cost-effective heating systems. However, the European DH supply still heavily depends on fossil fuels and requires a challenging transformation to reach the climate goals. Figure 1 shows the DH fuel supply mix of European member states and United Kingdom. The figure indicates that more than half of the fuel input comes from fossil fuels and nonrenewable waste. The remarkable share of renewable district heating comes from the use of biomass.

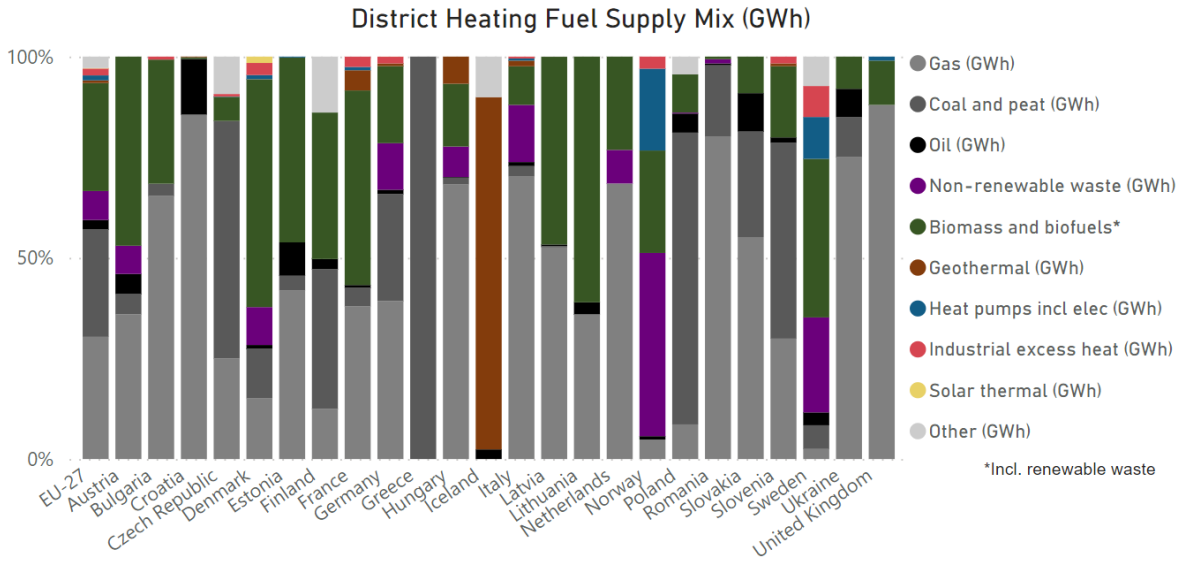

Figure 1: District heating fuel supply mix of EU member states and United Kingdom [4].

3.1 European Union Legislation on District Heating

Due to climate change and the high carbon emissions, the EU legislation reacts to this situation and plans decarbonization which is also focused on the DH. The legislation concerning the DH reflects the goal of being the first carbon neutral continent in the world. The most important legislative package Fit for 55 published in July 2021 contains a few legislative proposals, which are relevant for the DH: revision of the Renewable Energy Directive (RED), revision of Energy Efficiency Directive (EED), revision of EU Emission Trading System (ETS) and revision of Energy performance of Buildings Directive (EPBD). DH plays an important role in the decarbonization sector and therefore the EU puts stress on sustainable heating and cooling. "It delivers energy efficiency, facilitates the integration and storage of intermittent renewables, provides a link between a wide range of local sources of heat or cold and the buildings in which they are needed, particularly in cities. The proposals provide a more interconnected and coherent energy framework, with increased ambition and opportunities to set the sector on its way to 2050." [5]

4 DISTRICT HEATING IN AUSTRIA

In Austria, around 29 percent of final energy consumption in 2020 was used for space heating/cooling and hot water supply [6]. By using highly efficient combined heat and power (CHP) for DH in densely populated areas, it was possible to significantly reduce Austria's CO2 emissions, starting from the 1990s. In 2020, a total of 23 TWh of district heat was generated in Austria (see Figure 2). The growth of district heating generation in recent years was mainly driven by biomass, which accounted for 10.2 TWh or 44% of total district heating generation in 2020 [7]. The second largest source of DH was natural gas, which accounted for 7.6 TWh or 33% of district heating generation. Industrial excess heat and waste incineration, with 2.9 TWh (12%) and 1.8 TWh (8%) respectively, were also important but much smaller contributors to district heat generation. Coal with 0.4 TWh (2%), petroleum with 0.3 TWh (1%) and heat pumps, geothermal and solar with a total of 0.3 TWh (1%) played a comparatively minor role in district heating generation in 2020 [7]. In 2021, coal was phased out with the closure of the coal-fired district heating plant in Mellach [7].

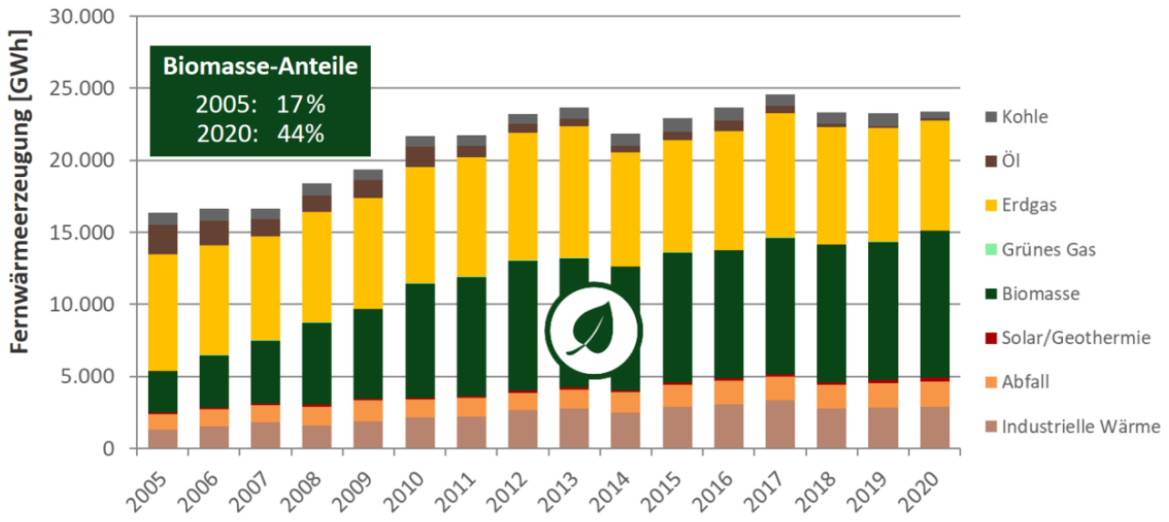

Figure 2: Historical development of district heat generation in Austria, 2005-2020 [2][5].

The pipe length of the hot water networks of the heating supply companies in Austria increased from 4,100 kilometers in 2010 to about 5,600 kilometers in 2020 [6]. Other sources also indicate the total pipe length is of all DH companies are about 10,000 kilometers, accounting for the local heating networks [7]. There are almost 5 million apartments in Austria. The number of apartments connected to DH is about 1.4 million, representing 28% of the total apartments. The city of Vienna takes the lead with the highest number of apartments

(1,066,262) and highest connection rate (44%). The statistics for all the Austrian states are given in Table 1.

Table 1: Number of apartments connected to DH in Austrian states and Austria [7].

	Total Number of Apartments	Number of Apartments Connected to DH	Share
Austria	4,937,709	1,386,057	28%
Burgenland	167,669	17,079	10%
Carinthia	333,209	88,535	27%
Lower Austria	949,790	161,243	17%
Salzburg	313,887	95,381	30%
Styria	694,740	231,186	33%
Tyrol	427,402	50,832	12%
Upper Austria	774,827	236,019	30%
Vienna	1,066,262	472,649	44%
Vorarlberg	209,923	11,407	5%

4.1 Targets and Transformation Strategies Towards a Carbon-Neutral DH

The Austrian government aims to reach carbon neutral heat supply by 2040. The framework for transition through a decarbonized is published under the Austrian Heat Strategy. The strategy focuses on phasing out oil and coal heating systems which are almost entirely used by individual heating systems. For instance, oil heating is banned for new buildings from 2020 [9]. Similar regulations are planned to gradually phase out oil heating systems by 2035. However, such a phase-out plan does not yet exist for gas heating and is still to be drawn up [9]. Currently, these regulations are being jointly developed by the central government and local administrations under the Renewable Heat Act [9]. The intended goal of the Renewable Heat Act is to replace existing oil and coal heating systems with climate-friendly heating systems such as district heating, biomass heating systems or heat pumps by 2035. Such regulations will be a motivation for customers to switch district heating.

The Austrian Government recognizes DH as significant medium to decarbonize the heating sector, hence offers several subsidies. For district heating and cooling (DHC) expansion projects, subsidies are available under the Heating and Cooling Pipeline Expansion Act (WKLG) and Environmental Support Act [6]. These subsidies aim to accelerate DH grid

expansion in densely populated areas. So far, more than 125 million euros in subsidies have already been paid out [6].

However, Austria does not have an official transformation strategy for the district heating sector. Therefore, the DH utilities form their own strategies to decarbonize their district heat supply based on their existing technologies and locally available renewable and waste heat sources. The only comprehensive roadmap available is prepared by the Austrian Energy Agency on behalf of Association of Gas and Heat Supply Companies (FGW). Figure 3 shows the results of the decarbonization scenario of this study.

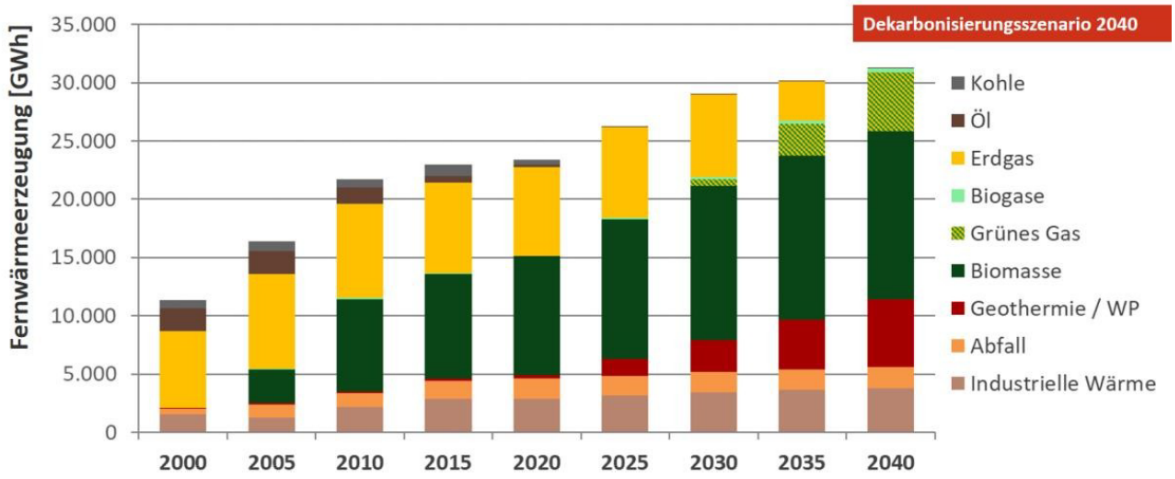

Figure 3: Roadmap to carbon-neutral DH in Austria [7].

The biggest DH areas (based on number of apartments connected to DH) in Austria are Vienna, Upper Austria, Styria, and Lower Austria. DH is supplied by the utilities owned by local administrations such as Wien Energie, Energie AG, Energie Graz, Energie Steiermark, et cetera.

Among these utilities, Wien Energie is the only one publicly sharing their transformation strategies towards decarbonization. The Viennese DH system consists of a primary and secondary DH network. The primary network is old and primarily located in the city center, supplying heat to the mostly old and poorly insulated buildings. The primary network works with a maximum temperature level of 150°C using pressurized water. The secondary network is connected to the primary grid. The high temperature heat in the primary grid is transferred to the secondary grid through heat exchangers. The maximum supply temperature in the secondary grid is around 90°C. Figure 4 shows the DH network map of Vienna (the primary network is represented by red and secondary network is represented by blue).

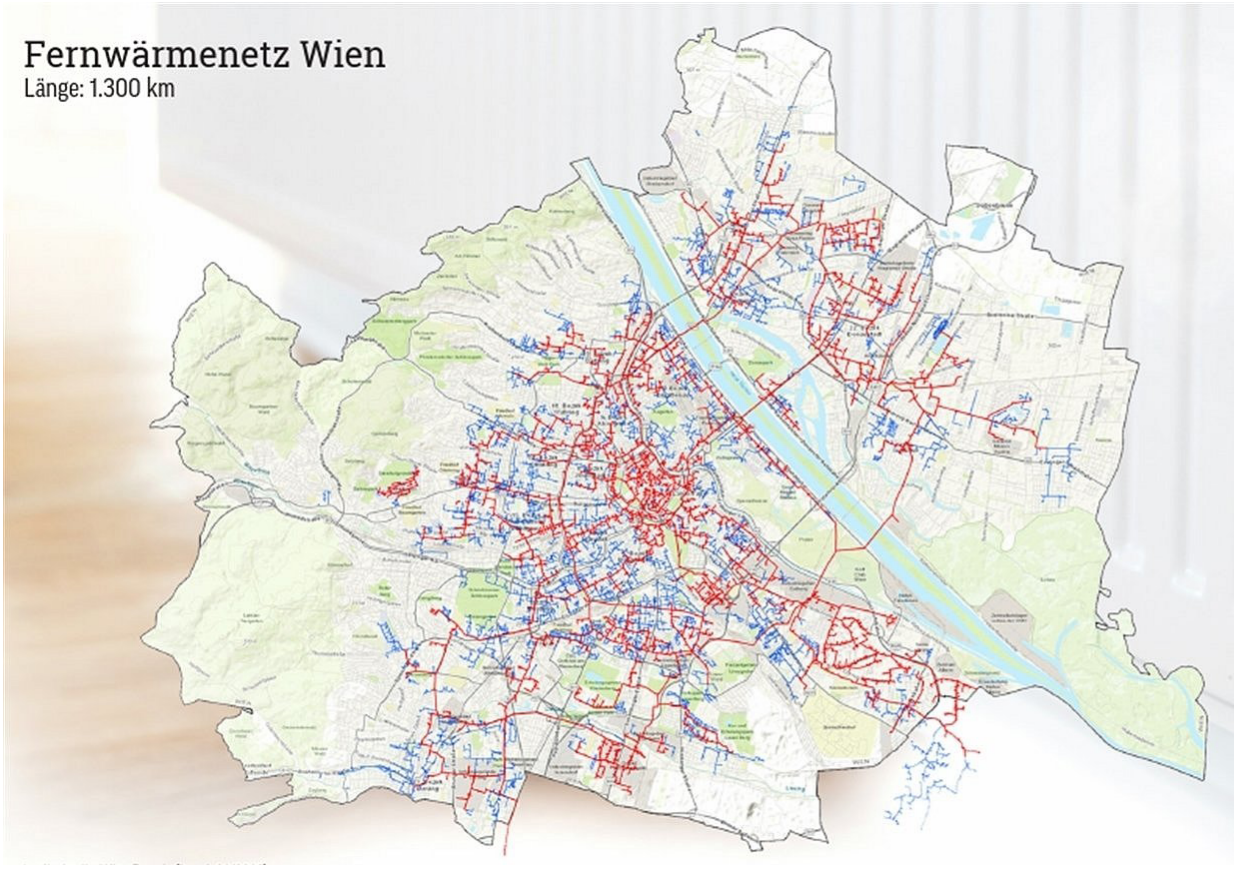

Figure 4: The DH network of Vienna (red: primary network, blue: secondary network) [7].

Vienna aims to achieve a significant transition in its heat supply by 2040. The utility company, Wien Energie, sees geothermal energy and large-scale heat pumps as the most significant ways to decarbonize the city's DH system. According to Wien Energie's heat transformation strategy, 56% of the city's heat requirements will be satisfied through district heating systems [11]. This transition will involve a substantial shift in the energy sources used for district heating. More than half of Vienna's district heating will be generated through geothermal energy and large-scale heat pumps [11]. These renewable energy sources will play a crucial role in decarbonizing the district heating sector. Simultaneously, the share of combined heat and power (CHP) plants, which currently contribute around 52% of heat production, is projected to decrease significantly to only 13% by 2040 [8].

To achieve carbon neutrality, the operation of CHP plants will increasingly rely on green gas from the 2030s onwards. This shift to green gas will enable these plants to achieve zero emissions by 2040. This transformation will contribute to the overall reduction of greenhouse gas emissions from Vienna's heating sector.

Additionally, a significant portion of the remaining heat supply will be sourced from waste incineration plants and waste heat recovered from industries. These waste-to-energy and waste heat recovery systems will play an essential role in utilizing available resources and reducing overall energy waste.

To reach the decarbonization goals, Wien Energy is building the most powerful large scale heat pump in Europe. The heat pump will use the heat from the wastewater treatment plant of the city. The total installed capacity will be 110 MW. In the first phase 55 MW power will be active at the end of 2023. The heat pump is planned to be operated in full capacity (110 MW) in 2026. The maximum supply temperature of the heat pump is 93°C. It is enough for the secondary network but not for the primary network. In addition, the 110 MW capacity is high enough to cover the needs of the secondary network. Therefore, the challenge is finding alternative supply sources to supply district heating to the primary network. Or the city of Vienna needs to transform its primary DH network to a lower temperature one. This also comes with additional requirements such as well insulated buildings hence requires building renovation. To supply DH at higher temperatures, Wien Energie will install 120 MW of geothermal energy for direct use by 2030 [12]. Figure 5 shows the pathway to decarbonization of Vienna's DH system [12].

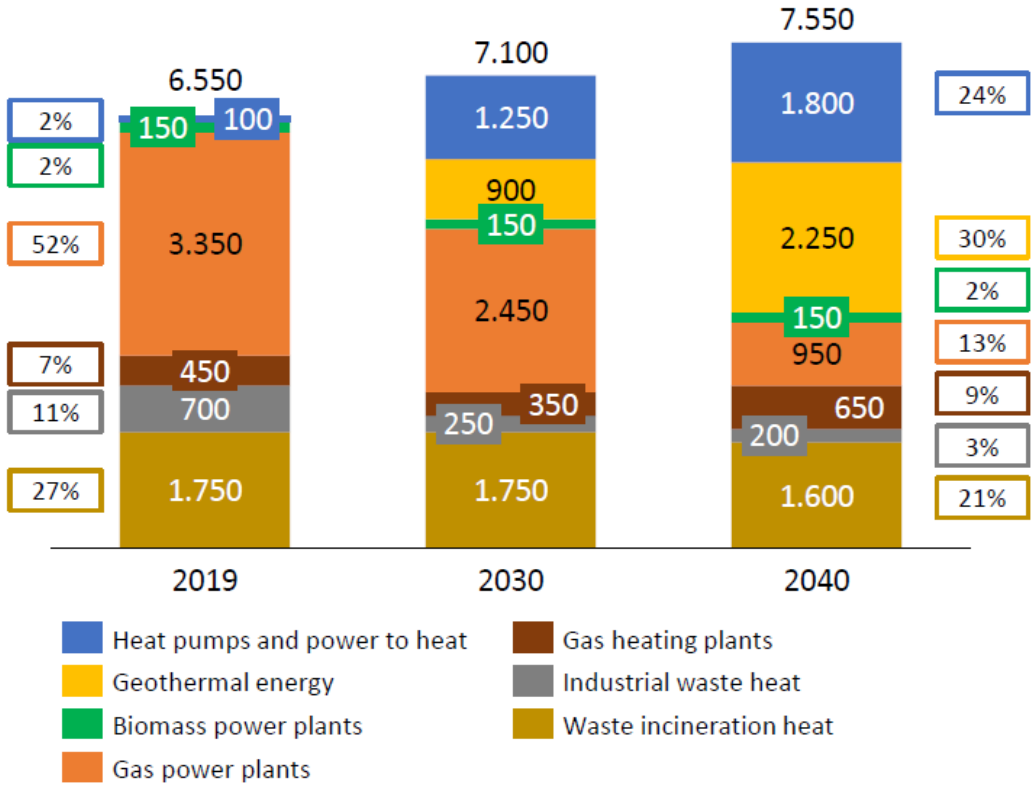

Figure 5: „Climate neutral 2040": District Heating Generation [GWh] [12]

5 DISTRICT HEATING IN THE CZECH REPUBLIC

DH in the Czech Republic represents the source of heat for ⅓ of flats in the country according to the data from the census in 2021 [13]. More concretely, 1.7 million households, more than 4 million inhabitants and 40 % of the population [14]. Almost ½ of heat production is provided to households, 28% to the industry and the rest to the tertiary sector. [14] Therefore, DH represents significant source of heat for the Czech Republic and its aim is to maintain this method of heat production. The main fuel for heating production is coal but the share has a declining tendency. The Czech Republic has a long history of district heating systems and is one of the leading countries in Europe in terms of district heating infrastructure. District heating is a widely used method for heating residential, commercial, and industrial buildings in urban areas. According to the statistics the Czech Republic belongs to the group of European countries with medium share of DH in the country, more than 20 % as well as Poland, Romania, Sweden and Slovakia [3].

5.1 History of the District Heating in the Czech Republic

The history of the DH in the country dates to the end of 19th century when the first power plant in Karlín in Prague started to supply the steam for heat to the school and to the city hall. The big expansion of DH in the country dates to the 20s to 40s in 20th century. The reason behind this expansion is explained by the growing industry production, new technologies and rising number of flats for working class. The next wave of expansion and also the biggest one dates to 50s and 60s. It is because of growing heavy industry, rising energy demand and building of arising housing estates. The government and central planning at that time preferred massive building of central projects infrastructure. Housing estates continued even in 70s and 80s, so the DH represented a suitable solution. On the other hand, there was a lack of new technologies, investments, so the heating production was demanding on energy and the maintenance was not provided as it was needed. The end of the 20th century and the beginning of 21st century brought new perspective on energy and climate change. Foreign investors, competition, privatization, and the EU legislation also had also impact on the future of the DH in the country. More focus was taken on the effectivity, new technologies such as desulphurization units, cogeneration units, denitrification, new energy sources but also energy efficiency as thermal insulation of houses for lowering the heat demand. On the other hand, the process of building new district heating systems stagnated with the exception of biomass systems [3].

5.2 Current State of the District Heating in the Czech Republic

District heating in the Czech Republic is primarily based on the use of combined heat and power plants, which produce both electricity and heat. These plants typically use natural gas or coal (hard and brown) as fuel sources, although there has been a gradual shift towards cleaner energy sources, such as biomass and waste-to-energy plants, to reduce environmental impact and carbon emissions. The Czech Republic sees the DH as a significantly important source of heating methods. It is the most common way of heating households and for almost 4 million people. Therefore, the Czech Republic wants to continue in the DH technology mainly from following reasons: DH provides the energy savings thanks to the cogeneration method, DH can have many primary energy sources, DH contributes to the clean air protection, DH secures energy security of the country because of electricity and heat production which supports running of electrical system [14]. The district heating network in the Czech Republic is extensive, covering a significant portion of the country's urban areas. It is operated by various companies, both public and private, including municipal utilities and energy companies. The largest district heating provider in the Czech Republic is Pražská teplárenská, a.s., Teplárny Brno, a.s. and ČEZ, a.s. [15].

The heat distribution systems in the Czech Republic measure around 4 500 km. The largest heating systems are located near the biggest cities: Praha, Plzeň, Brno, Ostrava and Olomouc. The following table shows the length of different heat distribution networks in each region of the country including the heat supply per year [14].

Table 2: Heat distribution networks in the Czech Republic [14].

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

Hot water networks represent the biggest share of the DH system in the Czech Republic. Steam networks are the least represented. It can be observed that the main fuel for heat generation is produced by lignite and in traditionally hard coal regions energy source of the same name.

"Gross production of heat for sale was 112 961 TJ in 2020. Coal and coal fuels represented 55,1% of production in 2020, natural gas and other gas represented 30, 2 %, renewable energy sources covered 10,2 % and other sources added 4,4%. Heat supply reached 93 752 TJ with the highest share for households (49,3%), industry (27,2 %), commercial and public services (23%) and other sectors (0,5%)."[14]

Following table indicates the changes in energy sources for heat generation for DH. [14]

Table 3: Share of energy sources for heat production in DH [14].

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
coal and coal products	65%	62%	62%	61%	60%	60%	59%	58%	56%	55%	52%
oil products	2%	3%	2%	1%	1%	1%	1%	1%	1%	1%	1%
natural gas	28%	28%	30%	30%	29%	28%	30%	30%	32%	32%	33%
renewable energy sources	3%	4%	4%	5%	7%	8%	7%	8%	8%	9%	11%
other sources	2%	2%	3%	3%	3%	3%	3%	2%	3%	3%	4%

It is clear that the major share is represented by coal. On the other hand, there is a cautious decline in the share. Slowly increased share has the natural gas, always around 30%. Renewable energy sources are certainly increasing, but the overall share is still only around 10%.

It can be concluded that DH has significant importance for Czech Republic even from historical reasons, because it is the main method for heat distribution for more than 40 % of population. The most extensive DH networks are situated near the biggest cities of the country. Hot water networks represent the most common system of heat transmission as well as coal for the heat production energy source. From the perspective of the country the DH will play its role in the future and the state counts with this heating system from various reasons including the variable primary energy sources, advantages of cogeneration process etc.

5.3 Targets and Transformation Strategies Towards a Carbon-Neutral DH

As already mentioned, the Czech Republic is one of the countries that have a moderate representation of DH in the system and want to continue their use. Given the pressure for green and emission-free solutions, but also emission allowances prices the DH system needs to be revised and decarbonized. Moreover, it is already facing some problems in the current situation. First of all, the price of emission allowances is too high, which may have a negative impact on pricing. There is also the legislation on air protection and the situation created by the war in

Ukraine and rising electricity and gas prices. That is why the government wants to place strong emphasis on the revision and investments in the DH. The government has set targets for increasing the share of renewable energy sources in the country's heating sector, including district heating. Fuel mix should radically change in the following decades. Complete phase out of coal and oil products should happen by 2040, phase out of natural gas in 2050. The mentioned energy sources should be replaced by biomass, biomethan, hydrogen, solar power, heat pumps, nuclear energy and biogas. The following table shows the prediction of fuel mix for heat next decades [14].

Table 4: Prediction of fuel mix for DH in next decades [14].

TJ	2019	2030	2040	2050
coal and coal products	52 178	4 696	0	0
oil and oil products	186	0	0	0
natural gas	22 155	27 214	13 629	0
peat	0	0	0	0
solid biomass	4 601	15 178	16 778	17 832
biogas	538	667	1 333	2 000
geothermal energy	0	1 500	8 500	11 000
solar energy	1	200	1 300	3 500
waste (renewable part)	1 890	5 556	4 167	2 778
nuclear energy	234	2 499	3 000	3 500
waste (non-renewable part)	1 260	3 704	2 778	1 852
electroboilers	13	1 296	2 592	2 592
heat pumps	87	90	1 590	2 500
industry waste heat	978	970	1 500	2 000
terciary waste heat	0	300	1 500	3 000
waste water	0	0	2 500	3 626
hydrogen	0	200	2 604	6 273
other fossil gases	3 423	3 423	0	0
biomethan	0	10 019	12 960	14 000
total supply	87 543	77 510	76 731	76 453
new customers	0	3 098	6 697	10 795
connected by customers	87 543	74 412	70 034	65 657

The prediction is only indicative considering the geopolitical situation which changes the plan of using natural gas as transition fuel. For reaching this target in fuel mix the Czech Republic defined some goals which contribute to the lowering emissions from the DH. One of the principals is based on keeping the DH efficient and even increase its efficiency. Moreover, the DH should transform, and the citizens have to be motivated to use low-emission fuels. The Czech Republic also wants to use the potential of nuclear, waste and biomass, possibly completed with natural gas for the transition period [14].

The state energy conception already supports the transformation of the DH and favours the production of electricity and heat from renewable energy sources. The focus on the investments

was taken and the transformation of the DH will be supported by the financial instruments from the Modernization fund and the Recovery fund. Regulation of heat pricing is being prepared by the Energy Regulatory Office. The state also provides protection of the DH systems from deconnections. According to the EU legislations the Czech Republic also has to differ the final user and final consumer with regard to the accounts and also provide the origin of heat from renewable energy sources. [14] Plan of the DH transformation and decarbonization was agreed by the European Commission in December 2022. As mentioned above, the main emphasis is put on the installation of new capacities using renewable energy sources as well as substitution of coal as the main source for the biomass [16].

Recently the Czech Republic obtained new resources for the DH innovation. "The European Commission has approved, under EU State aid rules, a €401 million Czech scheme to promote green district heating based on renewable energy and waste heat. The measure will contribute to the implementation of Czechia‘s National Energy and Climate Plan and to the EU's strategic objectives relating to the European Green Deal."[17] The financial sources will be then invested into new heat generation units fueled by biomass and waste. The expected capacity is 500 kW. [17] Furthermore, the Czech Republic prepares revision of State energy conception in 2023. The groundwork for this update is already in place and was approved 12 April 2023. It includes, for example, decarbonisation of the heating sector by increasing the share of renewable energy sources, increasing efficiency, and phasing out coal by 2033 [18].

6 COMPARISON OF AUSTRIA AND CZECH REPUBLIC

When comparing the district heating sectors of Austria and the Czech Republic, several similarities and differences emerge. Both countries have recognized the importance of decarbonizing their heating systems and have implemented measures to promote renewable energy in district heating. However, their approaches and priorities differ.

In Austria, the focus has been on phasing out oil and coal heating systems and replacing them with renewable energy sources. But, with the affect of the Russia-Ukraine war, new plans are also being developed to phase out natural gas. Biomass plays a significant role in Austria's district heating sector, with a substantial portion of the heat generated from biomass-fired plants. The country has made significant progress in expanding the use of biomass.

In contrast, coal and natural gas account for the largest share of the energy source for heat production in the Czech Republic. However, the Czech Republic wants to completely reduce coal by 2033 and later to reduce natural gas. In the future, as in Austria, biomass should play a significant role in heat production. It should be the largest energy source in 2050. The transformation of DH is carried out by investing in heat production from renewable energy sources and the biomass mentioned above. It has also emphasized energy efficiency measures and the modernization of existing district heating networks.

While both countries have made progress in decarbonizing their district heating sectors, they face common challenges of decarbonization and CO2 reduction under the EU legislative plan. Austria is relatively advantageous since it already integrated high share of renewables into its DH supply. However, the Czech Republic has a fossil share more than 80% in its DH supply, thus it has a profound transformation ahead.

7 CONCLUSION

The district heating sectors in Austria and the Czech Republic demonstrate different approaches to achieve decarbonization, reflecting their unique energy landscapes and policy priorities. Austria's focus on renewable energy sources, particularly biomass, has led to significant advancements in phasing out fossil fuel-based heating systems. The Czech Republic, on the other hand, aimed to higher energy efficiency measures and infrastructure upgrades to improve the performance of existing district heating networks. Further transformation that will increase the share of biomass and renewable energy in the fuel mix is still a challenge for the Czech Republic.

Despite these differences, both countries share common challenges in integrating intermittent renewables and modernizing aging infrastructure. Addressing these challenges requires continued investment, policy support, and collaboration between stakeholders.

In conclusion, the district heating sectors in Austria and the Czech Republic are on a path towards decarbonization, albeit with distinct strategies. Both countries have made significant strides in reducing the carbon intensity of their heating systems and promoting renewable energy sources. By leveraging their respective strengths and learning from each other's experiences, Austria and the Czech Republic can contribute to the broader European Union's decarbonization goals and pave the way for a sustainable and low-carbon future in the district heating sector.

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