DECARB CITY PIPES 2050

City Reports

Deliverable 4.1

Introduction

As part of the Decarb City Pipes 2050 project, **City Reports** have been authored by author teams of Utrecht University and Urban Innovation Vienna for the participating cities of Bilbao, Bratislava, Dublin, Munich, Rotterdam, Vienna and Winterthur. The reports are based on data gathered during the project through surveys, interviews, and document analysis. Each report was reviewed by city representatives.

The city reports provide an **overview of the planned decarbonization** of urban heating and cooling (H/C) systems in the different cities, the planning process, and the challenges the cities face. All city reports are organized in the same way: The first chapter introduces the city, followed by a concise summary of the H/C status quo and outlook in chapters two and three. Chapter 4 gives an overview of the relevant policy frameworks as well as governance structures and processes. Chapter five discusses the challenges and potential solutions for the H/C transition. Chapter six highlights and summarizes favorable conditions and remaining challenges for the city.

Bilbao, with a history of transformation, has a favorable climate leading to lower heating demand. The city benefits from significant autonomy in urban planning, supported by national and regional strategies for the H/C transition, despite lacking clear regulations. Limited knowledge in managing the energy sector prompted the establishment of a local energy agency. Challenges include a small existing district heating system, with the potential for a new system in the pilot district of Zorrozaurre. Key transition strategies involve electrification through centralized boilers and heat pumps, but energy source clarification is hindered by private ownership. Challenges also include a shortage of skilled labor, a low refurbishment rate, and unclear financing for heat pumps and refurbishment.

Bratislava's heating transition presents a dual perspective. The city holds potential for widespread implementation of zero-carbon H/C networks through its extensive district heating networks. However, challenges arise as residents opt out of these networks, diminishing their efficiency and hindering the city's progress towards sustainable heating. Governance complexities, including (semi-)privatization and a decentralized structure, further complicate the transition. Overcoming these challenges demands a proactive effort from various stakeholders to align strategies and address issues in financial and organizational capacity.

Dublin has robust plans and strategies for the heating and cooling transition, with a focus on spatial planning and Decarbonizing Zones. The energy agency Codema possesses significant capacities to guide the transition effectively. Dublin stands out for envisioning diverse energy sources and incorporating low-temperature

networks in residential areas, considered the most energy-efficient option. However, challenges include unclear financing, the gas sector's dominance, lack of district heating networks, retrofitting requirements for buildings, and the absence of cooling plans. Additionally, there's a knowledge gap among the general population regarding district heating, with awareness initiatives just beginning.

Munich seeks to lead in sustainable heating by setting ambitious targets, promoting geothermal energy as a low-carbon option, and applying a particpatory neighborhood approach. While recognizing the financial opportunities and long-term benefits, Munich faces challenges such as upfront costs, planning complexities, limited space, and a shortage of standardized solutions and skilled craftsmen. The current high heating demand in Munich emphasizes the urgency of decarbonization, requiring retrofitting efforts for a substantial number of buildings. Financial instruments, including subsidy programs, are essential, but overall costs, particularly for older buildings, remain a challenge. Exploring EU and national funding, utilizing existing options, and promoting personalized funding advisory services are crucial for achieving higher retrofitting rates.

Rotterdam employs a coordinated and participatory governance approach for a the H/C transition, emphasizing affordability and bottom-up involvement. The district-oriented strategy, including homeowners and housing associations, encourages connection to the planned district heating network. Rotterdam leverages its spatial energy strategy along with potential access to residual heat from the port. However, challenges arise from a lack of clear national regulation and financing, with legal uncertainties surrounding the pending National Heat Act, such as the debate over public or private ownership of heating companies – increased by the recent collapse and new elections of the Dutch federal government.

Vienna, as both municipality and federal province, shapes its own building regulations and has effective policies for the heating and cooling transition. Key strategies include spatial energy planning and municipal utilities control. Vienna excels in coordinating actors through programs like "Phasing Out Gas" and institutional capacity-building. Challenges include the absence of national regulations impacting property rights, hindering heating system exchanges for rented flats. Funding for exchanges and refurbishments is unclear. Vienna faces a shortage of skilled workers and tight timeframes. The approach to cooling in the transition remains uncertain.

Winterthur, with a tradition of ambitious climate goals and governance, benefits from the Cantonal Energy Act and a successful referendum, providing a favorable legal framework for the H/C transition. The municipal energy action plan and interdepartmental working groups enhance spatial planning. Winterthur's municipal utility aids implementation through in-house coordination with other infrastructure networks. Challenges include identifying climate-neutral energy sources for district heating, reliance on waste incineration, a tight timeframe for expanding the district heating network, and limited consideration of refurbishment and cooling.

City Reports:

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#2 Bratislava

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DECARB CITY PIPES 2050

BILBAO

City Report on the governance on heating and cooling and the potential for change management

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Introduction & Context

This city report provides an overview of the policy context and governance situation in Bilbao regarding the decarbonization of urban heating systems.

To establish the context, the first chapter provides a concise recap of Bilbao's Heating and Cooling (H/C) Outlook to 2050 and the subsequent H/C Plan. The next chapter gives an overview of the existing national, regional and local policy framework as well as an overview of the governance structures within the municipality and the process through which the city aims to tackle the H/C transition. The third chapter highlights challenges in the aforementioned governance system and strives to provide solutions to address them, notably also through regulatory and financial tools and improvements.

A former industrial city with important port activities, Bilbao is situated in a valley by the Atlantic coast, surrounded by mountainous areas, and with ocean access. By population, it is the largest city in the province of Biscay and in the Basque Country, and the tenth largest city in Spain overall. In 2023, the city had 346,843 inhabitants, as the head of the metropolitan area of a conurbation of more than 900,000 inhabitants stretching along the Nervion estuary (City of Bilbao, 2023).

FIGURE 1: MAP OF BILBAO (SOURCE: OPENSTREETMAP)

Nowadays, Bilbao is a vigorous service city that is experiencing an ongoing social, economic, and aesthetic revitalisation process, started by the iconic Bilbao Guggenheim Museum, and continued by infrastructure investments, such as the airport terminal, the rapid transit system, the tram line, the Azkuna Zentroa, and the currently under development Abandoibarra and Zorrozaurre renewal projects.

As capital of the Biscay province, Bilbao is divided into 8 different districts (Deusto, Uribarri, Otxarkoaga, Begoña, Ibainondo, Abando, Errekalde and Basurtu-Zorrotza). The Basque Country has its own Statute of Autonomy and is therefore self-governed.

Unlike other European regions, the Basque Country's gas supply is secured and reliable, as Russian production accounts only for a small share of gas imports. Most of the natural gas

consumed in the region is imported from Algeria through a series of pipelines. Additionally, the region benefits from an LNG regasification plant located on the Basque coast.

Despite this strength, the increase of gas and electricity prices is seriously affecting citizens and heightens the risk for energy poverty, and measures such as subsidies are already being taken to reduce burdens. At the same time, the current situation should also be seen as an opportunity to transform the energy system and decarbonise the heating & cooling and electrical sectors.

Bilbao's Status Quo

According to the latest emissions inventory (2018) (Decarb City Pipes 2050, 2020), the city accounted for 1'004 kt CO_2eq of GHG emissions. Annual GHG emissions from the city have been steadily declining since 2005. Bilbao's main challenge relates to the decarbonisation of the heating sector, in particular, how to integrate more renewable energy sources. A particularity of Bilbao is the high degree of buildings under protection, representing almost 40% of the overall building stock, mostly located in the city centre. (Decarb City Pipes 2050, 2020)

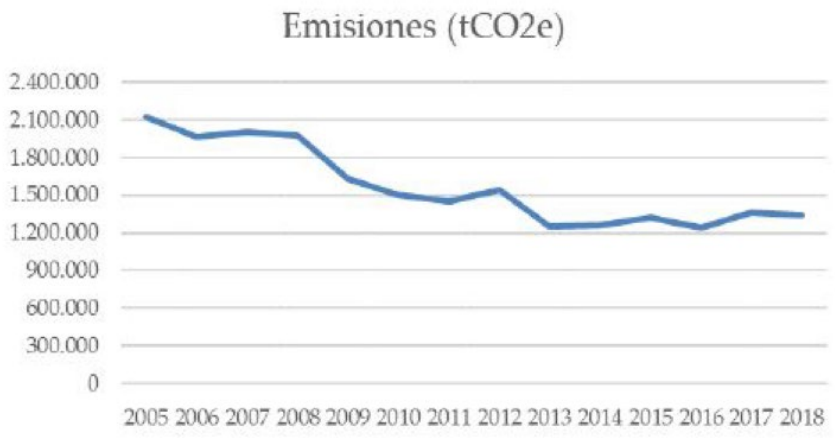

FIGURE 2: HISTORIC GHG EMISSIONS OF BILBAO (SOURCE: BILBAO H/C OUTLOOK)

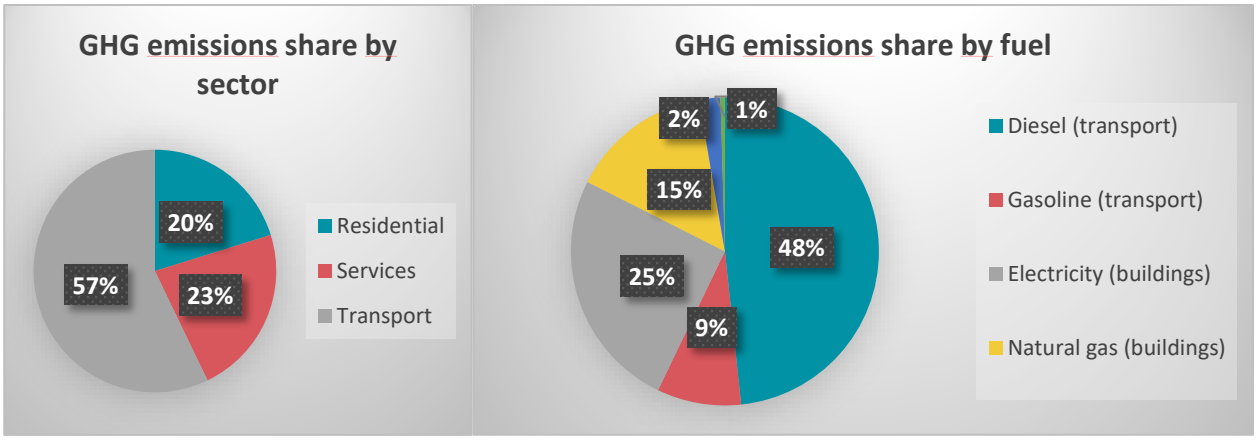

FIGURE 3: GHG EMISSIONS BY SECTOR AND BY FUEL (SOURCE: BILBAO H/C OUTLOOK)

A total of 807 GWh of heating and cooling consumption was reported for the total building stock in Bilbao (543 GWh for space heating and 264 GWh for domestic hot water). According to 2018 data, thermal energy supply consists of 90% natural gas (740 GWh).

In the **residential sector**, the total final heat consumption amounts to 260 GWh for space heating and 185 GWh for domestic hot water, which results in a total final consumption of 445 GWh/a.

The distribution of different types of heating in the residential sector (Figure 4) shows a very low penetration of individual heat pumps (below 1%), 15% for direct use of electricity (Joule effect) and more than 50% for individual gas boilers.

Around 30% of the systems are centralised oil and gas boilers, which is an important figure when considering centralised DH systems. The existence of old oil boilers also has to be taken into account in the replacement process.

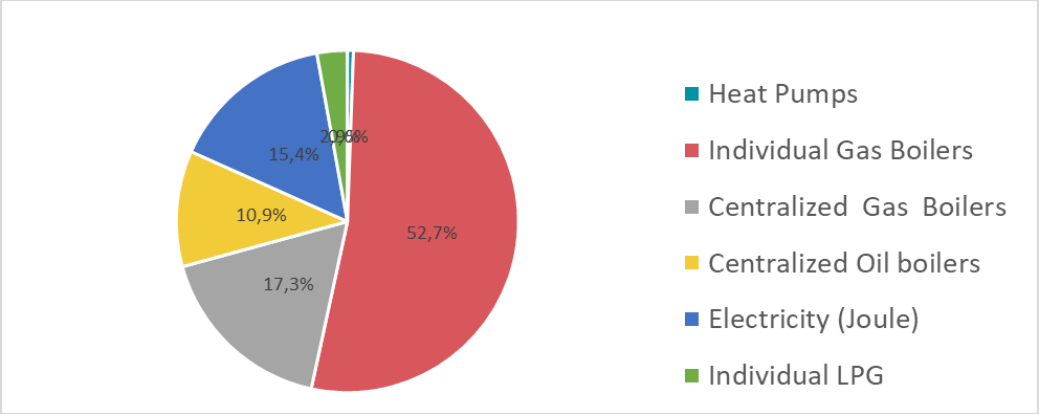

FIGURE 4: TYPE OF HEATING SYSTEMS IN RESIDENTIAL BUILDINGS (BY % OF HEATED AREA) (SOURCE: BILBAO HEATING AND COOLING PLAN)

For the **non-residential sector**, a similar analysis shows that 282 GWh of heat consumption is used for space heating and 79 GWh for domestic hot water. As shown in Figure 6, natural gas boilers are the most common systems, but there is a remarkable 30% share for heat pumps, either individual or centralised.

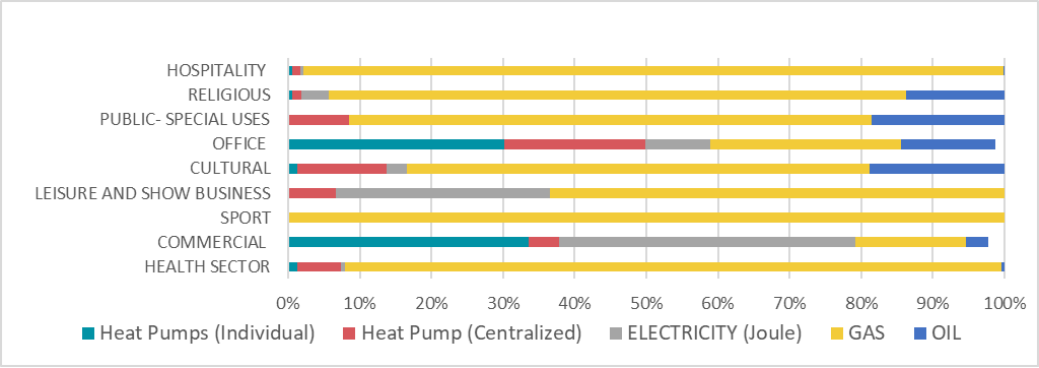

FIGURE 5: SECTORAL DISTRIBUTION OF HEATING SYSTEMS TYPES IN NON-RESIDENTIAL BUILDINGS (BY % OF HEATED AREA) (SOURCE: BILBAO HEATING AND COOLING PLAN)

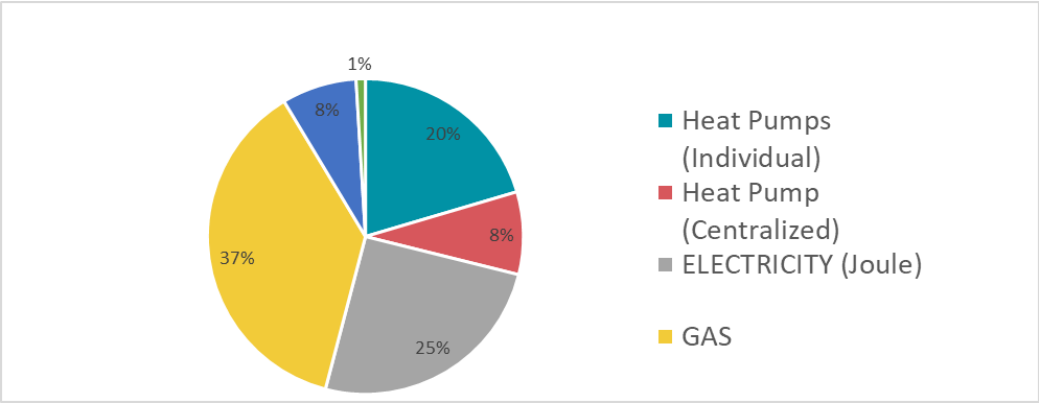

FIGURE 6: TYPE OF HEATING SYSTEMS IN NON-RESIDENTIAL BUILDINGS (BY % OF HEATED AREA) (SOURCE: BILBAO HEATING AND COOLING PLAN)

Since natural gas, by a wide margin, is the main source of heating and cooling, gas infrastructure is distributed all over the city. Bilbao has only one district heating (DH) network operating on biomass and natural gas which supplies energy to all the buildings of the Basurto hospital. As part of EU-funded ATELIER project, a new DH pilot (low temperature geothermal network) has been designed on the city island of Zorrozaurre as part of the area's urban development from a brownfield to a new city centre area (Steinbeis-Europa-Zentrum, 2023).

Cooling has a very low impact on the city's energy consumption, with 136 GWh that are mainly consumed in tertiary buildings. (Decarb City Pipes 2050, 2022a)

Bilbao's H/C Outlook 2050

In its heating transition, and trying to meet that 2050 decarbonisation goal, Bilbao anticipated in a first rough analysis a comprehensive shift from individual and central natural gas heating systems to a total electrification of the heat supply in the city. In combination with some degree of heat savings in buildings as well as the possibility to reduce final heat demand through behavioural changes (see Figure 7). It must be highlighted that this was a preliminary outlook based on general assumptions. A more data-based qualified study has been integrated into an updated H/C Plan.

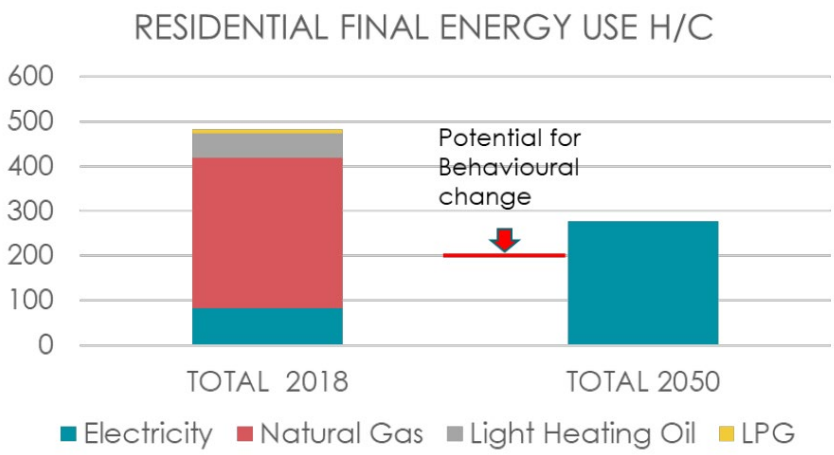

FIGURE 7: H/C OUTLOOK TO 2050 (SOURCE: BILBAO H/C OUTLOOK)

With the aim of electrifying space heating and domestic hot water demands for residential buildings, a combination of centralized heat pumps (aerothermal or connected to low-temperature sources in conjunction with DH networks), individual heat pumps (aerothermal), and direct electric heating (Joule effect) will be promoted. Energy demand for cooling will increase (and could be supplied by some of the heat pump systems), however, it will remain comparatively low.

At this first stage Bilbao assumed that 50% of current individual space heating combustion systems (gas and LPG) will be changed to individual aerothermal heat pumps, the other 50% to direct electric heating systems. Renewable energy sources for the electricity required for heat pumps and electric heating are not identified yet. All current centralized gas and oil boilers are projected to be substituted by centralized heat pumps. As for domestic hot water, 75% of current individual domestic hot water systems will be changed to individual heat pumps, and 25% to direct electric heating systems. Again, all centralized domestic hot water systems will be substituted by centralized heat pumps.

Sustainable/green gases for heating in residential buildings are not a priority solution but require further analysis.

For the residential sector, an increase in the housing stock of about 20% is anticipated for 2050, together with an assumption that approximately 25% of all buildings will have been refurbished by that year. More than 50% of the building stock is thought to still be associated with relatively high energy demands for heating (>20 kWh/m2/a). (Decarb City Pipes 2050, 2020)

The **H/C Plan** developed in the “Decarb City Pipes 2050” project gives a first overview on different strategies to decarbonize the city of Bilbao in the long term and how these could be applied in different geographical areas of the city. This is expected to serve as a first step to start the process of more detailed analysis and viability studies for key projects such as district heating networks and the natural gas phase-out.

The document focuses on a feasibility analysis of possible solutions per district in order to decarbonise the thermal sector. The evaluation considers **three strategies**: **centralized district heating systems**, **individual systems** such as heat pumps and the **deep renovation of the building sector**. Aiming to identify, which solution is more suitable for each district of the city, the analysis comprises of four layers: the renewable energy

resources potential of the city, buildings characteristics, the urban design of the city and energy demand data.

As outlined in Table 1 below, each layer is broken down also into several sublayers. For instance, with regard to the buildings characteristics, sub-aspects include: the level of protection of buildings, which buildings are public, the current fuel of buildings and the configuration of the building energy system (individual or centralized boilers). All that data has been collected in the project and included in the GIS tool controlled by Tecnalia.

Dimensions	Layers
Resources – Exchange of Heat Potential	Free spots and Green areas
	Distance from riverbed
Buildings Characteristics	Protected buildings
	Public buildings
	Fuel
	Configuration of the heating system
Urban Characteristics	Degraded areas
	Future/existing plans / PGOU
Energy Demand	Heating demand (kWh/m^2)
	Heating density
	Heating/cooling ratio

TABLE 1: LAYERS AND SUBLAYERS TO IDENTIFY ENERGY SOLUTIONS PER DISTRICT/AREA (ADAPTED FROM: BILBAO HEATING AND COOLING PLAN)

The evaluation of this variety of features was undertaken by a pair-to-pair approach, and for each of the three strategies separately. The aim is to compare all layers and sublayers by pairs and assign a proportion among them and that finally shows the importance of each sublayer for each of the three solutions.

For a strategy focused on **deep renovation of the building stock**, the focus is put on degraded areas which can profit from subsidies or other financial incentives. When loking at **individual heatpumps**, the focus is put on new development areas where technical requirements can be planned from the outset. Two areas with high potential are the island of Zorrozaurre and the the neighbourhoods of San Francisco and Bilbao la Vieja which are newly-built areas and/or set for urban expansion. Both of these strategies, are severly hindered by the high degree of protected buildings pervading large part sof the city which limits the options for changes made to buildings.

On the other hand, the strategy focusing on **district heating networks** gives greater weight to the availability of resources or adequate space for the construction of infrastructure required. Protetcion status is considered less of an issue for this approach. Again, urban development plans are a key leverage point here because infratsructure can be included already in the planning phase, reducing overall costs.

Dimensions	Layers	Sc1	Sc2	Sc3
Resources	Distance to green areas and available spaces	1,8%	1,7%	25,5%
	Distance to water bodies	1,8%	1,7%	25,5%
Building characteristics	Protected buildings	27,3%	25,2%	1,7%
	Public buildings	24,4%	23,0%	1,7%
	Fuel for heating purposes	6,8%	3,6%	0,6%
	BES configuration	3,8%	6,3%	4,6%
Urban planning	Degraded areas	12,9%	6,0%	3,1%
	Current and future urban development plans -	3,2%	18,1%	28,2%
Energy use	Heating demand (kWh/m^2)	13,0%	9,1%	1,0%
	Heating density	3,9%	3,7%	7,2%
	Heating/cooling ratio	1,1%	1,5%	0,9%

FIGURE 8: PERCENTAGE OF INFLUENCE OF EACH SUBLAYER FOR IMPLEMENTING THE DIFFERENT SCENARIOS (ADAPTED FROM: BILBAO HEATING AND COOLING PLAN)

Figure 8 shows the percentage of influence of each sublayer (free spots and green areas, fuel, degrade areas, heating demand, etc.) for the implementation of the three scenarios (centralized district heating systems, individual systems, and deep renovation of the building sector.).

As an example, Figure 10 depicts the **hotspots** (in dark red) **where DH systems will be more favourable in Bilbao**, compared to low favourability in blue areas. Areas along the river perform generally well because of the heat availability, including the historical centre with a high heat demand density .(Decarb City Pipes 2050, 2022a)

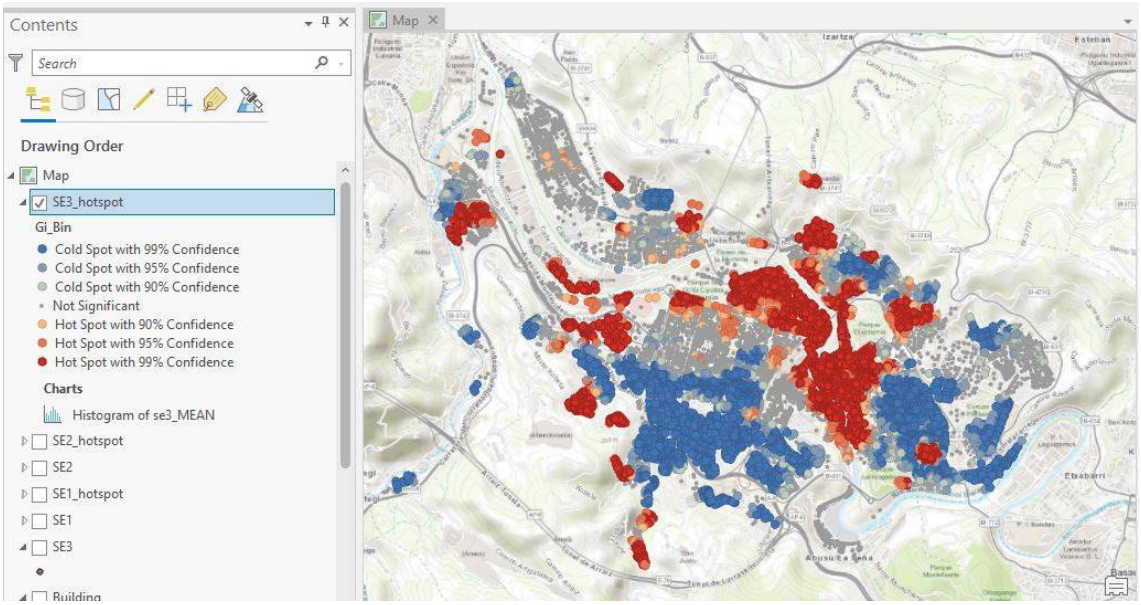

FIGURE 9: FAVOURABILITY OF DH SYSTEMS PER AREA/DISTRICT (RED: FAVOURABLE; BLUE: NON-FAVOURABLE)

Governance of the H/C transition

Legal Framework and Policies

National/federal policies & targets

The aim of the **Integrated National Energy and Climate Plan 2021-2030** is to set Spain's long-term objectives as to become a carbon neutral country by 2050 by mitigating at least 90% of gross GHG emissions compared to 1990. The Plan aims to reduce emissions through decarbonising the following sectors: electricity generation, mobility and transport, residential, commercial and institutional sectors, industry (combustion). (European Commission, n.d.)

By reducing the use of fossil fuels and promoting renewable energy sources in the three energy-intensive sectors – transport, heating & cooling and electricity – renewables will account for 42% of the total energy end use in 2030.

In the heating & cooling sector, it is expected that, in addition to continuous technological improvement, new players and investment models will emerge to drive decarbonisation. In this context, the Plan focuses on renewable energy communities and proposes regulatory development that allows them to exercise their right to generate, consume and sell renewable energy. It also focuses on promoting of a set of administrative and economic measures.

One of the measures for the implementation of the **Long-term strategy for the energy rehabilitation of the building stock sector in Spain** (2020 update) (measure 7.5) is specifically focused on the promotion of energy communities and district networks. (Ministry of Transport, Mobility and The Urban Agenda, 2020)

The 2019 update of the **Technical Building Code** (DB HE 2019), implementing the most recent provisions of the **Energy Performance of Buildings Directive**, included new requirements both for domestic and non-domestic buildings concerning the building envelope and overall energy performance of buildings, such as limits for total primary energy use and minimum requirements for renewable energy use in domestic hot water and electricity. This encourages the use of renewable energy systems, and potentially the switch to district heating networks with low primary energy factors. (Ministry of Transport, Mobility and The Urban Agenda, 2019)

Regional policies & targets

The **Basque Energy Strategy 2030** mentions the potential of building refurbishment and renewable heat for decarbonising the heating supply in the building sector, but only few general comments about potential of district networks are included (Basque Government, 2017).

The **Energy Sustainability Law 4/2019** establishes a GHG emission reduction target of -40% by 2030. It requires the promotion and implementation of renewable energies in the public administration sector to reduce dependence on fossil fuels. The different Basque

public administrations, each being responsible for its own buildings and facilities, must achieve a 60% reduction in energy consumption by 2050, with an intermediate reduction target of 35% by 2030. Furthermore, each public administration must generate enough renewable energy by 2030 to cover at least 32% of its buildings' and facilities' energy demand, including both thermal and electrical generation systems. (GESE Integral de Servicios Energéticos S.L., 2023)

Reducing heating & cooling energy use through refurbishments, and integrating renewable heat in buildings is a central part to achieve these goals. As of the entry into force of this law, 100% of purchased electrical energy must be of renewable origin.

Decree 254/2020, specifying the application of this law, requires public administrations to promote studies on centralized energy systems and to improve energy efficiency of the existing building stock. For new developments, it requires them to consider centralized energy system for energy supply and the use of renewable energies.

City policies and targets

With the **Bilbao Environmental Strategy 2050**, the city aims to achieve carbon neutrality by 2050 while simultaneously improving citizens' quality of life and cutting in half the risks associated with climate change (Herranz-Pascual, 2019)

The initial **Sustainable Energy Action Plan 2020** for Bilbao was published in 2012, with a plan until 2020. It included various measures to reduce energy use for heating, focussing mostly on promoting building refurbishments and improving gas boiler efficiency, as well as some integration of renewable energies. (Oficina contra el Cambio Climático de Bilbao, 2012)

Bilbao is currently in the process of developing a Sustainable Energy and Climate Action Plan (SECAP 2030), where different measures for building refurbishments and integrating renewable energies for heating & cooling will be included, supported by the work done under the Decarb City Pipes 2050 project.

Process of H/C planning in the city

Spain has a fairly decentralised governance system, which is divided into 17 autonomous communities, each with its own parliament. This gives great importance to how the central government interacts with these regions and their representatives, who have competence to implement key national energy and climate policies. In the energy sector, the autonomous communities are responsible for areas such as authorising power plants and energy networks. The decentralised governance system has benefits, as regions and municipalities can work more directly with end users to promote changes in energy consumption and transport.

The municipal strategy of the city of Bilbao includes the heating transition as a relevant long-term goal. The first draft of Bilbao's decarbonisation plan elaborated in Decarb City Pipes project in 2022 intends to identify the most appropriate renewable energy solution for each district.

The plan and, consequently, the decarbonisation process are not independent either of the peculiar situation that defines Bilbao in contrast to other European cities. There are some challenges that the city is confronted with but also several strengths on which it can rely.

Bilbao has performed a big urban transformation during the last decades thanks to a very efficient and autonomous urban governance model. The city has been reconverted from an industrial city dedicated to port activities to an attractive urban area thanks to a public-private collaboration model involving local and national administrations as well as private partners.

This background and experience are really valuable also to implement the heating transition.

The city has almost complete autonomy over urban planning which is a clear advantage for the heating transition. Moreover, the Basque country has a very powerful auxiliary industry in the energy and electricity sector, including companies with great experience such as Iberdrola and Tecnalia.

On the other hand, the City Council does not have the authority and the knowledge to manage the energy sector, and energy-related competencies are spread across the administration. The Local Working Group in Bilbao set up under Decarb City Pipes 2050 and which is led by the Commission for Mobility and Sustainability under the city administration, is divded into a political commission (decision-making body, consisting of city councillors) and a technical commission (core group of technical municipal departments). It is in charge of the city's energy transition process and collaborates with municipal departments and institutions that already have strong roles in the city development. The commission also collaborates with regional institutions as well as with utilities, DSOs and other external stakeholders A local Energy Agency has been established in the year 2022 for improved coordination. Engaging the private sector in this process is not an easy task either since it entails a massive and unprecedented administrative burden. In this regard, pilot projects (e.g. the island of Zorrozaurre) are really valuable to demonstrate solutions and then scale them up and accelerate later.

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This working group, among other responsibilities, is tasked to elaborate a Local Actuation Plan to meet the requirements of the Sustainability Law and to develop the SECAP for the year 2023. The first Plan only refers to public buildings, where interventions in the heating sector are already in progress. However, there is still the need to refine and detail an actuation plan at city level. Also, the H/C Plan elaborated during the Decarb City Pipes project is a relevant first document that, however, needs to be expanded and supported through more specific studies and analyses of economic, structural, social and environmental issues.

Politics of heating decarbonisation and stakeholders involved

The Bilbao City Council has a coordinated plan for the decarbonisation of public buildings based on the inclusion of heat pumps. The Basque Energy Agency is also a very important entity that has led the decarbonisation of the region over the last 40 years. Other representatives from the industry are also important in this process through their knowledge and experience in the sector. A key player in this regard is Tecnalia, a centre of applied

research and technological development in Spain, and a member of the Basque Research and Technology Alliance.

A severe hurdle in the heating transition is the involvement of privately-owned energy companies in this process. Private companies are primarily focused on their own profitability and their activities are not necessarily aligned with decarbonisation or social equity. Some are counting on integrating a share of hydrogen into the natural gas network, but it remains highly unclear if this solution will allow to fully decarbonise heat supply of residential buildings in Bilbao. However, others such as the private-public company Telur, focusing on the design of geothermal networks, have been a key actors in the Zorrozaurre pilot project when defining the boreholes for geothermal energy and the district heating network, as well as coordinating with the municipality and private developers.

Potential for Change Management

Priority urban governance challenges & how to address them

Political commitment and prioritisation are key issues. Bilbao's warmer climate entails a lower heating demand, making modifications of the heating systems a lower necessity and priority overall. Also, the gas network was constructed in Bilbao only around 35-40 years ago, making it hard to argue for the decommissioning of the system.

The Bilbao City Council is in principle committed to working towards the energy transition and achieving climate neutrality, which is underlined by ongoing plans and projects. However, the actions in the heating strategy will require **more resources** both in terms of investment and qualified staff in the future.

Energy producers and energy distributors in the city of Bilbao are almost exclusively **privately owned**, complicating the implementation of the decarbonisation plan. However, their role in mobilizing resources remains essential and must be achieved through appropriate business models and concessions.

The H/C Plan could be an tool to direct private companies towards viable heating projects that are in line with the city's interests or for the City Council to identify where private companies could be facilitated in their endeavours.

There is also a **lack of installers** of renewable energy systems and, for example, existing installers **need upskilling** before they are able to install heat pumps.

Furthermore, **public acceptance** of the heating transition is a key factor to make sure that, i.a. citizens are willing to connect to DH systems or to install a heat pump. While Bilbao does not have a DH system yet to evaluate public opinion, recent examples in in nearby cities are highlighting barriers and difficulties to convince residents.

Furthermore, **high upfront investment costs** present a major barrier, even if DH systems and heat pumps are generally economically viable in the long term. This should be addressed through a combination of a regulatory approach and financial incentives.

The development of the district heating pilot project in Zorrozaurre is a great learning experience for the scaling up of this type of solutions in the city and acts as a driver of the heating transition. The success of the DH is fundamental in order to evaluate possible replications in other areas It is the first low temperature geothermal DH system in the Basque Region, which can demonstrate the feasibility of such a project on the district scale. It also underlines the large administrative effort required to handle developments of this scale, i.e. due to work concessions, tenders, etc. Hence, the dissemination of the results and a clear funding framework will also be essential to create support among administrations and citizens, and make such projects attractive to private companies. It is also true that Zorrozaurre is a brownfield and thereby it is not the same case as urban dense areas in the city centre, where the deployment of a DH is more complicated due to lack of space and the dismantlement of the gas network and construction works.

Regulatory improvements

The supplier companies of thermal energy are private and end consumers can select their own supplier and the corresponding energy source.

Although increasing natural gas prices are favouring investments into renewable sources and decarbonisation, it also provides incentives to the largely private energy suppliers to stick with fossil fuels that provide the highest revenue margins. A regulatory framework is necessary to support administrations in phasing-out natural gas and in their ability to promote DH systems and achieve a high connection rate among residents. This could include a tax regime on fossil fuels and/or subsidies for renewable energies.

To harness the aquathermal potential of the river, a legal framework for heat exchange with the river and for geothermal boreholes is needed.

Financial instruments

The heating transition should be based on a solid financial investment scheme supporting the right solutions (individual systems such as heat pumps, total refurbishment of the buildings and centralized systems), and involving not only the public administration but also the private sector.

A “mixed economy” approach as seen in Nordic countries – where DH infrastructure is partially publicly-owned, regulated and supported by a tax system – could have a positive impact in nudging towards the preferred heating systems.

The installation of heat pumps needs an alternative business model. Upfront costs are high and, at the moment, unaffordable for a large number of citizens. One possibility is the involvement of ESCO, a private energy company, for heat pump installation: the company could potentially work on the refurbishment of a building including heat pump installation and afford the upfront costs while residents will be charged all or partial operation and maintanance costs.

The realisation of large-scale projects, such as DH projects, also entail high investment costs and have long-term payback periods. In the pilot area in Zorrozaurre, the municipality has been bearing the costs for the network construction expenditures in a substantial part

thanks to European and national funds. These funds will be crucial for the energy transition in the following years. In addition, the replication of such projects must be aligned with a sustainable business models based on a public-private collaboration, as the engagement of private sector for the design, commissioning and the monitoring of projects will be essential.

The refurbishment rate is relatively low (around 1%) and must be stimulated. The publicly-owned company SURBISA is responsible for encouraging refurbishments of residential buildings within the municipality, supported through an existing plan of subsidies and grants from the administration (SURBISA, n.d.). However, this task also requires involving the private sector, including banks. Offering advantageous and customized credits to residents can promote refurbishments considerably.

Conclusions

Bilbao is a city with a history of transformation. Regarding the heating and cooling transition, the city has the advantage of a warmer climate, which entails a lower heating demand. Nonetheless, when it comes to the governance system, the city is in a very favorable position because of the almost complete autonomy over urban planning. Also, important strategies and plans are in place at the national and regional levels to support the heating and cooling transition. However, a law with clear regulations is lacking. The city has limited knowledge of managing the energy sector but has established a local energy agency for improved management and coordination. Moreover, the Decarb local working group was set up in a way to coordinate political will with technical expertise by combining a decision-making body, consisting of city councillors, with a core group of technical municipal departments.

Apart from the scarcity of skilled labor, the city faces the main challenge of a small, existing district heating system, while a new system is only realistic in the pilot district of Zorrozaurre. The main strategies for the transition are therefore electrification e.g., through centralized boilers working on aerothermal heat pumps, individual systems such as heat pumps, and the deep renovation of the building sector. However, energy sources for the electrification are not clarified yet, complicated by energy production and distribution mainly being in private hand. The refurbishment rate is currently at 1% and almost 40% of the overall building stock is under protection. Finally, the financing of heat pumps and refurbishment is not entirely clear.

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DECARB CITY PIPES 2050

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DECARB CITY PIPES 2050

Bratislava

City Report on governance on H/C and potential for change management

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Introduction

This city report provides an overview of Bratislava's policy context and governance situation regarding the decarbonisation of urban heating and cooling (H/C) systems.

To establish the context, the first chapter will summarise Bratislava's heating and cooling (H/C) Outlook until 2050 and its H/C plans. The second chapter overviews the existing national, regional and local policy framework. At the same time, it introduces the municipal governance of H/C and the process through which the city aims to tackle the H/C transition. The third chapter highlights challenges in the aforementioned governance arrangements and strives to propose solutions, notably through regulatory and financial instruments and improvements.

Urban geopolitical context

Bratislava is the capital of Slovakia and the political, cultural, and economic centre of this Central European country. With the collapse of Communism in the Eastern Bloc during the 1980s and the dissolution of Czechoslovakia in 1992, the Slovak Republic was established on the 1st of January 1993. As such, Bratislava has only relatively recently regained its status as a European capital city. Uniquely, the capital city borders two sovereign states, as it is located only 18 kilometres away from the border with Hungary to the south and 60 kilometres from the Austrian capital, Vienna, to the west of the city. The city is situated along the Danube River, surrounded by the Little Carpathians mountain range and stretches across the Záhorská and Podunajská lowlands. (Publications Office of the European Union, 2022; World Population Review, 2022).

Bratislava's administrative land area is 367,6 km^2 and comprises five districts. The largest is Bratislava V - Petržalka, whilst Bratislava I comprises the historic old town (World Population Review, 2022). These districts are further segmented into 17 smaller districts. Despite being one of Europe's smaller capitals, Bratislava is the largest city in Slovakia, with a population of just under 440,000 in 2022 (ibid.). Considering the city's heating infrastructure, it is important to acknowledge the substantial influx of commuters, which reaches around 200,000 per workday. Moreover, Bratislava is closely intertwined with the wider metropolitan area, which boasts over 650,000 residents (ibid.). The concentration of corporate headquarters in the capital has contributed to its prosperity, as in 2020, Bratislava ranked as the seventh wealthiest city region in the European Union in terms of regional GDP per capita, surpassing the EU average by 173% in purchasing power standards (Office K.P., 2020). Though start-ups, businesses and corporate headquarters are expected to continue to be established in the metropolitan region, the city's population is projected to remain relatively stable in the coming decades (Municipality of Bratislava, 2019).

Climate Action Energy Vision

The municipality of Bratislava places a strong emphasis on sustainable development goals and integrated urban planning. Bratislava's Mayor Matus Vallo, who assumed office in 2018, is actively pushing for its climate ambitions and advocating for EU net-zero greenhouse gas emissions by 2050 (Energy Cities, 2022; Interview 2, 2022). Recently, the city finalised its Sustainable Urban Development Plan, which outlines various objectives, including a 55% reduction in greenhouse gas emissions by the end of the decade and specific actions to attain this target. Bratislava's climate change adaptation strategies have primarily focused

on smart city solutions, sustainable transportation, and mobility. Additionally, significant attention has been directed towards housing and building refurbishment, waste treatment sectors, stormwater management and green infrastructure throughout the city (Publications Office of the European Union, 2022).

Regarding energy planning, Bratislava 2030 entails the development of a new SECAP 2030 (Publications Office of the European Union, 2022). The city is also committed to conducting analyses of stationary sources of greenhouse gas emissions and establishing robust data-gathering systems to review behavioural changes in energy consumption patterns. Finally, a strategy for renovating the many traditional concrete multi-apartment blocks has been drafted, contributing further to Bratislava's energy planning endeavours (ibid.).

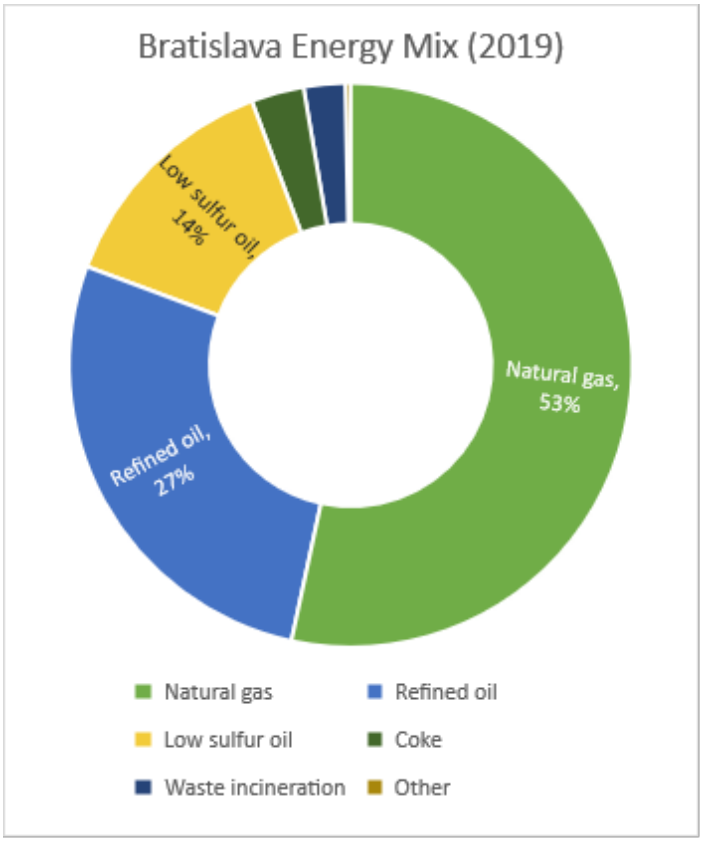
Slovakia heavily relies on imported oil and natural gas, making its energy security vulnerable. As the EU's second most gas-dependent country, Slovakia's energy supply largely depends on gas imports from Russia and Ukraine (Interview 6, 2022). With 90% of the population having access to natural gas through an extensive pipeline network, Slovakia's energy landscape faces challenges due to this reliance. The recent energy crisis caused by the invasion in 2022 led to a significant surge in gas prices, prompting Slovakia and Hungary to oppose a complete European embargo on Russian oil (Barigazzi et al., 2022). European leaders have agreed to reduce Russian gas imports by 90% by the end of 2022 to address the situation. However, the precise impact of the energy crisis on Slovakia, including Bratislava, is yet to be fully assessed (BBC, 2022).

Bratislava's H/C Status Quo

Energy mix

Bratislava's energy mix, mirroring the national trend, heavily relies on natural gas. In the city's energy consumption, natural gas comprises 53.38% of the fuel consumed. Refined and low sulfur oil account for 27.3% and 13.6%, respectively. The remaining 6% comprises coal, waste incineration, wood, and coke (hard coal) (Municipality of Bratislava, 2019). This strong dependency on fossil fuels poses challenges in achieving a sustainable and decarbonised heating system, further highlighting the need for diversification and exploring alternative energy sources for Bratislava's energy needs.

FIGURE 1: BRATISLAVA ENERGY MIX (2019)



SOURCE: MUNICIPALITY OF BRATISLAVA, 2019

Heating and Cooling Infrastructure

District heating coverage

Bratislava has an extensive district heating system with many (unconnected) local networks. These can be characterised as the first generation of district heating systems based on high-temperature steam (Barco-Burgos et al., 2021). For economic reasons, the individual district heating networks remained separate (island) networks and were never physically connected (Municipality of Bratislava, 2019; Interview 5). Because of the physical and organisational fragmentation of the urban territory into these disconnected island networks, data on the exact coverage in Bratislava is unknown. However, around 70% of buildings are estimated to be connected to some form of DHNs. The systems were privatised after the fall of the Soviet Union, and different heating companies currently manage them. Each district has a multiplicity of energy suppliers for heating, of which the company MHTH is the most prominent supplier (Interview 4). The condition and level of modernisation of the district heating networks (DHNs) vary spatially, even within the MHTH-controlled DHNs. Whereas Bratislava East still operates on the energy-inefficient combination of hot water and steam, Bratislava West operates fully on the more energy-efficient distribution of hot water, and the Dúbravka district and Petrzalka district operate on decentralised block boilers (Municipality of Bratislava, 2019).

During the former Communist regime, Bratislava's urban heating systems were publicly owned, and their operation was centralised and governed by national state decisions (Municipality of Bratislava, 2019). Current DHNs represent the inherited infrastructure from the socialist period. After Slovakia’s independence, the DHNs were modernised using European structural funds and private investments. The country privatised substantial parts of the economy, including energy utilities and heat supply (Interview 1; Cigáňová, 2007). Heat provision through DHN is still regulated; across Slovakia, more than 350 licensed companies provide heating services at a regulated price (Interview 4). The supply of heating service is thus achieved through multiple different nationally and internationally owned private utility providers. In Bratislava, MHTH manages the majority of DH infrastructure and block boilers (Interview 4).

Most buildings in Bratislava fall under two categories in terms of heating. The first group relies on the central district heating networks, fed by various gas pipelines throughout the city (Interview 6). These heating networks generally operate at high values of evaporating temperature, meaning water can be distributed at 120-160 ^{o}C (Barco-Burgos et al., 2021). Low-temperature district heating networks (evaporating temperatures of 70-100 ^{o}C) are uncommon. The centralised heat supply ensures the heating of individual low-rise buildings in the city. The second category of buildings is those with decentralised boilers. Boilers provide heat to individual low-rise buildings in the city, and block boilers cater to buildings up to 7-9 apartment blocks (ibid.; Municipality of Bratislava, 2019). In some instances, the district heating networks are linked with block boilers. In other cases, heating is exclusively supplied by smaller systems based on block or individual house boilers.

Shifts away from DHNs

Due to increasing consumer demand, there is a noticeable trend among private developers to establish decentralised heating systems in Bratislava (Interview 2). In line with this trend, private developers either opt not to connect new neighbourhoods to existing DHNs or to disconnect from them. The Slovak Act on Thermal Energy (Energie Portal, 2015), which

aims to simplify the adoption of renewable energy sources for heating, supports this development. Consequently, there is a growing investment in decentralised low-carbon heating alternatives. This might create a vicious cycle with DHNs becoming increasingly less cost-efficient and individual options becoming increasingly appealing.

Regarding the alternatives being used, limited information is available on the prevalence of electric heating. Additionally, there seems to be a lack of collaboration between the municipality and the electricity distribution company ZSD. On the other hand, certain industries and households still rely on coal or coke for heating, albeit in small quantities (Municipality of Bratislava, 2019). The use of wood for heating is more widespread. Information on other sources, such as renewables or heat pumps, is scarce.

Composition of the built environment

Most Slovaks own the house or apartment they live in - as much as 91.3%, compared to the EU average of 69.3%. Individual apartment residents are responsible for their heating costs as part of their housing expenses. Therefore, heat customers are primarily private housing cooperatives and individual building owners. The share of apartments with regulated rent (i.e. social housing) makes up only 1.2% of the housing stock compared to the EU average of 8.7% (Liptáková, 2020). Despite municipal aspirations to repurchase some privatised apartment blocks at market rates and provide affordable housing, the current state of social housing in Bratislava remains comparable, standing at 3% (Interview 1). A side effect of this development is an above-average share of overcrowded and multigenerational households compared to the EU (Liptáková, 2020.)

In the last decades, 46.1% of residential housing in Bratislava has been insulated and renovated in line with the European Energy Performance of Buildings Directive (Slovak Ministry for Transport and Construction, 2020). However, renovation is complicated, as, according to national legislation, a 75% majority vote of affected residents is required for works to connect to or disconnect from a heat source (Interview 7). The effects of this legal requirement are evident in the city, as some buildings remain with exposed concrete walls, meaning renovations for insulation have not yet taken place, and this leads to spatial variegation in building energy efficiency and connections to the DHNs.

Governance of the H/C transition

Legal Framework: Policies

National/federal policies & targets

Slovakia operates under a dual state administration system and autonomous regional and local self-government (European Committee of the Regions, 2023). This means the central government, the National Council of the Slovak Republic, has primarily a legislative function. The regional and municipal governments combined have the right of territorial self-administration, meaning both regions and municipalities are self-governing in territorial

development. Further complexity is added in Bratislava, which is divided into 17 relatively territorially autonomous city districts.

The legislative competencies for heating and cooling are set mainly at the national level. Slovak legislation is expected to undergo significant changes in the coming years, illustrated by the draft of a possible new law on climate in early 2023. At the national level, Slovakia aligns with the EU's target of reducing emissions by 55% by 2030. The draft of the climate law establishes the goal of attaining carbon neutrality by 2050 and adhering to the EU's 55% reduction target (Enerdata, 2023).

Furthermore, Slovakia has developed the Energy Policy of the Slovak Republic (EPSR). The EPSR is a strategic document stating the primary goals and priorities of the energy sector until 2035, with a long-term perspective reaching 2050 (Ministry of Economy of the Slovak Republic, 2014). The strategy is based on four pillars: energy security, energy efficiency, competitiveness and sustainable energy. Its overarching objective is to contribute to the sustainability of the Slovak energy sector by fostering long-term sustainable growth and competitiveness within the national economy. The EPSR emphasises ensuring the reliability and stability of energy supply, promoting efficient energy utilisation at optimal costs, and safeguarding environmental protection. These are generally long-term goals set out by the national government and are to be executed in cooperation with the territorially self-governing regional and local authorities.

However, despite the existence of national and EU policies, their ability to effectively facilitate the transition is often limited. The primary legislative function of the National Council complicates executing national policies. Insufficient enabling legislation and regulatory complexities at the State level create barriers for cities striving for climate neutrality. The national regulatory frameworks do not adequately address the challenges of mitigating climate change at the regional and local levels, limiting effective and sustainable energy policy implementation. Municipalities have had difficulties advocating for changes that would simplify the implementation of projects. To address these challenges, it is important to collaborate with both the regional and municipal authorities to establish a comprehensive strategy and regulatory framework at the national level.

City policies and targets

The citizens of Bratislava are subject to four levels of governance. First, the national Slovak government. Second, the self-governmental regional government “Region of Bratislava”. Third, the self-governmental Municipality of Bratislava constitutes an organisation working within the region and operating as its own administrative unit. Fourth, the city’s 17 districts also enjoy relative autonomy. Crucially, each of the 17 city districts has the status of legal entity (sub-municipality) and has its own elected assemblies and executives, set of competencies, and taxation laws, as stipulated by Article 29 of the Statute of Bratislava in 2008. For heating and cooling in Bratislava, this means policies are to be applied to and executed by these 17 districts.

This governance structure, which brings decision-making processes closer to citizens, also leads to a fragmented approach to urban planning across the 17 autonomous districts. While this localisation enhances citizen participation, it poses challenges to implementing a cohesive city-level strategy. Consequently, political contestations and impasses are common occurrences. This fragmentation of urban responsibilities can present difficulties in ensuring the coherence of urban energy planning and implementing heating transition strategies (Publications Office of the European Union, 2022, p.55). The districts exhibit

considerable heterogeneity in population, surface area, and urban development strategies, which can result in fiscal competition among them. Furthermore, the decentralised decision-making processes in urban planning and public procurement can be intricate and time-consuming, leading to potential delays and complications (Publications Office of the European Union, 2022).

Bratislava Heating Concept - 2019

The decarbonisation of the heating and cooling systems and the overall energy transition in Bratislava are formulated based on national objectives but developed and applied locally. In the case of Bratislava, a dedicated strategy specifically focused on heating is in place. The current heating concept primarily revolves around infrastructure maintenance, heating supply efficiency, and building renovation (Interview 2). The strategy developed on heating is called the Koncepcia Rozvoja Hlavného mesta Slovenskej republiky Bratislavy v olbasti tepelnej energetiky 2019 (Development Concept for Bratislava, the Capital City of the Slovak Republic, in the field of thermal energy 2019). The development plans for energy consumption in Bratislava encompass three different scenarios.

1. The first scenario assumes the development of the current heat infrastructure, assuming the usage of natural gas distribution networks to meet heating demand. It is assumed that 40% of the increase in heat consumption will be provided by natural gas, 20% from other sources and 40% by sustainable heat suppliers (Central Heating Supply, block boiler plants and local heat pumps). The heat consumption from industry is assumed to be provided by gas-fired boilers. Consumption in the residential and tertiary sectors is assumed to be provided with sustainable heat suppliers where possible. Otherwise, a gas connection is assumed. This scenario is based on current trends in the Bratislava heating market. The potential for energy savings will be evenly spread up to 2040.
2. The second scenario also assumes the development of the current heat infrastructure. It differs from the first scenario in assuming the increase in consumption will partly be covered by heat from Waste Heat Production in the city. The heat currently unused for electricity generation will be supplied to the Central Heating Supply. The potential for energy savings will be evenly spread up to 2040.
3. The third scenario assumes a change in the structure of the heat infrastructure in the city. This scenario assumes the implementation of the 4th generation of DHNs combined with smart city concepts. This cumulates in the simultaneous use of DHNs, central heat sources and individual heat sources of self-consumers (e.g. local heat pumps). It is assumed that objects of heat consumption will be connected to the DHNs, in which they can redistribute excess heat. The city identifies this scenario as the most preferable scenario.

However, Bratislava needs a specific, agreed-upon strategy or action plan to guide the transition towards *zero-carbon* heating and cooling (Interview 2). Each scenario mentioned remains in some way dependent on carbon emissions for its heating. The city's current absence of such a strategic direction can be attributed to several factors: Slovakia’s governance structure, the country’s regulatory framework, and insufficient municipal capacity and technical expertise. Stakeholders state that the heating strategy is insufficient and await stronger strategic leadership from the city (Interview 5, 2022).

Process of H/C planning in the city

Currently, no dedicated department within the city is specifically responsible for developing H/C planning. Relevant responsibilities are instead distributed across multiple actors and departments, such as the department for construction or technical networks (Interview 2). Furthermore, the energy sector in Bratislava is predominantly privatised, resulting in heating and cooling services being provided by various companies. Consequently, the city has limited decision-making authority over the heating and cooling systems and networks. (Municipality of Bratislava, 2014, 2019).

The city's involvement in pilot and demonstration programs for the energy and heat transition often stems from being awarded EU project funding. In addition to participating in the Decarb City Pipes 2050 project, Bratislava is engaged in EU-funded initiatives such as Atelier, which aims to develop citizen-driven Positive Energy Districts (Atelier, n.d.). Moreover, the city has recently been approved as a beginner city participating in the EU's 100 climate-neutral and smart cities by 2030 mission (Publications Office of the European Union, 2022). As highlighted by the city's mayor (Euractiv, 2022) and the Director of the responsible municipal department (Interview 2), these EU-funded projects enable Bratislava to serve as an experimental and innovation hub for the transition towards climate neutrality. However, there is a risk that these projects, which are often temporary and location-specific, may not contribute to a comprehensive city transition strategy.

Stakeholder involvement

The key stakeholders involved in the heating transition are displayed in **Table 1.**

Table 1: Relevant Stakeholders

Stakeholder	Description
The Slovak Innovation and Energy Agency	A contributory governmental organisation established by the Ministry of Economy of the Slovak Republic, tasked to inform, educate, monitor and evaluate, support energy efficiency and innovation and participate in international cooperation.
Energy Centre Bratislava	NGO aimed at promoting and supporting rational energy usage and energy efficiency.
Slovak Gas Industry SPP-Distribúcia MH Teplárenský Holding (MHTH)	Bratislava's Heat Company & Distribution Service Operator. A state-level and publicly-owned gas company.
Veolia Energia Slovensko Group	Major Slovak energy company group, consisting of many companies, focused on providing heat and energy, waste management and water management.
SLOVNAFT	International oil refinery, focusing on production, warehousing, wholesale and retail sales and distribution, providing oil as a fuel to Slovakia.
Termming, a.s.	A regional thermic management company operating in many districts of Bratislava and the region.
Engie Group	International energy company group, with many associated companies operating in Slovakia.

Given the municipality's limited strategic governance capacity, as a result of both limited personnel and the described governance issues, the sustainable heating transition has been delegated to voluntary private utility providers (Municipality of Bratislava, 2019; Interview 2). These competitors vary in their levels of commitment to the transition and differ in their proposed technical solutions and spatial domain. Furthermore, cooperation with the private sector has not yet been formalised. As of this moment, public-private partnerships occur on an ad hoc basis.

Discussions with private utility providers for the city confirmed a keen desire for strategic leadership from the city – "The heating strategy for Bratislava is not sufficient currently. We need a clear vision and an action plan, and the city needs not to be afraid to apply it" (Interview 5). Concurrently, the city looks to the private sector to address climate change adaptation and provide the technical direction to inform the heating transition (Publications Office of the European Union, 2022; Interview 1).

Potential for Change Management

Key urban governance challenges

Despite the ambitions of the city's Mayor and the unfolding energy crisis, the argument of climate change mitigation only rarely gains leverage in Eastern European countries (Interview 3, Interview 4). Instead, the discourse surrounding the heating transition in Slovakia revolves more around energy security and national pride (Interview 3, Interview 4). Slovakian households have been using natural gas as an energy source for decades. Until recently, most citizens considered gas an affordable, reliable, and relatively eco-friendly way to keep their homes warm. Whilst the city has conducted minimal outreach/education programs or private heating providers (Publications Office of the European Union, 2022, p46), involving citizens and building owners in the energy transition is reported as "very complicated in Bratislava" (Interview 7).

Regarding district heating as a zero-carbon option specifically, when it comes to receiving heat via DHNs, as opposed to being connected to the gas grid, building owners and private tenants tend to fear greater expenditure, given DHN prices incorporate costs of maintenance and network upgrades, as well as operational costs (Interview 5). Furthermore, DHNs are subject to unpopularity by association. In Bratislava and across the former Eastern Bloc countries, DHNs are sometimes perceived as vestiges of the collectivism of the Communist era, leading to disconnections and private developers' development of individual heating solutions (Interview 3; Interview 7).

A further challenge is the previously explained complex governance situation in Slovakia. Recognising the limitations of the governance arrangements present in Slovakia and

following Council of Europe standards, The Centre of Expertise for Good Governance is finalising general policy advice on the special status of Bratislava (Council of Europe, 2023; Slovak Ministry of Internal Affairs., n.d.). It recommends changing the governance structure for the city to enable a strategic coordinating and mediating role across the 17 districts (ibid.). Building human and financial capacity in the municipality is crucial for quality energy planning at strategic planning regions, cities and municipalities. That means the city must attract experts and muster the political will to create support and policy instruments to make change viable.

Financial instruments

The municipality of Bratislava faces limitations in its financial resources. The economic viability of the transition to zero-carbon heating relies heavily on two key factors: incentives and the mobilisation of financial institutions dedicated to energy efficiency (Municipality of Bratislava, 2022). This likely includes attracting financing from investors and developers, equity financing from heat supply system owners, and seeking funding from banks and other financial institutions within Slovakia. It is important to acknowledge that Slovakia has only recently started estimating the investment requirements for climate action, and there is currently no investment strategy for ongoing climate action plans. Additional funding can be realised through securing project funding from the European Union, although such funding often prioritises one-off innovation or experimental pilot projects (Interview 2). An added difficulty is that Bratislava, due to the high regional GDP, is in a disadvantaged position for allocating European funds. European funds are prioritised to regions with below-average GDP per capita, meaning the Bratislava region is only entitled to draw on a fraction of the allocated funds. Unlike other metropolitan regions, the low allocation of EU funding is not compensated by higher revenues (Municipality of Bratislava, 2022).

Bratislava itself encounters further challenges with funding. While the city has implemented progressive policies in various service areas and has increased its focus on governance, it cannot solely rely on its funding schemes. The city's ability to increase its municipal revenue is limited, as while the city has some freedom in levying its taxes, approximately 80% of Bratislava's income is governed by the state and beyond the city's control (Municipality of Bratislava, 2022). Although the metropolitan region generates around 28% of the national GDP, its share of personal income tax, the main funding source, is calculated as a percentage of the national total, resulting in only 14% allocated to the city (ibid.). Moreover, the city does not receive any portion of corporate taxes, leading to a minimal correlation between the city's economic success and its municipal budget. Additionally, the high level of public debt restricts the city's capacity to utilise financial instruments such as loans, guarantees, and equity. Taking on additional loans or repayable financing would exceed the legal debt threshold imposed by the debt brake regulations.

One potential solution explored in Bratislava is Energy Performance Contracting (InterWay, n.d.). Energy Performance Contracting is an innovative financing mechanism that allows energy efficiency improvements to be implemented in buildings without upfront capital investment. Under an Energy Performance Contracting arrangement, an energy service company undertakes the upfront costs of implementing energy efficiency measures. It is repaid through the resulting energy savings over a predetermined period (Ministry of Finance of the Slovak Republic, 2014).

Bratislava has launched several public procurements seeking offers for refurbishing its building stock using Energy Performance Contracting, but the response has been limited. The low interest in Energy Performance Contracting could be attributed to a lack of readiness in the market, as the concept is still considered relatively novel and unfamiliar to

many stakeholders. While EPC may hold potential for the future, it is important to note that it addresses only one aspect of Bratislava's funding problems.

Conclusion

In conclusion, the heating transition in Bratislava is two-sided. On the one hand, the extensive DHNs covering the city provide the potential for widespread implementation of zero-carbon H/C networks. A swift update of the DHNs and incorporation of sustainable energy sources to fuel the networks could make Bratislava a leading city in the transition towards sustainable heating. On the other hand, the city faces many challenges in reaching this potential. Increasingly, residents have started to opt out of their heat provision by DHNs, making the DHNs decrease in efficiency. This leads to a vicious cycle in which DHNs become increasingly less appealing as the leading sustainable heating option, hampering the potential of present infrastructure. The city concept of heating is deemed insufficient by stakeholders as it does not portray a strategy towards a zero-carbon H/C system, and clear leadership from the municipality is missed.

The unique situation surrounding governance and management of the heating transition further complicates the process. The (semi-)privatisation of the heating utilities and the consequent fragmented utility structure adds difficulty, especially considering Bratislava's highly decentralised and fragmented governance structure. The implementation of sustainable heating options faces long bureaucratic processes, with private stakeholders, district authorities, and municipal and regional authorities all needing to be aligned for development to occur. Barriers in financial and organisational capacity further complicate these processes.

Again, the heating transition in Bratislava is two-sided. There is great potential for sustainable H/C, and great challenges need to be overcome to reach this potential. Addressing these challenges will require a proactive effort from all parties involved.

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Interviews & City Visit Observations

- **Interview 1**: City of Bratislava, Lighting, Energy and E-mobility Department Employee – 10 may 2022
- **Interview 2**: City of Bratislava, Lighting, Energy and E-mobility Department Director - 18 may 2022
- **Interview 3:** Bankwatch representative – n.d.
- **Interview 4**: MH Teplarensky holding, Senior Project Manager – n.d.
- **Interview 5:** Veolia Energia Slovensko, Institutional Relations Manager, Veolia Energia Slovensko, Senior Manager for Customer Care Department – 17 May 2022
- **Interview 6:** SPP-distribúcia, Head of Strategy & Development of Asset – 17 May 2022
- **Interview 7:** Veolia Operation Coordinator - 2022

DECARB CITY PIPES 2050

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DECARB CITY PIPES 2050

Dublin

City Report on the governance of heating and cooling and the potential for change management

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Table of Content

Introduction & Context

This city report provides an overview of the policy context and governance situation in Dublin regarding its decarbonisation of urban heating systems. To establish the context, the first chapter provides a recap of Dublin's heating and cooling (H/C) Outlook to 2050 and its H/C Plans. The second chapter gives an overview of the existing national, regional and local policy framework as well as an overview of the governance structures within the municipality and the process through which the city aims to tackle its H/C transition. The third chapter highlights challenges in the aforementioned governance system and strives to provide solutions to address them, notably also through regulatory and financial tools and improvements.

Dublin is capital of the Republic of Ireland and by far the largest city on the island. According to the most recent consensus in 2016, Dublin County is home to roughly 1.34 million inhabitants[1]. As of 2021, the population of the Greater Dublin Area, which comprises Dublin County and the counties Meath, Kildare and Wicklow, is even estimated to be 2.02 million, or 40.5% of the total population[2]. The County of Dublin is divided into the local government areas of Dublin City, Dún Laoghaire–Rathdown, Fingal and South Dublin. The City of Dublin itself has around 544,000 inhabitants[3].

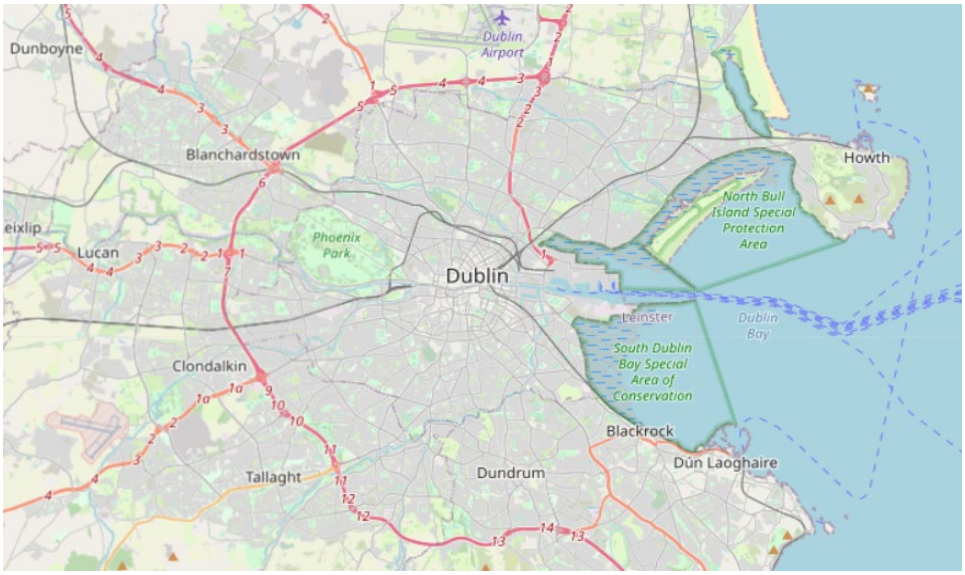

FIGURE 1: MAP OF THE CITY OF DUBLIN (SOURCE: OPENSTREETMAP)

[1] https://www.esri.ie/publications/prospects-for-irish-regions-and-counties-scenarios-and-implications
[2] https://www.dublinchamber.ie/About-Us/Economic-Profile-of-Dublin
[3] https://datacommons.org/place/wikidataId/Q1761/?utm_medium=explore&mprop=count&popt=Person&hl=de

It has been estimated by the Economic and Social Research Institute in 2018, that Dublin County will see an annual population increase of an average of 0,9%[4]. According to the Irish National Planning Framework (NPF), around 137,500 additional homes have been planned for Dublin. This accounts for roughly 25% of additional houses planned to be built in Ireland by 2040.[5]

Dublin has become a pioneer in Ireland for local level energy planning and district heating systems implementation, both of which are completely new practices in Ireland[6]. The city is emphasizing the important role district heating (DH) can play in improved energy efficiency and emissions reduction through the use of low carbon energy resources and has now committed to developing a citywide DH scheme, outlined in the "Dublin City Climate Change Action Plan 2019-2024"[7]. The construction and expansion of the district heating system is thus being seen as one of the technical solutions to decarbonize urban heating systems in Dublin. The City is to this end currently in the process of developing its first district heating network.

The current geopolitical and energy crisis has driven up electricity and fuel prices as gas is the marginal generator of electricity, and has subsequently sparked a bigger interest in switching from gas to alternative heat sources. On the other hand, it has increased the capital costs for heat equipment and prolonged lead-in times for ordering heat pumps to between 6 and 12 months, which delays the heating transition efforts and increases its overall costs.

Dublin's H/C Status Quo

When it comes to decarbonisation, heating is a hugely important sector in Ireland, as it represents approximately 40% of its energy demand, twice of its demand of electricity. It is currently the worst performing sector in terms of renewable proportion, even behind both, the electricity and the transport sector.

With a renewable heat proportion of just 6.3% of total heat production, Ireland is one of the worst performing countries in the EU. As of 2022, gas accounts for 65% of Dublin's final

[4] https://www.esri.ie/system/files/publications/RS70.pdf
[5] https://npf.ie/project-ireland-2040-national-planning-framework/
[6] Decarb City Pipes 2050: Dublin´s Heating and Cooling Plan. 2022. https://decarbcitypipes2050.eu/wp-content/uploads/2022/09/D3.3-HC-plan-Dublin.pdf
[7] https://www.dublincity.ie/residential/environment/dublin-city-councils-climate-change-action-plan-2019-2024/dublin-city-council-climate-action-plan-2019-2024#:~:text=The%20final%20plan%20contains%20219,greenhouse%20gas%20emissions%20by%202030.

energy demand for H/C, followed by electric heating[8] at 15%, oil at 10% and other sources, such as coal or biomass fuel also at 10%.

With a total length of 5,692 km, the gas network covers almost the whole city. More than half of it is being for the provision of low-pressure gas. The network was developed at national level by semi-state-owned companies, who back then did not consider if DHC grids may be a better option.[9]

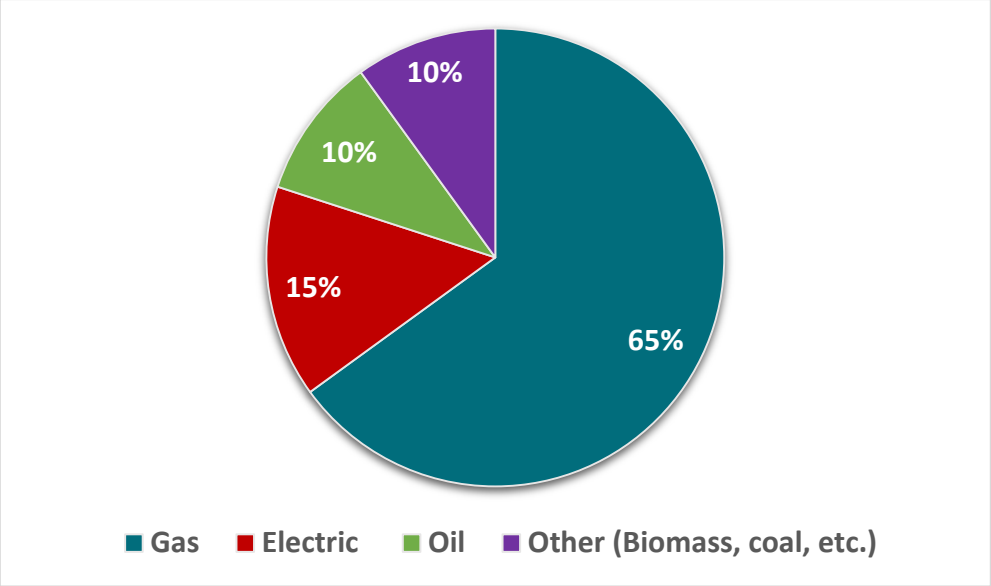

FIGURE 2: FINAL H/C ENERGY DEMAND BY TYPE OF HEAT SUPPLY IN 2022 (SOURCE: CODEMA)

Until 2019, it has hardly been regarded that district heating might be the better option for the city. With less than 1 %, Ireland currently has one of the lowest shares of district heating (DH) in the heat market in the EU. A 2019 study performed by Heat Roadmap Europe researchers and results from SEAI´s National Heat Study, however, estimates for Dublin a potential of about 50-60% DH share[10]. The potential for district heating has also been recognised in the national Climate Action Plan 2021[11], which states a target of 2.7 TWh of heat to be supplied via district heating by 2030. This target represents 10% of all residential and commercial heating in Ireland.

Dublin has already made quite the progress in district heating in the last few years. In July 2022, the first large-scale DH network in the county went operational in Tallaght. This DH network is the first not-for-profit public utility in the country and the first to use data centre waste heat as its heat source. The city is developing a much larger network in the Poolbeg area, which will use waste heat from the nearby incinerator. An existing network in the

[8] It needs to be noted that electric heating in the city is predominantly refers to direct electric heating, heating pumps in turn are hardly used currently.
[9] Decarb City Pipes 2050: Dublin´s Heating and Cooling Plan. 2022. https://decarbcitypipes2050.eu/wp-content/uploads/2022/09/D3.3-HC-plan-Dublin.pdf
[10] https://www.seai.ie/data-and-insights/national-heat-study/
[11] https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/

Grangegorman area also plans to utilise geothermal energy to replace its existing gas based production.

Dublin's H/C Outlook 2050

In its H/C Outlook for 2050, that has been elaborated in the context of Decarb City Pipes 2050, Dublin outlined what sources are to be used in the future to meet its estimated future heating and cooling demand. Figure 3 shows that the main changes between now (2021) and 2030 is the significant reduction in heat available from power plants as renewable electricity generation increases. This reduction is offset by increased heating potential from data centres and from renewable electricity generation which would otherwise be curtailed.

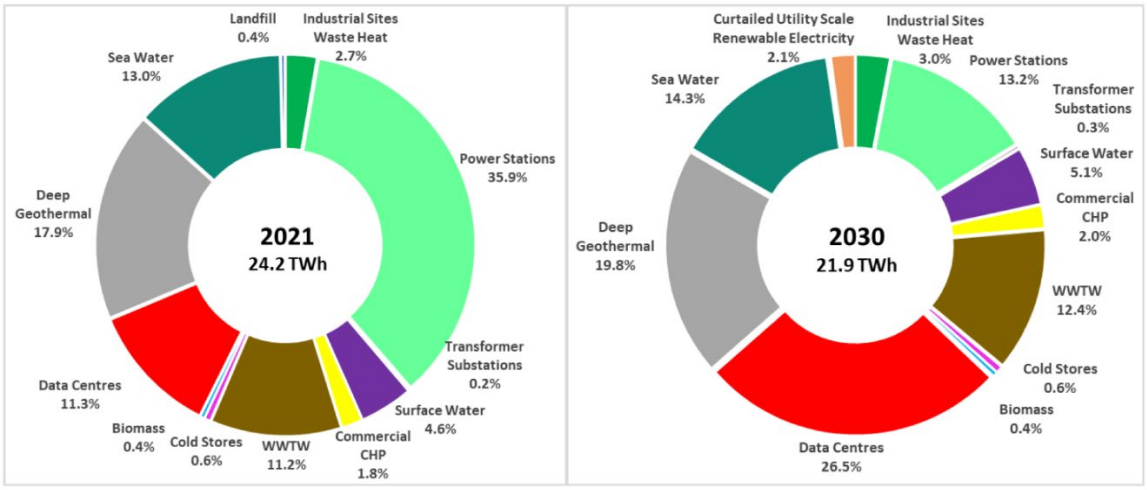

FIGURE 3: HEAT ENERGY SOURCE AVAILABILITY IN 2021 AND IN 2030 (PROJECTED) (SOURCE: DUBLIN H/C PLANS)

Figure 4 gives an overview of heat sources available in Dublin (currently approximately 530 sources) and their locations within the city, including the heat source potential from data centres and the geothermal heat potential (in grey).

It needs to be noted that Dublin considers green hydrogen not suitable for low-exergy applications such as space heating and hot water preparation due to inherent inefficiency when compared with alternatives. In general, Dublin calculates that its transition away from fossil gas will require a drastic reduction in customers connected to the gas network (from 700,000 customers to 150,000 customers). However, despite this, Dublin also expects positive social and economic impacts, due to jobs being created and increased well-being of inhabitants.

A heat analysis conducted in the scope of the Dublin Region Energy Master Plan – using Codema's spatial energy demand analyses – looked at low-carbon heating options, district heating and heat pumps (air/water/waste heat), and under the assumption that green hydrogen/biomethane would be prioritized for process heat.

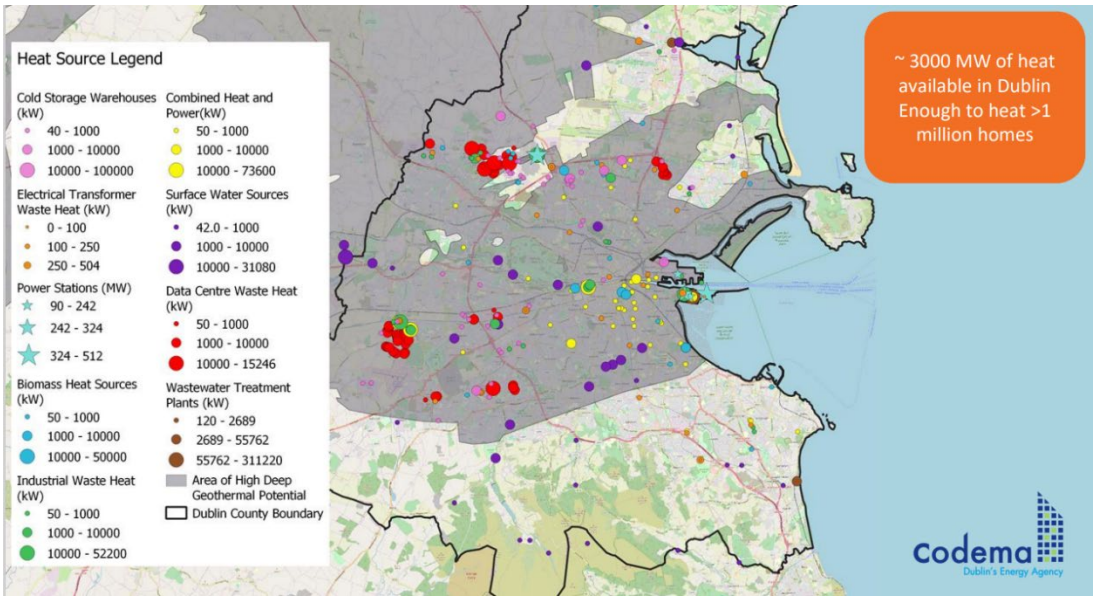

FIGURE 4: AVAILABLE HEAT SOURCES IN DUBLIN (SOURCE: DUBLIN H/C PLANS)

In order to verify the overall suitability for district heating in the city on a more granular scale, the current heat demand (see Figure 6) was calculated using most recent information (domestic building energy rating, CSO, research) and comparing these results against metered data to improve estimates where possible. Based on this assessment, it has been found that 83.5% of heat demand in Dublin city is suitable for district heating (above 120TJ/km2) and that this could increase to 96.6% with supporting regulations in place.

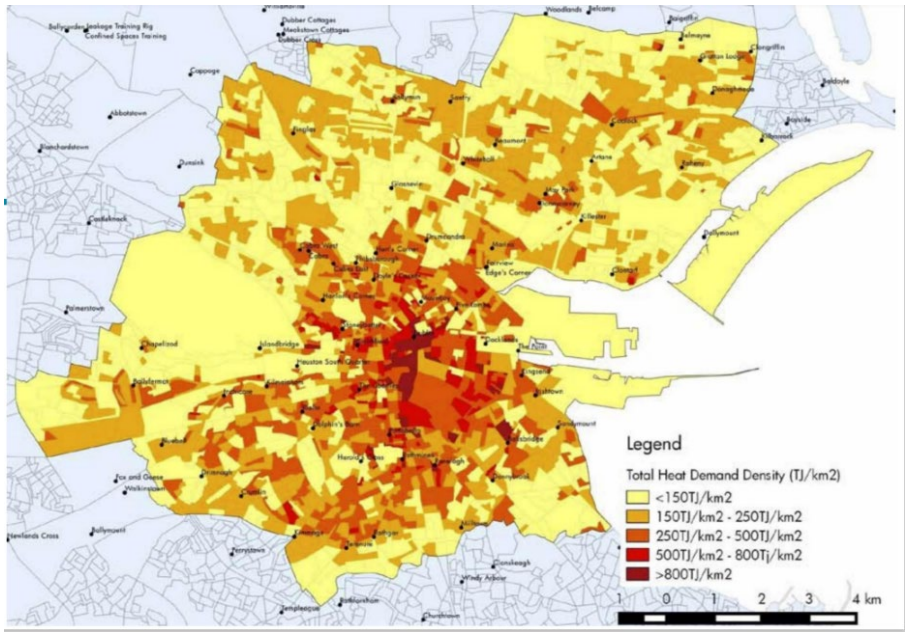

FIGURE 5: TOTAL HEAT DEMAND DENSITY IN THE CITY OF DUBLIN AREA. RED INDICATES AREAS WITH HIGHER HEAT DEMAND DENSITY. (SOURCE: DUBLIN H/C PLANS)

Inspecting every part of Dublin based on the type of area and the technologies that are best suited for reducing energy-related emissions within a respective area, the following central conclusions were drawn:

- Dublin can mobilize enough renewable & waste heat sources to heat the equivalent of over one million homes and over 70% of Dublin's homes suitable for DH.

- DH is the most feasible low-carbon heating option for 87% of heat demand in Dublin by 2050.
- Heat pumps are most feasible option for 13% of heat demand in Dublin by 2050 – serving 72’500 homes.
- To meet the national 2.7TWh target of heat supplied by DH in Heat Plan, the city requires a 10-fold increase in DH construction by 2030. Heat pumps can be used as an interim solution.

While possible high temperature district heating systems will centre only around the industrial areas, low temperature networks can supply heat to large shares of resident areas. The integration of renewable/low-carbon heat sources will be necessary, mainly of geothermal, solar thermal energy, green gas and waste heat. Also, sufficient bridge funding will be key to allow for roll-out and expansion of DH networks at the required scale.

Drawing from the aforementioned analyses, **Dublin’s H/C Plans** spatially represent the future supply situation for 2030 and 2050. They outline which technology (between heat pumps and DH) is the most suitable for a given area based on total carbon abatement costs. Further details on how these plans were developed can be found in H/C Plans of Cities with Cross-city synthesis (D3.3).

Figure 6 and Figure 7 show the final results mapped both for 2030 and 2050, with red indicating a favourability of DH and blue for heat pumps, and a darker colour shade indicating a more distinct favourability. Notably, the areas suited for DH increase between 2030 and 2050 as up-front capital investment in the network infrastructure is recouped over a longer period in this scenario. This effect will continue beyond 2050.

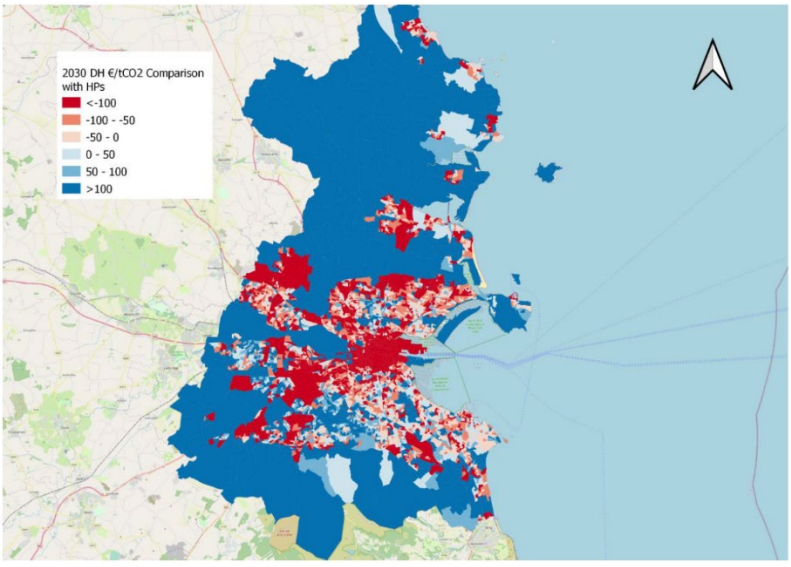

FIGURE 6: SCENARIO 2030: DH AND HP PRIORITY AREAS BASED ON LOWEST NON-DISCOUNTED CARBON ABATEMENT COST (SOURCE: DUBLIN H/C PLANS)

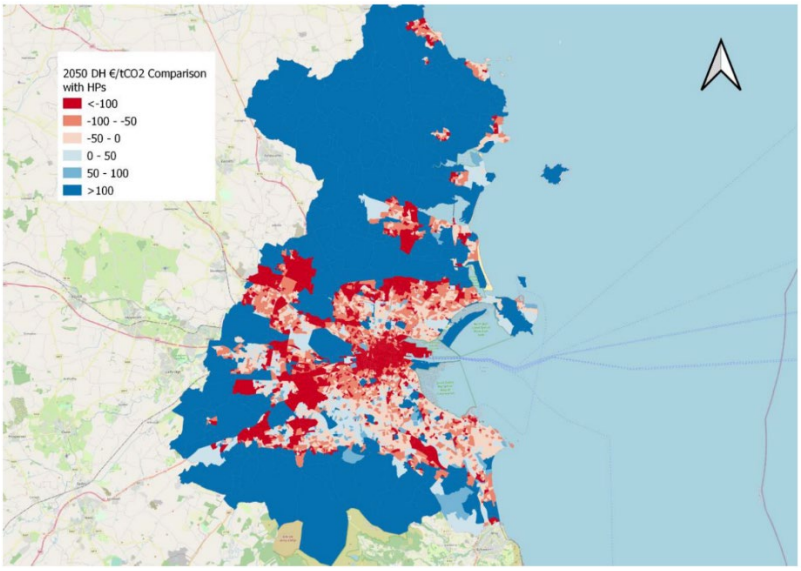

FIGURE 7: SCENARIO FOR 2050: DH AND HP PRIORITY AREAS BASED ON LOWEST NON-DISCOUNTED CARBON ABATEMENT COST (SOURCE: DUBLIN H/C PLANS)

Governance of the H/C transition

Legal Framework and Policies

National/federal policies & targets

Ireland supports the EU's ambition to achieve a net zero target by 2050. It's interim target for 2030 is -51% in emissions compared to baseline of 2018. The most recent national targets are outlined within its Climate Action Plan 2021. One of the main targets comprises that 2.7 TWh of Ireland's heat demand (approximately 10% of all residential and commercial heating) will be supplied by DH networks by 2030.

The plan also sets out over 180 actions to ensure Ireland achieves its 2030 targets for carbon emissions. To support this roll out of DH, the Climate Action Plan includes measures that the government will take, namely to:

- support through the Climate Action Fund.
- establish a system of governance for the development of district heating policy.
- perform research to support the rollout of district heating in Ireland.
- develop a regulatory framework to protect customers & suppliers.
- ensure a planning framework that encourages and facilitates the development of DH – zoning of areas for DH.
- identify appropriate financing mechanism to support delivery of DH including financial incentives similar to retrofit grant programs.

- update relevant regulatory & legislative tools to enable roll out of DH infrastructure.

The above-mentioned goals are further broken down into explicit measures: For example, Action 165 outlines requirements for Local Authorities to design and implement Decarbonizing Zones. By end 2021, all councils in Ireland have to identify at least one DZ where will decarbonise by 7% reduction/year national target.

Project Ireland 2040[12] is the national long-term strategy to ensure that future growth is compact, connected, regionally balanced and sustainable. This strategy incorporates the National Planning Framework, which sets the vision and strategy for the development of Ireland to 2040, and the National Development Plan 2021-2030, which provides the enabling investment to implement this strategy. The intention behind the strategy is to align investment plans with the National Strategic Objectives for 2040 in a cohesive and defined manner.

The National Planning Framework supports the development of district heating networks in Dublin, Cork, Galway, Waterford and Kilkenny, where technically feasible and cost effective, to assist in meeting renewable heat targets and reduce Ireland's greenhouse gas emissions. The compact and sustainable pattern of development envisaged by the National Planning Framework requires less energy and makes renewables-based systems of energy distribution, such as district heating, more feasible.

Regional policies, strategies plans & targets

On the regional level, which is in this case the County of Dublin, the Eastern Midlands Region Assembly's "Regional Spatial & Economic Strategy" (RSES) is the strategic plan for economic development and spatial planning until 2031. It includes two notable Regional Policy Objectives for the H/C transition: Local authorities shall consider the use of heat mapping to support developments which deliver energy efficiency and the recovery of energy that would otherwise be wasted. A feasibility assessment for district heating in local authority areas shall be carried out and statutory planning documents shall identify local waste heat sources. And: Local authorities shall include policies in statutory land use plans to promote high levels of energy conservation, energy efficiency and the use of renewable energy sources in existing buildings, including retrofitting of energy efficiency measures in the existing building stock and energy efficiency in traditional buildings.

The Dublin Regional Energy Master Plan says that DHS is the most feasible option to manage the decarbonisation of heat, which is a national requirement. The aim is to provide a low-carbon heating option for 87% of the heat demand in Dublin by 2050, supported by heat pumps. However, a proper analysis in terms of waste heat capacity and geothermal capacity has only been investigated over the last three to five years, to identify heat sources that can be put into a local network and have the opportunity to meet the heating demand.

[12] Project Ireland 2040 : https://www.gov.ie/en/campaigns/09022006-project-ireland-2040/

City policies, strategies, plans & targets

The Dublin City Climate Change Action Plan (2019-2024), which was created by Dublin's energy agency, Codema, lists 200 actions across 5 key areas (inc. energy & buildings) to develop a city-wide DH scheme. Furthermore, the Draft Dublin City Development Plan outlines the following actions, such as:

- New development should generally demonstrate / provide for […] energy efficiency, energy conservation, and the increased use of renewable energy in existing and new developments, and for connection to (existing and planned) decentralised energy networks including the Dublin District Heating System where feasible.
- To support the production of energy from renewable sources, such as from solar energy, hydro energy, wave/tidal energy, geothermal, wind energy, combined heat and power (CHP), heat energy distribution such as district heating/cooling systems, and any other renewable energy sources, subject to normal planning and environmental considerations.
- To support the exploration for, and development of, geothermal energy resources having regard to emerging government policy on geothermal energy.
- To actively encourage the development of low carbon and highly efficient district heating and decentralised energy systems across the city utilising low carbon heat sources such as renewable energy and waste heat recovery and to promote the connection of new developments to district heating networks where such systems exist/can be developed in a given area.
- To support the development and expansion of any necessary energy infrastructure which will deliver the low carbon Docklands and Poolbeg catchment of the Dublin District Heating System (DDHS) project including, its pipeline infrastructure and its energy centre with energy storage and back-up heat production.
- To encourage proposed and existing developments and facilities (such as data centres) to capture and utilise otherwise wasted heat, and use waste heat either on-site, or in an adjoining, and nearby sites, in compliance with all relevant Energy Efficiency Regulations.

Process of H/C planning in the city & stakeholders involved

Codema as Dublin's Energy Agency has been responsible for developing the heat strategy for the city with key involvement of the planning department. Codema alone has a staff of 33 people with 4 people dedicated to the development of the heat strategy only. The energy agency has been building skills and practices in developing district heating with the Dublin municipalities through numerous EU & national level projects.

Other stakeholders involved in the heating transition and associated issues are the Sustainable Energy Authority Of Ireland (SEAI), the national Departments of the Environment, Climate and Communications (DECC) and of Housing, Local Government and Heritage (DHLGH), the National Treasury Management Agency (NTMA), and the Geological Survey Ireland (GSI) as the national earth science knowledge centre, as well as gas, electricity and DH utilities. They all convened in the context of the "Local Working Group to

Decarbonise Dublin's Heating Sector" set up in the scope of the Decarb City Pipes 2050 project.

National policy with relation to DH is currently being developed and it is hoped that a national DH delivery unit will be responsible for allocating public financing to projects as well as providing technical assistance to smaller local authorities. Heat networks are currently unregulated in Ireland but this is likely to change with the Commission for the Regulation of Utilities (CRU) likely to perform this role as the sector grows. The CRU currently regulate the electricity, water and gas markets.

Currently, Dublin is not yet at the stage of contacting householders. This will be arranged by the city council who will bring in a partner with experience of citizen-engagement and commercial retail.

Politics of heating decarbonisation

There are also several points of conflict, when it comes to the phase out of fossil fuels. The gas industry is currently still predicting an expansion of their network, which is, however, not compatible with the energy transtion. In fact, a drastic reduction in customers connected to the gas network is required, namely from 700,000 to 150,000 customers. The main heat company is Gas Networks Ireland, which is a subsidiary of an commercial public-private company with responsibility for the delivery of gas infrastructure and services in Ireland.

Furthermore, there is an interest by special sectors for the use of green hydrogen to lock-in customers to gas in the short to medium term. The industry argues with a loss of jobs in the fossil fuel sector, if phased down in favour of more sustainable heating methods.

In Dublin, new or expanding industrial sites are required to produce a waste heat report which describes the heat available (quantity of heat, timeline for heat availability, temperature availability). If a network is either existing or planned in the area, waste heat collectors are required. The local authorities are also looking to introduce a requirement for all buildings of a certain size to fill out an energy statement outlining information that will inform energy planning in the city, including heat planning.

Furthermore, the Dublin City Council is trying to develop an appropriate evidence base to identify specific zones where only district heating would be used on the grounds of the national heat study & the regional energy master plan. Dublin is focusing on the planning instrument of zoning to phase out natural gas district by district through so-called 'Decarbonisation Zones (DZs)' and 'Sustainable energy Zones (SEZs)', whose designation is required through the 2019 national Climate Action Plan. The definition of such a Decarbonising Zone has been further specified by Codema and Dublin's Metropolitan Climate Action Regional Office (2020) in a respective briefing paper. A Decarbonising Zone is thus an "area spatially identified by the local authority, in which a range of climate mitigation measures can co-exist to address local low carbon energy, greenhouse gas emissions and climate needs. The range of policies and projects developed are specific to the energy and climate characteristics of the spatial area covered by the DZ. This can include a range of technologies and measures addressing electricity, heat, transport, building energy efficiency, carbon sequestration, energy storage, grid frequency/inertia etc."

The execution will primarily be done by the local authority planning teams which can put requirements on new developments, particularly in strategic development zones. DH opportunity areas will undergo a more detailed techno-economic analysis for the feasibility of the DH network usually conducted by Codema. Typically, the best performing areas are prioritised for further analysis but if the engagement from potential customers in the area is high then these areas can leapfrog those which might look better on paper. This recognises the vital importance of having stakeholder engagement in bringing a project to fruition.

In regards to the resources the city has to stimulate energy retrofitting of buildings, this can currently only be undertaken in specific strategic development zones, since in some of them there is a requirement for new buildings to be future-proofed to connect to DH. Currently, three strategic development zones exist in Dublin and three in the wider metropolitan area.

Potential for Change Management

Priority urban governance challenges & how to address them

The following aspects were mentioned in the questionnaire, as answered by Codema:

- Available materials, skills and labour in the supply chain
- Availability of funding for infrastructure
- Muncipal capacity and coordination
- Citizens engagement & trust
- Stimulating energy retrofitting of buildings and encouraging DH connection and heat pumps
- Engaging with private sector (e.g. PPP, concessions)
- Gaining political will
- Data management
- Uncertainty regarding appropriate technology

There is an agreement today that more bottom-up effort is required to support the roll out of DH in Ireland. However, **municipalities are limited in their level of autonomy** regarding influencing the use of energy and emissions in their regions. The instrument most widely used currently is through planning permissions for new developments, i.e. with a requirement to make buildings “DH-enabled”, meaning that buildings have to be able to connect to a DH system. However, since there is currently no requirement for buildings to connect, there might be a demand risk for DH networks in Ireland. This challenge could be addressed with a zoning approach. However, there still is in general a lack of awareness of DH being an option. This also needs to be addressed to reduce a demand risk.

As a further step, a requirement to connect would be a desirable legal basis. Additionally, more guidance on implementing national plans on the local & regional level could speed up

the transition. In parts, this has already been done. For example through Codema and Dublin's Metropolitan Climate Action Regional Office's briefing paper on how to implement Decarbonising Zones.

The available **materials, skills & labour in the supply chain** need to be developed in order to deliver on the potential for DH in Dublin. The current national government target of 2.7TWh by 2030 reflects the supply chain growth experienced by other countries when they first began adopting DH in the 1970s. As Dublin is more advanced in the planning and development of DH systems, it is fair to assume that the majority of this target will be met by Dublin.

Knowledge & expertise is a big gap at the moment as this represents a new sector. Dublin is trying to tackle that by providing training courses for engineers and on district heating. These courses include every part of the project from planning to modelling, from policy to development at the national level, to installing, and to designing. **Coordination on the municipal level** will be key to alleviate these bottlenecks.

Other key actions could be:

- how-to guides (incl. heat planning, DH feasibility studies, etc.) to help consultants and other stakeholders to get involved in the industry,
- ongoing support for technical knowledge-sharing and confidence-building,
- opportunities to transition from the fossil fuels sector into district heating due to similarities in skills,
- setting national targets in developing supply chains to attract the required personnel & labour force.

The availability of **funding for infrastructure** could be enhanced: currently, public funds are meant to be available for feasibility work and project development, however, there is a lack of clarity on available budgets or how to access these funds. More guidance for investors should also be developed.

There is a **high risk for low demand for DH networks** connection in Ireland as there is currently no requirement for buildings to connect – a **zoning approach for DH** could address this. In general, there is also a lack of awarness of DH as a viable option – actions on citizen engagement could help to reduce demand risk.

Regulatory improvements

As a pilot project, Dublin designated DH zones and implemented building requirements within these zones, which led to important learnings on the mapping and techno-economic sides.

On the legal framework side, one of the learnings is that an appropriate and detailed legal basis has to be developed which can **reduce misinterpretation and possible loopholes** and, therefore, prevent that buildings are constructed which are not DH-enabled. Further, the **definition of a DH-enabled building** itself could be made clearer.

To reduce demand risk, **zoning for DH** should be established, which would include a requirement for buildings to futureproof for DH. In conjunction, there could be a hierarchy of

low-carbon heating technologies where DH acts as the first priority and a decision not to connect would require proof that a different solution is the better option.

The **Planning Development Act (2000) should be reviewed** to include DH as an utility, such as gas, water pipes, and sewage pipes, to simplify the process for obtaining planning permission. To achieve this, the definition of individuals and entities authorised to provide or carry out works for the provision of district heating could be revised.

National policy relating to DH is currently being developed and it is hoped that a national DH delivery unit will be put in charge for allocating public financing to projects as well as providing technical assistance to smaller local authorities. Heat networks are currently unregulated in Ireland but this is likely to change with the Commission for the Regulation of Utilities (CRU) – currently regulating the electricity, water and gas markets – likely to perform this role as the sector grows.

On the County level, it has to be ensured that heat planning practices are embedded in the planning system (via local authority development plans). Some requirements are already in place on which these could build. Also, waste heat requirements for new and expanding industrial sites need to be identified across all local authority areas.

On the municipal level, energy statement forms for planning consent for buildings should be established. What is more, it needs to be ensured that new or renovated buildings in DH areas are DH-compatible.

Financial instruments

Large amounts of public grant funding to invest in DH infrastructure will be necessary, of which some could come from a renewable heat obligation. Additionally, a fair taxation of gas and other fossil fuels compared with electricity should be implemented to support the uptake and viability of heat pumps. Funding for retrofitting exist at the national level through the Sustainable Energy Authority of Ireland.

Conclusion

Dublin has important plans and strategies in place to support the heating and cooling transition. Moreover, the strategies are linked to spatial planning, exemplified through the Decarbonizing Zones. The energy agency Codema has important capacities in staff, knowledge and experience to guide and implement the transition. A special feature of Dublin is the envisioning of diverse energy sources and an infrastructure that includes low temperature networks in residential areas. The latter are currently seen as the most energy efficient and sustainable option.

Challenges for Dublin include the unclear financing of the H/C transition, the dominance of the gas sector and lack of DH networks, as well as the retrofitting requirements for buildings with the goal to connect to low-temperature networks. Cooling is not highlighted yet in the planning of the transition. Finally, a knowledge gap of the general population remains on the DH option, since participation and the contacting of householders is just about to start.

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DECARB CITY PIPES 2050

Munich

City Report on governance on H/C and potential for change management

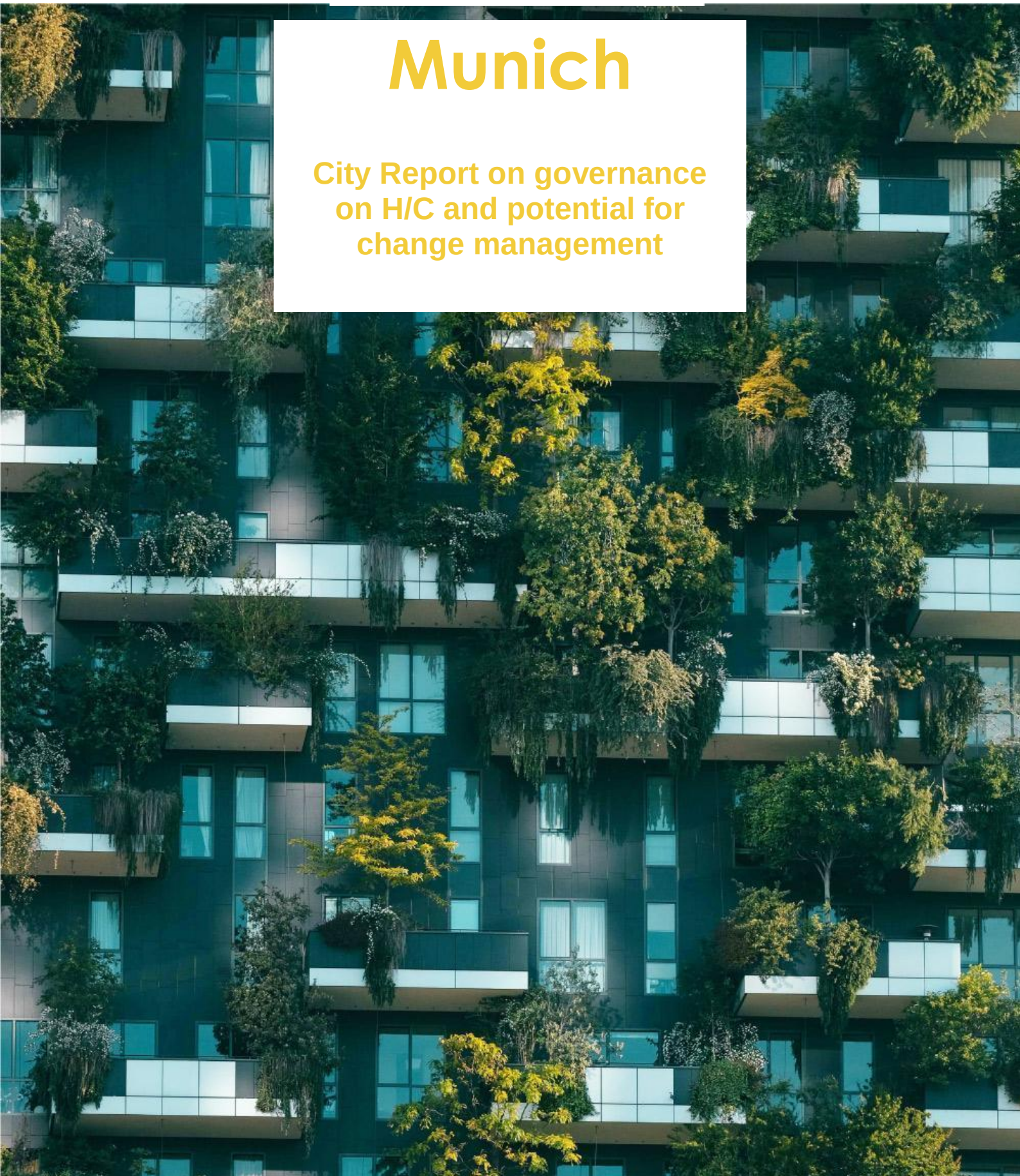

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Table of Content

Introduction & Context

This report presents a comprehensive analysis of Munich planned efforts to decarbonize its urban heating systems. It covers various aspects including the policy landscape, governance structure, and the challenges associated with this endeavor. To provide a contextual background, the initial chapter introduces Munich and provides a brief overview of its Heating and Cooling Outlook until 2035. Subsequently, the following chapter outlines the existing national, regional, and local policy frameworks in place. Additionally, it discusses the governance structures within the municipality and outlines the city's approach to the heating and cooling transition.The third chapter focuses on identifying and addressing the challenges present in the governance system. It also explores potential solutions, including regulatory and financial tools, to overcome these challenges and facilitate the decarbonization process.

Munich, the capital of the state of Bavaria, situated in southern Germany, has seen substantial population growth in recent years. According to the latest estimates, this upward trend, albeit at a marginally reduced pace, is projected to persist in the long term. At the close of 2022 the city had a registered population of 1.56 million residents. Fast forward to 2040, the number of residents, with Munich as their primary or secondary residence, is expected to climb to approximately 1.85 million (Perspective München, 2019). As Germany's third-largest city and the European Union's eleventh-largest, Munich has a rich cultural history and serves as a global nexus for art, science, technology, finance, publishing, culture, innovation, education, business, and tourism. The city, renowned for its high living standards, hosts a plethora of world-class museums, universities, and cultural institutions. Munich's rich history, beautiful architecture, and vibrant cultural scene make it a magnet for tourists worldwide. However, climatic projections for the city are alarming, with average temperatures predicted to rise by about 2.5 °C by 2050 and by 4.0 °C by 2100. Furthermore, by 2050, a marked uptick in summer and heat days is anticipated, accompanied by a discernible drop in cold days (Gondhalekar & Ramsauer, 2017).

The implications of the ongoing geopolitical crisis are significant. Policymakers find themselves in a tight spot, trying to strike a balance between climate action, sustainable development, and managing fuel supply disruptions and price shocks resulting from climate change, Russia's invasion of Ukraine, and the fallout from COVID-19. Europe is grappling with multiple crises, including an economic downturn, soaring inflation rates, and energy supply disruptions stirred up by international armed conflict and the pandemic. Natural gas accounts for about 27% of Germany’s energy mix, and before Russia's war in Ukraine, slightly more than half (55%) of the gas consumed in Germany was sourced from Russia (Oltermann, 2022). Germany's heavy dependence on Russian natural gas and its historically significant imports from Russia have sparked concerns about potential hitches in decarbonization efforts. Some coal plants have even been revived to offset the risk of a Russian energy shutdown. The reliance on Russian natural gas and the competition for liquefied natural gas (LNG) in Asia and Europe have raised concerns about the resilience of energy and heating infrastructure, spotlighting vulnerability. The conflict has also heightened the risk of energy poverty, especially among vulnerable groups, thereby intensifying urban inequalities (Brew, 2022).

Munich´s Heating & Cooling Outlook 2040

Current H/C status quo

The total energy demand for all heated buildings in Munich is 12.2 TWh/a. In 2021, this demand is covered by natural gas, accounting for 57% (7,000 GWh/a); district heating, accounting for 34% (4,200 GWh/a); and oil accounting for 9% (1,050 GWh/a) (Decarbcitypipes2050,2021). No data is available on the use of electric heating or wood, but these sources are projected to contribute very little to the overall demand. In Munich, the majority of the energy demand is for heating residential buildings. This accounts for approximately 70% of the city's overall heat demand. This demand is currently estimated at 6.3 TWh/a. Large apartment buildings, regardless of age of the building, tend to have the highest energy demand, in all categories of construction years.

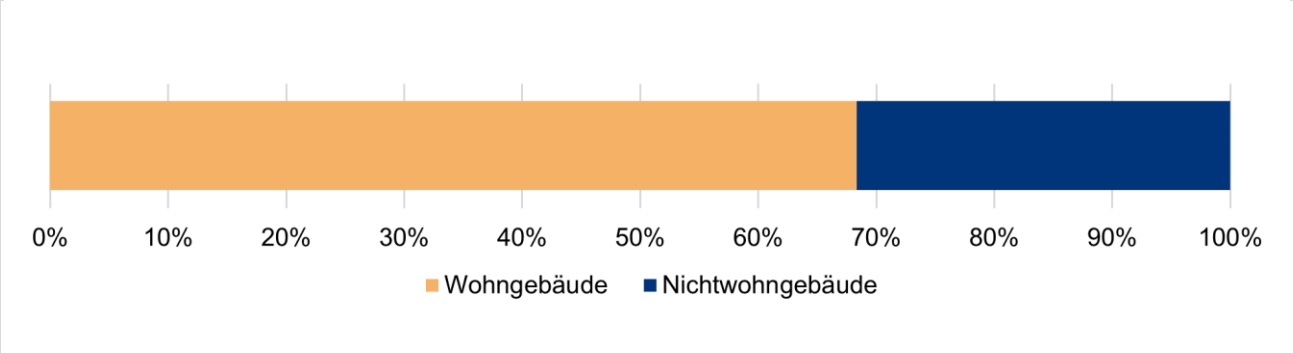

Figure 1: Comparison of heat demand of different building types. Orange: residential, blue: non-residential(Decarbcitypipes2050,2021).

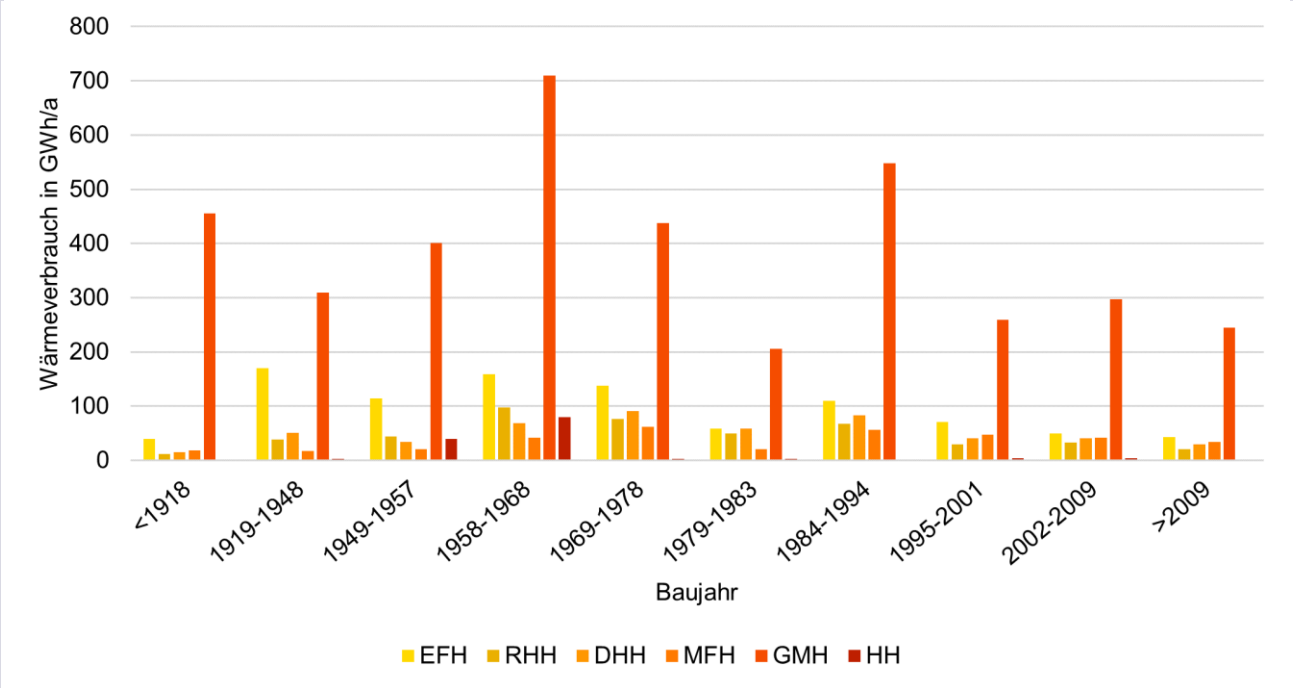

Figure 2: Main residential building types per block (Yellow: Single-family houses; Orange: Semi-detached houses and terraced houses; Red (from light to dark): Apartment buildings, large apartment buildings and high-rise buildings) (Decarbcitypipes2050,2021).

Munich utilizes a diverse energy mix to cater to its heating and electricity requirements. The city boasts six geothermal plants, with the largest one located in Sendling. Other geothermal facilities are situated in Riem and Freiham within Munich's city limits, and Sauerlach, Dürrnhaar, and Kirchstockach in the surrounding region. These geothermal plants play a pivotal role in supplying eco-friendly electricity and heat. Additionally, there are plans to expand the Kirchstockach site and establish a new plant in Munich (SWM, 2022). Munich is also supplied by heat through residual waste of a waste incinerator (around 650.000 tons per year). The incinerator utilizes designs to efficiently co-generate both heat and electrical energy (WTERT,n.d.). Regarding heating power plants, the Freimann facility relies on natural gas, while the Munich-North plant utilizes coal and residual waste. Meanwhile, the Munich-South plant uses natural gas as energy source. In a noteworthy collaborative effort, neighboring communities such as Feldkirchen, Aschheim, and Kirchheim in eastern Munich have jointly established AFK GmbH, the first inter-municipal geothermal energy project in Germany. This initiative has led to the creation of a shared geothermal heating network (Cariaga, 2022).

H/C Outlook

The city of Munich sees itself as a pioneer in achieving climate neutrality. In December 2019, the city council declared a climate emergency and decided that the entire city should become climate neutral by 2035. These ambitious goals were reaffirmed in the coalition agreement for the city council period 2020-2026 (FFE & Öko-institute, 2021 p.11). Nevertheless, the municipal utility (Stadtwerke München, SWM) has set its sights on a less ambitious target. The aim for Munich is to establish a district-heating network powered around two thirds by geothermal energy by 2040. Apart from geothermal energy, heat from residual waste and likely biomass and hydrogen are planned as heat energy sources. These target extends beyond the timeframe set by the city council by an additional five years (Farquharson's, 2016). FFE & Öko-institute have also concluded that the 2035 goal is only feasible if there is made use of climate compensation (2021).

Deep geothermal solutions are the favoured choice for heating sources in the inner city, where various heating sources (such as waste heat) are linked to a district heating network, while in suburban areas, heat pumps, particularly Earth-coupled systems, are expected to be the preferred choice due to their reliability and the favourble conditions for thermal use of groundwaters (shallow geothermal energy). However, despite the preference for Earth-coupled systems, the German market is currently dominated by air heat pumps, making up approximately 85% to 90% of the market share. The popularity of air heat pumps is attributed to their affordability. The widespread use of air-sourced heat pumps may pose challenges, especially during winter when there is increased demand on the electric network. This surge in demand can potentially lead to issues when the heat exchangers of air heat pumps fail, resulting in heavy electrical loads that may even lead to blackouts (Interview 6).

Governance

Germany is a federal nation state. Regarding climate mitigation in the German electricity sector, the primary responsibility lies with national legislation. However, there are also voluntary legislation and measures implemented by the Länder, as well as initiatives undertaken by municipalities, which complement the national efforts. National policies are set by the federal government and can be overridden by state or regional governments if

they are more strict or specific than the national law. This principle is known as "Bundesrecht bricht Landesrecht," which means that federal law takes precedence over state law. If state or regional governments wish to enact stricter measures in certain areas, they are allowed to do so as long as they do not contradict or undermine national laws. In German legislation, several factors significantly enhance the influence of the Länder. Firstly, the Länder have a direct role in the implementation of all national laws related to their financial and administrative matters through the Bundesrat (Hrbek,2004). Secondly, the establishment of renewable power plants and electricity networks relies extensively on the planning frameworks, land use regulations, and nature conservation policies determined by the Länder (Ertl,2010). Lastly, the Länder contribute to the economic advancement of renewable energy sources by providing support for their development.
Munich, as the capital of the state of Bavaria, operates under the laws and policies set by the state government and the city government. The city government of Munich also has some autonomy to create policies that specifically pertain to the municipality.

National policies and Politics of the heating transition

In 2023, the Building Energy Act (Gebäudeenergiegesetz, GEG) to ban new oil and gas heating systems starting from 2024 has been approved at federal level, with the intention of accelerating the adoption of renewable energy sources for heating and reducing dependence on natural gas (Igini,2023). From the beginning of 2024, only heating systems running on at least 65% renewable energy can be newly installed. The law includes exemptions and transition periods for low- and middle-income homeowners, and existing systems can continue to operate. However, specific systems, such as constant temperature boilders, that have been running for 30 years or more must be replaced. Despite efforts aimed at transitioning to renewable energy sources, the Building Energy Act, encountered obstacles and delays due to opposition from a faction within the coalition, namely the Free Democrats (FDP). The FDP expressed concerns about the feasibility, expenses, and integration of new CO2-saving technologies. To find common ground with the FDP, the government strived for a compromise by making significant amendments to the law. One of the key changes involves applying the legislation solely to new buildings in new development areas from January 2024, while delaying its implementation for existing buildings. Also, the Law for Municipal Heat Planning (Wärmeplanungsgesetz) was agreed on as complementing the GEG. According to this law, all municipalities have to issue municipal heating plans; municipalities with a population of 100,000 or more by 30 June 2026 and in smaller municipalities by 30 June 2028. The regulations of the GEG only apply to heating systems in new buildings outside of new development areas and in all existing buildings when the deadlines for the development of municipal heating plans expire. If the municipal heating plan is available before the expiry of these deadlines, the 65% renewable energy obligation applies one month after the municipality's announcement of an area designated for the construction or expansion of a district heating network or as a hydrogen network expansion area. Prior to the amendments and the agreement on the municipal heat plannign law, public opinion polls indicated that a majority of Germans were against the ban, as they feared it may lead to higher heating costs (Nova,2023). A significant number of fossil fuel-based boilers are in operation for 20 years or more, which means that newly installed gas or oil systems are expected to remain in use for a long time (Amelang, 2023).

The EEG 2023, a significant amendment to the Renewable Energy Sources Act (EEG), is aimed at expediting the expansion of renewable energies in Germany. It sets ambitious targets for renewable energy growth, striving to achieve a minimum of 80% electricity generation from renewable sources by 2030. However, the amendment does not extend the same benefits to sustainable heating sources.

Regional policies

The Bavarian State Minister for Economic Affairs, Regional Development, and Energy, Hubert Aiwanger, has introduced the "Bavarian Energy Action Program" as part of the state's energy transition strategy. This comprehensive program consists of 73 specific measures across 13 action areas and aims to provide a renewed momentum to the energy transition in Bavaria. One of the key focuses of the program is the development of deep geothermal energy, along with other renewable energy sources such as hydropower, bioenergy, wind, and solar power. The plan also addresses aspects like grid expansion, energy research, hydrogen technology, and increasing efficiency in the building sector. In terms of geothermal energy, the program aims to enhance the hydrothermal geothermal resources in Bavaria, establish three new transport pipelines by 2029, and support the expansion of district heating systems that utilize geothermal energy. The goal is to meet 25% of Bavarian heat consumption in the housing sector with geothermal energy by 2050. To facilitate implementation, a master plan for geothermal energy is being developed, along with a funding program for geothermal heat networks and research initiatives (Richter,2019).

City policies and targets

Motivated by an environmentally conscious youth movement and a significant proportion of environmentally-focused voters, Munich has set a clear objective to achieve climate neutrality by 2035. Responding to public demand for action, local authorities have been under pressure to expedite efforts towards this goal (interview 3,5). A major focus of the discussion has been the need for a more organized approach to the heating transition, with city authorities taking responsibility and defining clear parameters for different networks. The lack of decisive action among stakeholders has created a challenging predicament, leading to scattered solutions (interview 5).To address citizens' concerns about the district heating network's expansion, especially in light of the Russian gas crisis, the city is actively developing a heatmap. This heatmap aims to visually demonstrate the potential network expansion. Detailed maps of the extension will only be available in 2024. The economic feasibility of the expansion relies on sufficient interest from residents willing to participate. Therefore, the city has to assess potential demand and evaluate the practicality of implementing the heating network in specific areas based on residents' level of interest. This approach ensures a sustainable and viable level of participation that justifies the establishment of the network in selected locations (Interview 3).

Stakeholders

The city administration, composed of twelve departments, plays a crucial role in the design, implementation, communication, and evaluation of urban climate policy. Initially, climate protection within the administration was organized in a network-like manner, primarily through the implementation and development of the Integrated Climate Protection Concept (IHKM). Each department has had decentralized responsibilities, largely carried out autonomously. The Department of Climate and Nature Protection (RKU) and the Department of Urban Planning and Building Regulations have had the most significant weight and tasks related to energy and climate policy. To overcome isolated actions by individual departments, various decision-making and working levels, such as working groups, project groups, and steering committees at the departmental level, have been used for coordination.(Rave & Albrecht-Saavedra,2016). By now, responsibilities are mainly concentrated in the Department for Climate and Nature Protection, e.g., climate budgeting and the prioritization of measures.

Furthermore, cooperative climate policy has been practiced through the institutional coordination form of the "Munich for Climate Protection alliance", particularly between 2007 and 2013. Led by former Deputy Mayor Monatzeder and his deputy from the Department of Health and Environment (the predecessor of the RKU), this alliance involved key actors from various sectors, aiming to achieve higher commitment in and acceptance of climate protection. The alliance also served as a platform for generating new societal knowledge. Key players included businesses like BMW and Siemens, as well as industry associations such as the Chamber of Industry and Commerce. Close connections were established with other actors depending on specific topics or fields of action, such as municipal housing companies in building-related climate protection (Rave & Albrecht-Saavedra,2016). The city also collaborates with the publicly owned SWM, which aims to become independent of third-party energy providers and increase the production of renewable energy. FFE GmbH and Öko-Institut e.V. are important stakeholders in the heating transition in Munich. They collaborated to produce the report titled "Klimaneutrale Wärme München 2035: Mögliche Lösungspfade für eine klimaneutrale Wärmeversorgung in der Landeshauptstadt München" (Climate-Neutral Heat Munich 2035: Possible Solution Paths for Climate-Neutral Heat Supply in the State Capital Munich). SWM commissioned this report to outline the essential measures required for decarbonizing the heating system in Munich.

Munich heatplanning

The key infrastructural priorities for decarbonizing Munich's heating system encompass several aspects. The urban heat planning being developed for Munich, led by a SWM Heat Study in collaboration with FFE and Öko-institute, forms the foundation for this endeavor. To establish a comprehensive planning basis, SWM utilizes fine-grained data sources and the Model Munich, which involves the assessment of suitability areas and scenario calculations. The proposed priorities for decarbonization include various measures. Firstly, deep geothermal energy is intended to provide around two-thirds of the energy generation for the district heating system (DHS). Additionally, decentralized heating solutions are to be implemented, with around 30-35% of energy coming from groundwater heat pumps or air-based heat pumps. Furthermore, the energy refurbishment of buildings plays a crucial role. The aim is to increase the share of district heating in final energy consumption, targeting 50% by 2035 and approximately 70% by 2050. This involves connecting suitable buildings to the existing district heating network, optimizing the network itself (such as converting parts of the steam network to hot water to lower temperatures), and incorporating new renewable generation units for district heating and cooling.

These renewable sources include deep geothermal energy, waste incineration, biomass, waste heat, energy storage, and green hydrogen, although uncertainties exist regarding the specific role of each.To address areas outside the district heating network, the plan focuses on replacing oil and gas boilers with heat pumps and local heat grids. Groundwater heat pumps are particularly favorable due to Munich's high groundwater temperature and level, while local heat grids combine renewable energies and waste heat from sources like heat pumps, solar thermal systems, biomass, and heat storage. Standardizing and scaling locally suitable solutions are important considerations, with a transition period involving hybrid heat pumps that still rely on natural gas for peak load in buildings yet to be refurbished. Finally, reducing energy demand through the energetic refurbishment of buildings, especially older and poorly renovated structures, is a key objective. The plan aims to increase the renovation rate from the current level of around 1% to 2.5% by the mid-2030s. Additionally, the depth of renovations is targeted to align with the German standard EH55, which requires the renovated building to use only 55% of the energy consumed by a similar building according to the 2009 energy code (FFE & Oko-institure, 2021, Interview 1).

Neighborhood approach

Citizen engagement plays a crucial role in Munich's decarbonization efforts. Involving citizens is essential to raise awareness and garner support for the city's climate objectives, while also ensuring an inclusive and equitable transition. This engagement should span various stages, including providing information about heat planning processes, involving citizens in shaping neighborhood transition pathways, and offering financial incentives and support for energy-efficient retrofits. Special attention must be given to protecting vulnerable and marginalized communities from disproportionate impacts during the transition. To achieve these objectives, diverse forms of citizen engagement, such as public consultations, workshops, and information campaigns, are fundamental in building trust and fostering collaboration between citizens and municipal authorities. The neighborhood approach emerges as an integrated strategy that offers several advantages compared to building-by-building or city-wide-only approaches. It enables synergies, cost savings, and the large-scale integration of renewable energies and green infrastructure. The intelligent coupling of electricity and heat markets, as well as reaching critical investment levels, are also possible with this approach. Moreover, the neighborhood approach encourages citizen activation, facilitates coordination of interests, and promotes experimentation with innovative technologies. The process of identifying priority areas for implementing place-based solutions is driven by local stakeholders and aligns with the evolving heat planning system. Objective indicators such as building structure, land use, and dominant heat sources determine the size of priority areas, with adjustments based on ownership structure and alignment with other city planning requirements. It is worth noting that the neighborhood approach does not prescribe a standardized size for these areas (Muenchen, 2021). Interview B1 highlights the importance of an integrated approach in the district-level program, encompassing energy, mobility, and climate adaptation issues. Projects undertaken in various neighborhoods not only contribute to sustainable heating but also ensure price stability. The district approach in Munich focuses on analyzing distinct neighborhood characteristics to identify tailored and effective solutions. This approach is seen as a learning and adaptive process, allowing the city to leverage experiences from different areas to refine and develop its overall strategy (Interview 2).

Example case Riem

Matching the project economics with the financial capabilities of the municipality and meeting the needs of the residents are essential for a heating transition project to work. This principle has been exemplified in several projects implemented in Munich, such as in Riem. Riem, situated on the east side of the city, serves as a remarkable instance of a successful project directly benefiting the Munich region. The district is renowned for hosting the highly acclaimed Munich Exhibition Centre and is home to around 16,000 residents. To cater to their heating needs, Riem relies on a district heating network owned and operated by the SWM. In 2003, the SWM initiated the construction of a geothermal doublet to harness the 94°C heat from the Malm reservoir's thermal water. The project exemplifies the effective use of geothermal heat energy as a consistent power source for a system (Farquharson, 2016, p.192).

Potential for change management

Key challenges

- Capacity Barrier: The demand for competent professionals in energy consultation is high, but some individuals can become energy consultants without prior knowledge or experience, raising concerns about misinformation. Establishing university programs to educate and equip individuals with expertise is proposed as a potential solution (Interview 3, 4, 5).
- Space Constraint Barrier: Limited space in urban areas poses challenges for large-scale geothermal projects. Exploring opportunities outside the city and utilizing existing projects and pipelines are suggested to overcome this obstacle. Spatial constraints also affect individual heat pump installations, requiring cooperation and access to land for successful implementation (Interview 5).
- Information Availability: Transitioning from gas boilers to sustainable heating solutions is hindered by entrenched mindsets and practices. Heating system installers may prioritize recommending gas boilers over other options, leaving consumers ill-informed about alternative choices. The abundance of online advertisements further complicates access to accurate technical information for consumers. Addressing this disparity and ensuring access to reliable technical details is crucial for informed decision-making in heating systems (Interview 6).
- Split Incentive: In rented dwellings, split incentives arise when investors or building owners do not directly benefit financially from renewable energy installations. This poses a challenge, especially in countries with lower rates of homeownership like Germany. The diverse ownership structures in Munich require tailored approaches to address specific challenges for each type of ownership (Interview 1).

Regulatory improvements

The approval process for DHS heating options is often lengthy. In some cases, it can extend up to six months or even a year, leading to missed opportunities and the adoption of alternative choices. One interviewee warns that if the decision-making pace does not accelerate, it could pose a significant challenge for the transition process. To address this issue, the federal association on renewable energies (AGFW, et al., 2022) recommends the implementation of a geothermal development law that prioritizes public interest and safety. Such a law could allocate adequate space for geothermal projects in urban areas. Further, it could streamline the approval process through parrallelizing individual permits and binding procedural deadlines. Moreover, it could simplify procedures such as the standardization of approval requirements, including environmental impact assessments (EIA) and nature conservation. SWM and AGFW also recommend federal subsidies to mitigate financial risks associated with geothermal projects, e.g., geothermal energy for individual measures could be incorporated into the subsidy scheme Federal Funding for Efficient Heating Networks. To improve decision-making, the collection of geological data is emphasized. Further levers for geothermal energy are identified in simplifications of public procurement processes, improvements in the acceptance of geothermal projects, and the need for increased training and education for specialists in geothermal energy (AGFW, et al., 2022).

Financial instruments

Government support in the form of financial incentives, like tax credits, loans, and subsidies, can be crucial in overcoming the barrier of high upfront costs for renewable energy systems. For example, Germany's Market Incentive Programme allocated EUR 300 million per year for small-scale renewable heat systems, leading to over 1.8 million installations between 2000 and 2020 (IRENA,2020). Munich promotes heat pump adoption through subsidy programs like the Funding Program for Climate Neutral Buildings (FKG), which covers up to 25% of costs. Additionally, the Federal Funding for Efficient Buildings (BEG) program at the federal level offers 15% of subsidies. Combined subsidies can cover up to 55% of total costs (Stadtwerke München, n.d). The German government has launched the program Federal Funding for Efficient Heating Networks (BEW), mentioned above, a €3 billion funding program to support the transition of district heating systems to renewable energy sources, aiming to have at least 75% of heat supplied by geothermal, solar, and heat pump technologies. The initiative also focuses on decarbonizing existing networks and promoting efficient heat distribution. The program will cover feasibility studies, investments, and operating costs for renewable heat generation projects, with a maximum of 40% of investment costs supported (BMWK,2022).

The recent announcement by the Economics and Energy Minister of Bavaria, regarding a budget allocation of €10 million for geothermal research, has sparked critique regarding the low investment in the heating transition. Despite the state's overall investment of €500 million in renewable energy and hydrogen production projects, the allocated amount for biomass initiatives (€10 million) and geothermal research is combined only €20 million (Cariaga, 2022).

Several suggestions have been made for financial instruments at different levels. At the EU level, it is recommended to explore the Sustainable Europe Investment Plan, which provides funding for municipalities' heating transitions. The Renovation Wave Strategy is specifically highlighted for enhancing energy efficiency in buildings. Additionally, EU advisory services like Urbis, JASPERS, and ELENA can assist in navigating funding options and obtaining support for strategic planning and technical assistance related to renewable energy investments. Urbis is an urban advisory platform within the European Investment Advisory Hub, JASPERS (Joint Assistance to Support Projects in European RegionS) a major joint policy initiative of the EIB, European Commission (DG REGIO) and the European Bank for Reconstruction and Development (EBRD), and ELENA (European Local Energy Assistance) an advisory service of the European Investment Bank. At the national and federal level, there are funding programs available for heating transitions such as from the Federal Ministry for Economic Affairs and Energy, the Federal Office for Economic Affairs and Export Control (BAFA), and the German investment bank KfW. It is crucial to ensure proper market organization and regulations for the heat market to prevent inequalities in energy supply and cost distribution. In Bavaria, there are additional funding options like *EnergieBonus Bayern*, *Bayerisches Modernisierungsprogramm* (BayModR), and KommKlimaFöR. On the municipal level, strategic partnerships among local administrations are recommended to leverage existing knowledge and instruments, particularly when dealing with the trade-offs associated with financing programs for municipalities. Furthermore, personalized funding advisory and energy consulting services should be promoted for individuals, companies, and associations. Considering the co-benefits of the heating transition is essential, such as economic development, job opportunities, and tax revenue. It is also suggested to utilize ex post evaluation results systematically to enhance the effectiveness of existing policies and measures (Michaelsen et al., 2021).

Conclusion

In conclusion, Munich's Heating & Cooling Outlook 2035 showcases the city's commitment to becoming a pioneer in achieving climate neutrality and establishing a geothermal-powered district-heating network. Stadtwerke Munich (SWM) has set the target for a geothermal-powered district-heating network by 2040. By setting ambitious targets and pursuing innovative solutions, Munich aims to lead by example and inspire other European cities to transition to sustainable and renewable heating systems. Recognizing the potential of geothermal energy, Munich is focusing on establishing a district-heating network powered by this renewable energy source. Geothermal energy offers a sustainable and low-carbon option for heating, aligning with the city's objective of decarbonizing its heating system. Investing in geothermal energy presents a significant financial opportunity for Munich, with long-term cost advantages and reduced reliance on expensive fossil fuel imports. However, there are challenges to implementing these plans, such as high upfront costs, planning and permitting requirements, limited space for heating infrastructure, and a shortage of standardized solutions and skilled craftsmen for decentralized heating.

The current H/C demand in Munich highlights the significant energy demand for heating residential buildings, emphasizing the need for decarbonization efforts. Retrofitting a large number of buildings is essential to meet the city's emissions reduction target, indicating the scale of the challenge ahead. Financial instruments are crucial in facilitating the transition to energy-efficient and renewable heating systems. While subsidy programs exist, the overall costs remain high, particularly for older buildings requiring additional renovations. Exploring EU and national funding programs, leveraging existing funding options, and promoting personalized funding advisory services are essential steps,towards higher retrofitting rates.

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Interviewee	Date	City	Role
1	29-07-2022	Munich	Environmental Policy Specialist
2	11-03-2022	Munich	Urban Development Consultant
3	08-05-2023	Munich	Environmental Division Munich
4	09-05-2023	Munich	Sustainable Energy Company CEO
5	10-05-2023	Munich	Heating Systems Expert
6	12-05-2023	Munich	Energy Researcher

The roles of the interviewees have been anonymized to prioritize data privacy and confidentiality. By removing specific details that could potentially identify the individuals, it aims to safeguard their personal information and maintain their anonymity. Anonymization ensures that no sensitive data about the interviewees' professional roles can be linked back to their real identities, thus protecting their privacy and preventing any potential misuse of the data.

DECARB CITY PIPES 2050

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DECARB CITY PIPES 2050

Rotterdam

City Report on the governance of heating and cooling and the potential for change management

AUTHORS
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Table of Content

Introduction & Context

This city report provides an overview of the policy context and governance situation in Rotterdam regarding the decarbonisation of urban heating systems.

To establish the context, the first chapter provides a recap of Rotterdam's Heating and Cooling (H/C) Outlook until 2050 and its H/C Plans. The second chapter gives an overview of the existing national, regional and local policy framework as well as an overview of the governance structures within the municipality and the process through which the city aims to tackle the H/C transition. The third chapter highlights challenges in the aforementioned governance system and strives to provide solutions to address them, notably also through regulatory and financial tools and improvements.

As of 2022, Rotterdam has a population of 655,468 inhabitants, and it has the largest port in Europe. The present port industry is mainly fossil-based and energy intensive, producing a huge amount of residual heat. Situated in the greater Rhine delta, one-third of Rotterdam's surface is water. Like many cities around the world, Rotterdam is facing the effects of climate change and urbanization (Decarb City Pipes 2050, 2022a).

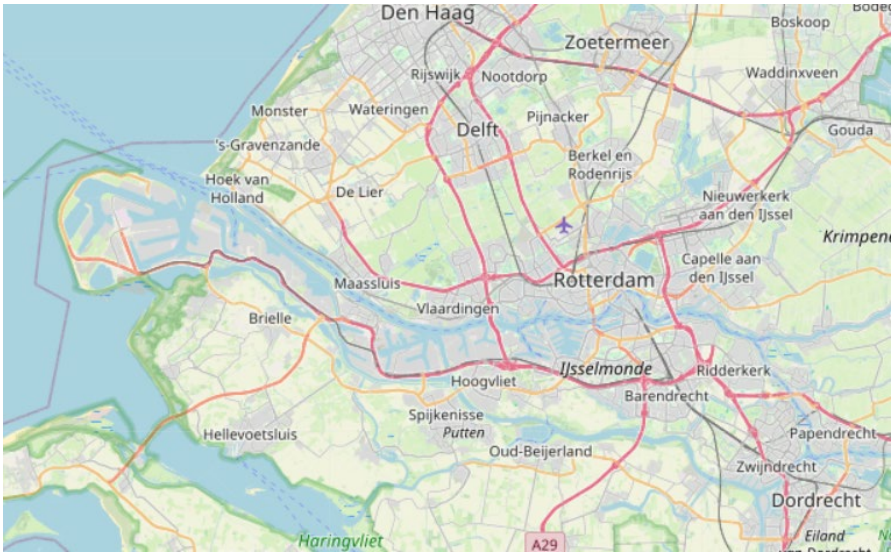


FIGURE 1: MAP OF THE CITY OF ROTTERDAM (SOURCE: OPENSTREETMAP)

Rotterdam's H/C Status Quo

The buildings sector is responsible for one third of Rotterdam's CO_2 emissions in the city. Fossil gas covers around two thirds of Rotterdam's heat supply with 66% of gas boilers for space heating and domestic hot water. The district heating (DH) network supplies 29% of connections. Individual systems (both fossil and renewable, such as electric heating or heat pumps) only cover a small fraction (5%).

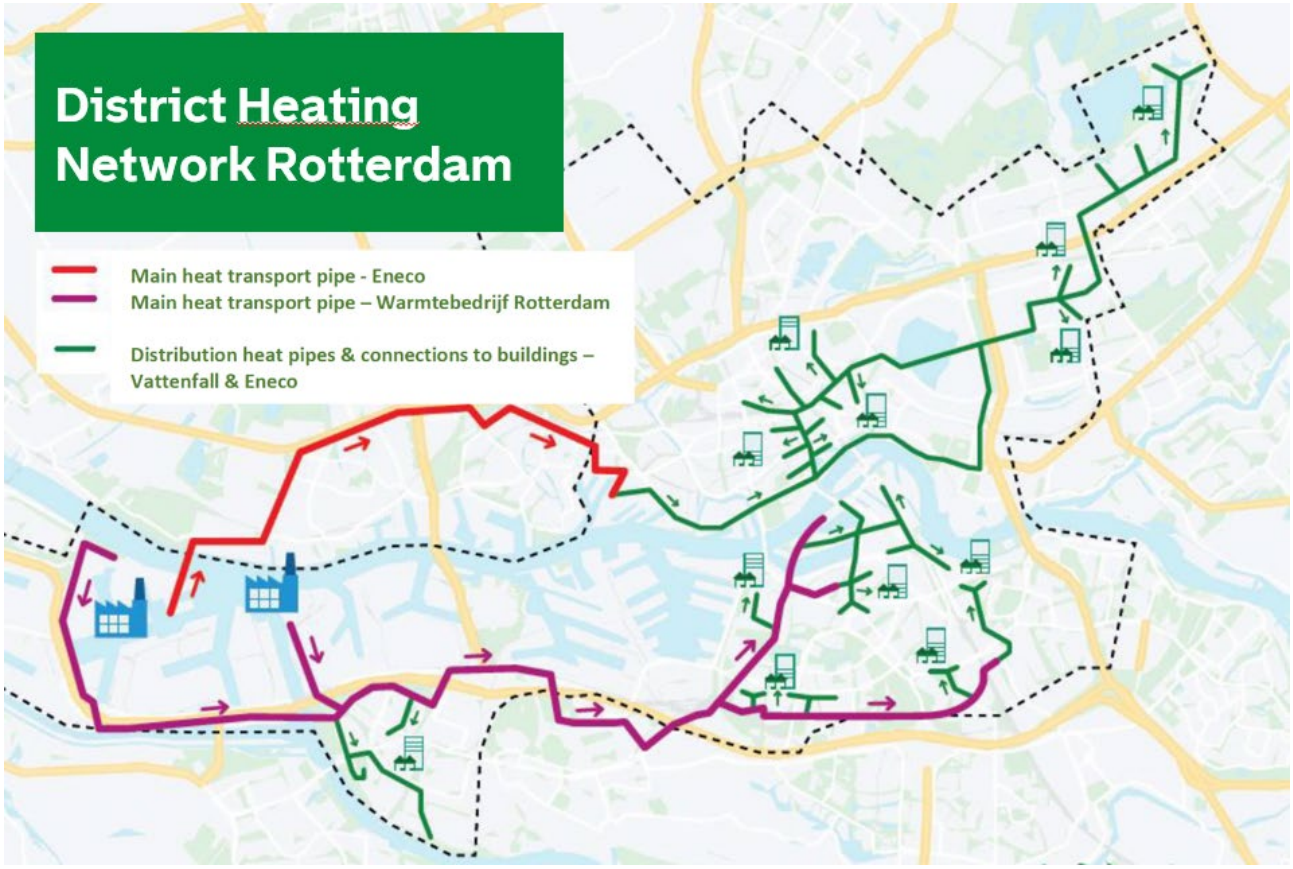


FIGURE 2: CURRENT ENERGY INFRASTRUCTURES FOR DISTRICT HEATING (SOURCE: ROTTERDAM HEATING AND COOLING PLAN 2022A)

The city has moderate building density and, subsequently, moderate heat density. Rotterdam has 255,000 connections to the natural gas grid. On the other hand, around 55,000 buildings, or one-fifth, in Rotterdam are connected to the DH network. The high-temperature DH network has been in place since the 1950s, is privately owned and primarily supplied by waste heat from the port. Post-war, in the 1950s, new district heating systems (DHS) were built using combined heat and power systems (CHP) on natural gas. The 1970s oil crisis, coupled with new regulations, prompted DHS to be built in new areas of the city. Since 2010, two transport pipelines have connected the city's waste incinerator to these DHS and the networks have again expanded. There are few low-temperature heat networks.

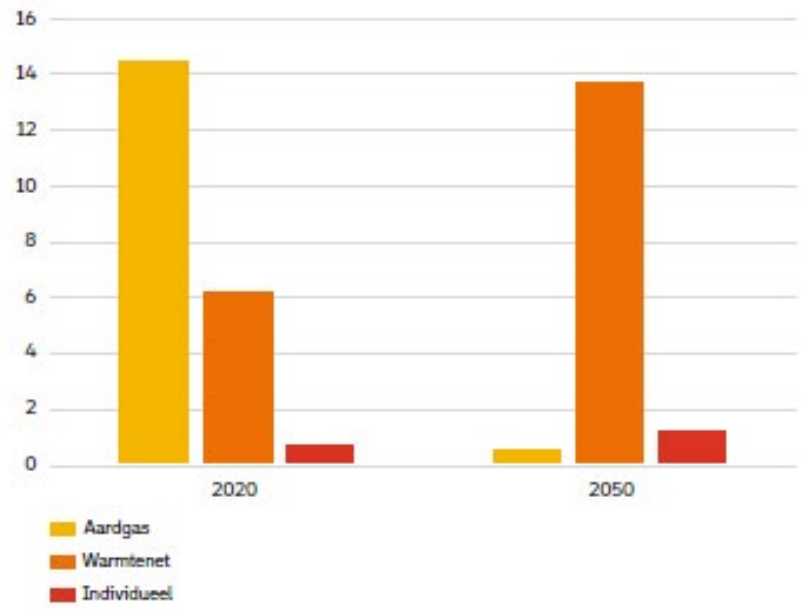
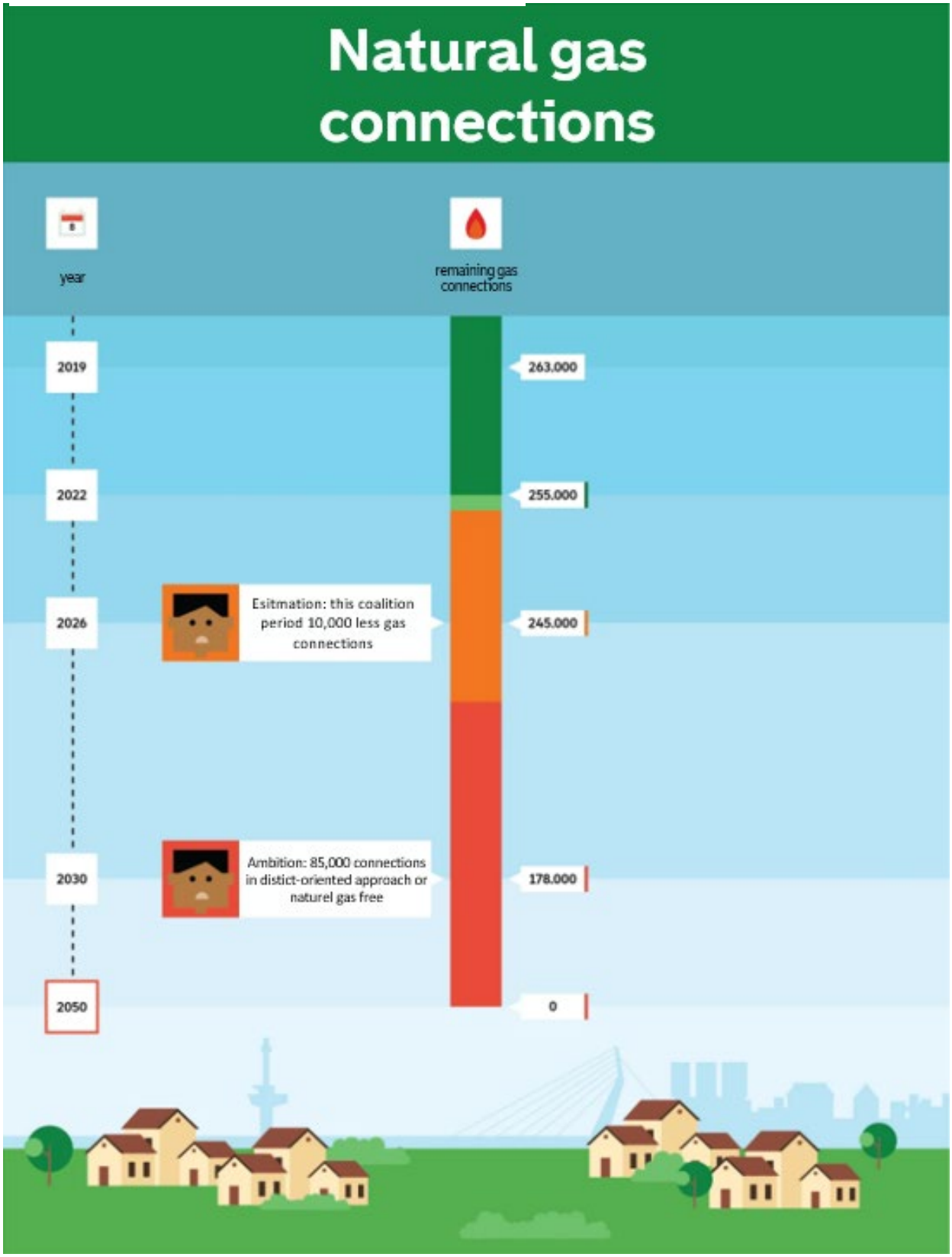


FIGURE 3: HEAT SUPPLY [IN PJ]: YELLOW: NATURAL GAS; ORANGE: DISTRICT HEATING NETWORK; RED: INDIVIDUAL SOLUTIONS
(SOURCE: ROTTERDAM CITY QUESTIONNAIRE 2022B)

FIGURE 4: OVERVIEW NATURAL GAS CONNECTIONS
(SOURCE: CLIMATE ACTION PLAN ROTTERDAM 2023)



Rotterdam's H/C Outlook 2040

Rotterdam aims to achieve climate-neutrality and, specifically, natural-gas-free heating by 2050, while simultaneously working towards sustainable energy supply overall and a smart, just, and resilient energy system.

Figure 5 and Figure 6 indicate Rotterdam's current and projected energy demand based on application, and also highlight how the current energy mix will evolve between today and 2030 and 2050, respectively.

According to its Heating and Cooling Outlook, as more buildings become natural gas-free, the collective demand for heat is set to increase, notably for the port and for industrial activity (see Figure 5). Because of the availability, affordability and low CO_2 emissions, **industrial residual heat** (from waste, electrolysis, industrial processes) **has great potential for supplying energy** to the heating network, but also to industrial steam networks.

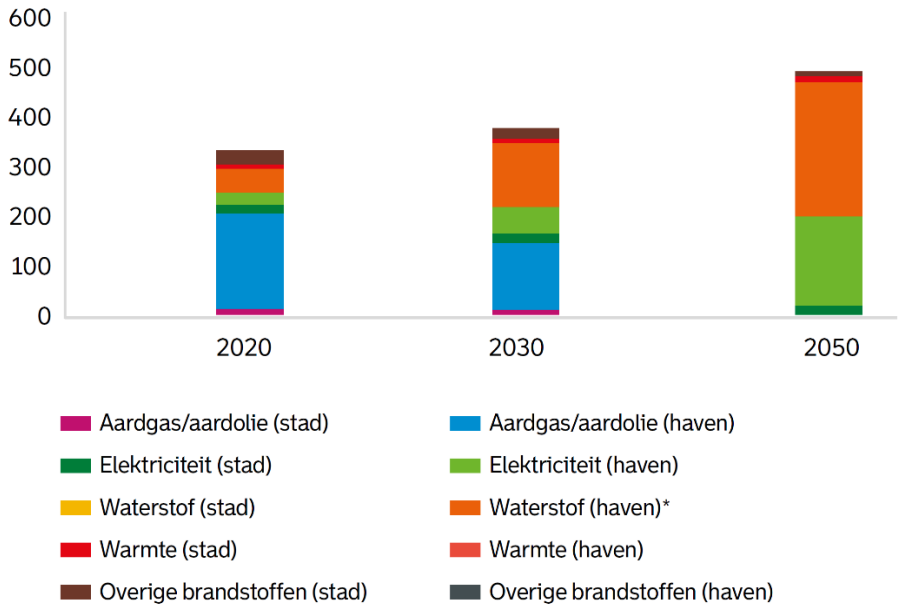


FIGURE 5: CURRENT AND PROJECTED ENERGY MIX IN ROTTERDAM (IN PJ) (SOURCE: ROTTERDAM ENERGY SYSTEM VISION 2021A)

Otherwise, (low-temperature) sources such as geothermal energy, aquathermy and urban residual heat (from data centres, small industries, etc.) can supply sustainable heat to the city, although the potential is smaller than for industrial residual heat and associated CO_2 emissions and costs are higher and the spatial impact in the city is often greater.

While alternative gases – such as hydrogen and biogas – can also serve as fuel for heat, their availability will be limited in the short term. High prices will make them an unviable alternative to natural gas for heating homes and the city aims to use high quality energy for high temperature processes. Rotterdam prefers to use them as a fuel for industrial heat,

heavy and long-distance transport, energy storage and grid stability where alternative options are scarce. Indirectly, the combustion of sustainable gases in industry will nevertheless produce residual heat for heat networks.

Total heating demand is expected to decrease in the future due to energy savings, i.e. through insulation and refurbishments. Building renovations also provide increased living comfort, health standards and the possibility of using heat sources and heating networks more efficiently. In buildings with good insulation, the temperature of the heat supplied can be lowered, allowing a greater diversity of heat sources to be used. Reducing the demand for heat is an important part of the heating transition.

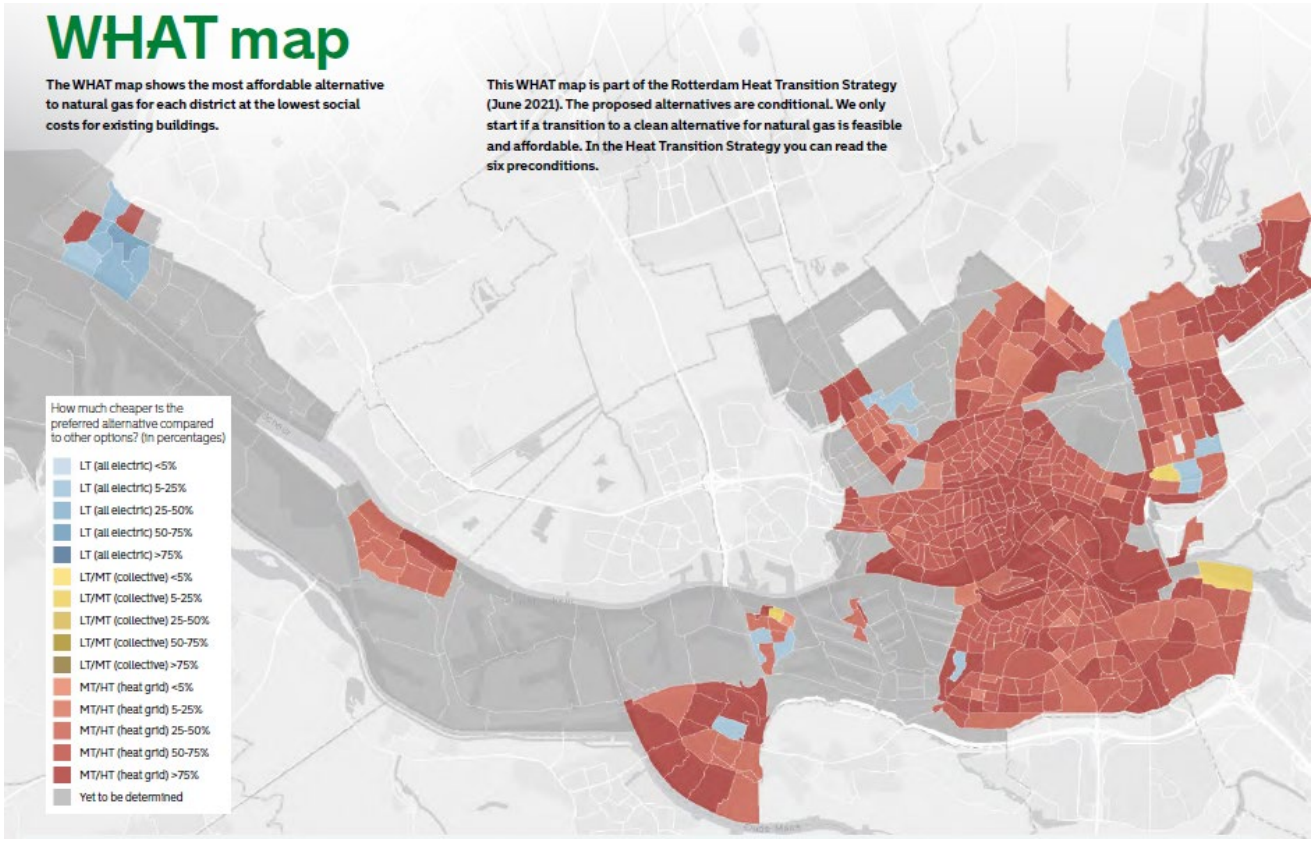


FIGURE 3: ROTTERDAM'S WHAT MAP (SOURCE: ROTTERDAM HEAT TRANSITION VISION 2021B)

In its H/C Plans, Rotterdam first established the **WHAT map**, showing the most affordable alternative to natural gas for each district at the lowest social costs for existing buildings. It outlines a long(er)-term strategy for potential solutions in various districts, but it does not take a definitive decision on a particular type of solution, but rather provides a starting point for district-oriented approach. The suitability of an alternative may vary from area to area and may change as a result of technological developments. The WHAT map finds that a **high or medium temperature heating network is the alternative with the lowest social costs for more than 85 percent of the city**.

For buildings where a HT or MT heating network is not the most viable alternative, the municipality will look at individual solutions, such as all-electric or hybrid heat pumps, a local LT heating network with appropriate sources or ground-coupled heat exchanger (GCHE) systems, which can also supply cooling.

All electric heat pumps as individual solutions are found to be relatively expensive as most existing houses in Rotterdam will need to be heavily insulated for this type of heating system. The WHAT map shows, which solution is preferred based on a detailed total costs calculation.

Not all alternative energy sources have the same potential at every location, are accessible or can be spatially accommodated, or are equally sustainable and affordable. For example, geothermal energy and TES require a lot of space and the proximity between the source and the customer. In addition, heat demand density, the housing stock and thus, for example, the desired temperature must be taken into account.

To use heat as efficiently and sustainably as possible, it is important to **match heat supply and demand**. For example, HT heat should be used in poorly insulated buildings, while LT heat should be reserved for buildings that are well insulated.

The source must also fit into the mix to **guarantee a resilient heating network**. Customisation of the ideal source mix is therefore necessary for each district/area. Here, peak and backup sources in the source mix are indispensable. While residual heat and gas-fired boilers currently provide the peak and backup supply, in a gas-free heating system, an alternative is needed, such as heat buffers or storage, green gas or hydrogen. As affordable sustainable heat sources available on a large scale that can meet peak demand are currently scarce and need to be developed and expanded. Another solution is to limit the peak with the help of smart delivery systems.

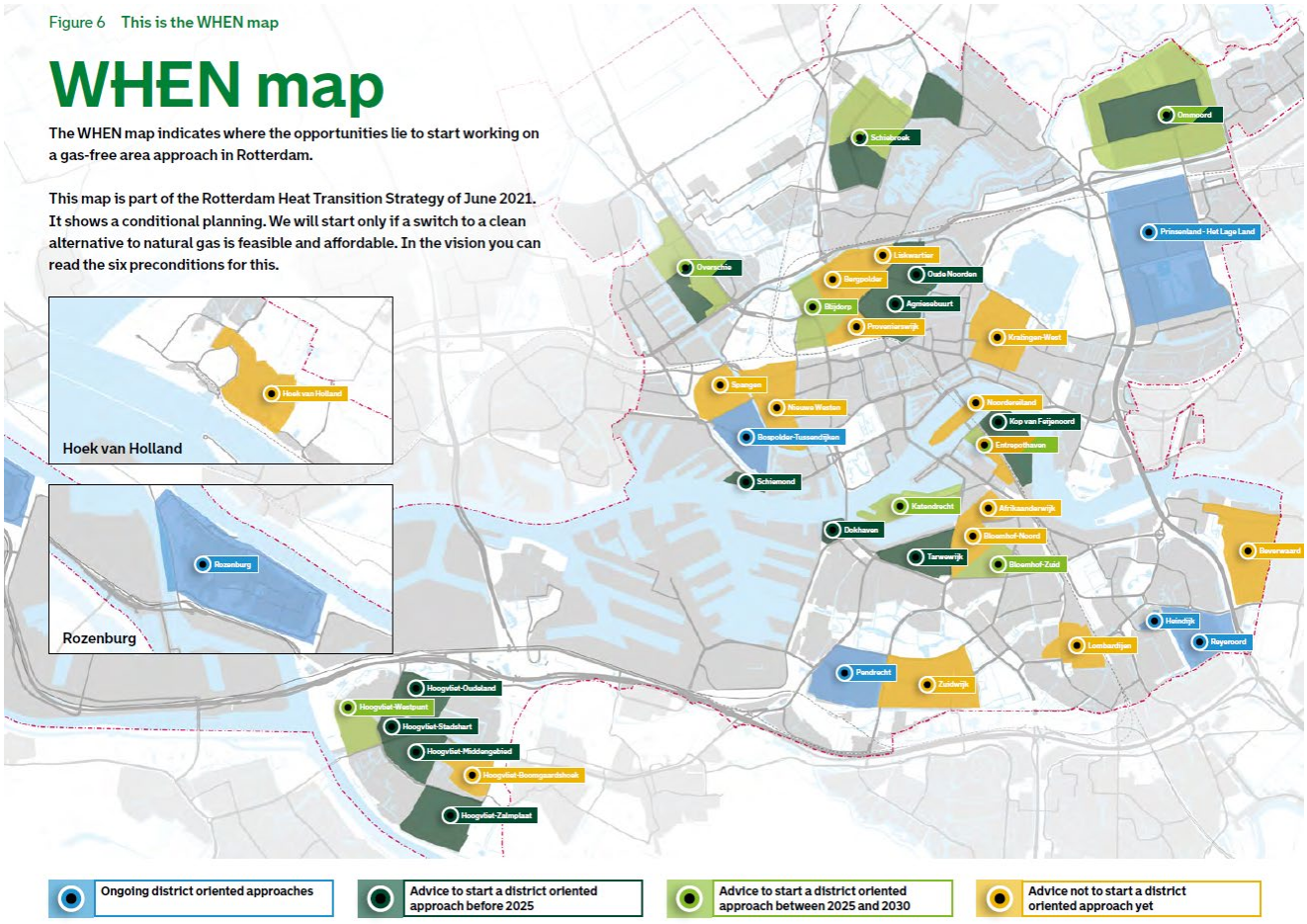


FIGURE 4: ROTTERDAM'S WHEN MAP (SOURCE: ROTTERDAM HEAT TRANSITION VISION 2021B)

In connection with the WHAT map, the **WHEN map** gives more specific timeframes and conditional heat planning for promising districts. The municipality started with a district-oriented approach in six districts. Specifically, fourteen districts were identified where the switch to natural gas-free heating through a district-oriented approach is possible called exploration districts. There are six preconditions that can influence this planning to start in those fourteen districts:

1. Compensation for implementation costs and sufficient implementation capacity of the municipality;
2. Sufficient investment and implementation funds as well as sufficient implementation capacity of housing corporations*;
3. Solutions for the unprofitable portion and pre-financing of the construction of collective heat solutions;
4. Additional financing and subsidies for private individuals, tenants and home owners associations;
5. Sufficient powers for municipalities in terms of legislation and regulations; and
6. (Im-)possibilities in spatial planning.

Due to the heating transition, the demand for collective heating is rising sharply and is given considerable technical, organisational and legal attention. Less attention is paid to the expected increase in demand for cooling, although this will also require changes to the city's energy system. The final energy demand for cooling is estimated at 390 GWh in 2050 (Decarb Transition Roadmaps).

There are various technical solutions for meeting the increased demand for cooling. As with heating, the first step is to reduce the demand, including through sun blinds, green-blue roofs or greening the city. Sustainable cooling can be generated by means of a heat pump, cooling from the ground or surface water stored in a GCHE or distributed via a collective cooling network. The last two technical solutions are already being applied in Rotterdam. The use of air conditioning should be minimised because of the negative impact it has on the environment by heating it up, producing noise and the increasing demand for electricity.

Governance of the H/C transition

Legal Framework: Policies

National/federal policies, strategies & targets

The Netherlands' national GHG emission reduction targets, set in the **Dutch Climate Act**, are -49% by 2030 and -95% emissions by 2050. In the national coalition agreement 2021-2025, the updated European target of -55% emissions until 2030 was adopted (Government, 2021).

Local authorities are, according to the Dutch Climate Act, designated the managers of the heating transition for the built environment. Promoting a multi-stakeholder and citizen participation process – involving property owners, housing associations, residents and residents' initiatives such as energy cooperatives, network managers and other public authorities –, municipalities were required to establish a **Transitievisie Warmte (TVW, "heating transition vision")** before the end of 2021 (see below).

The "New Heat Law", currently in elaboration, is the large-scale revision of the Heat Act of 2014. It consists of four themes, namely: market regulation, tariff regulation, sustainability, and security of supply. A central proposition is that heat infrastructure should go into public hands. In consequence, municipalities must therefore always ensure that the infrastructure for the heat supply is mainly in public hands. According to the Minister, public-private partnerships are possible, if a public party has decisive say in the DH company (infrastructure and supply).

In addition to the new Heat Law, the upcoming **Municipal Instruments for the Heat Transition Act (WGIW)** will, inter alia, give municipalities the deciding power to designate areas of the city to close off the gas network and to issue heat plots (Ministerie, n.d.).

Since July 2018, at a national level, all new construction is to be built without a gas connection, which was enacted by a change in the Gas Act.

Regional policies, strategies plans & targets

The Netherlands is divided into 30 energy regions implementing the provisions from the National Climate Agreement. The Regional Energy Strategy (RES) is established for each energy region and maps out local and regional opportunities, conditions and coherence between infrastructures. The organisational structure in charge of the elaboration of the RES is made up of administrative staff and officials from the involved municipalities guided by a project team and involving a stakeholder platform. The strategy's heat chapter defines the heat demand for the region as well as the potential heat sources and networks that require inter-municipal cooperation. In the context of heat supply, it examines how and where heat availability in the region can cover local heat demands. In the energy region Rotterdam-The Hague, Rotterdam has a special role, because it has an abundant amount of potential residual heat supply through the port. A corresponding scenario study and feasibility study by Gasunie for a provincial heat transport network show that the local heat vision is dependent on, among other things, the current and future heat availability in the entire region, while regional infrastructure is, in turn, dependent on the local heat demand, creating a mutual dependence.

The regional energy strategy (RES) for the energy region Rotterdam-The Hague also aims at savings of 20% or more energy in the built environment for heat systems through the use of available residual and geothermal heat in a future-proof energy mix. (RES Rotterdam Den Haag, 2021)

City policies, strategies, plans & targets

Rotterdam wants to be natural gas-free and climate neutral by 2050 in line with the national Climate Agreement. Following the Dutch Climate Agreement, local authorities were responsible for establishing their strategic Heating Transition Vision (TVW) in 2021. The vision

describes the goals of the municipality for the heating transition, how the plans will be achieved (particularly through using residual heat from the port using a district heating network and geothermal energy sources), the involvement of relevant stakeholders, and finally how and when the vision will be implemented, particularly using district-oriented approaches implemented at different stages. When the Wgiw will be implemented local authorities (municipalities) are responsible to establish a Heating Program (follow up from the TVW) every five years starting from 2026.

Rotterdam's Heat Transition Vision (RTVW), established in June 2021, focuses on minimising total social costs when selecting neighbourhoods and planning the transition. Through the Decarb City Pipes project, the municipality aims to initiate, facilitate and coordinate collaboration with stakeholders. (Gemeente, 2021b)

Process of H/C planning in the city and stakeholders involved

The Department for Sustainability, subordinated to the department for Urban Development, is responsible for planning the H/C transition in Rotterdam. It comprises 80 people in total, with around 20 people working on the heat transition. It has no continuous funding. In addition, colleagues outside this department also work in the heat transition, for example from spatial planning and engineering.

The process in which stakeholders are brought on board to negotiate and agree on decisions is a distinct feature of Rotterdam's process and can be characterised as highly participative and successful. At the earliest stage, homeowners, housing cooperations, grid providers, and utilities are brought together to collaborate and negotiate decisions. This could serve as an inspiration to other cities that seek to learn from Rotterdam's approach to stakeholder involvement.

The Local Working Group (LWG) on the heating transition established in the context of the Decarb City Pipes Project consists of a smaller inner circle of city administration staff in the Sustainability Department which works on three different levels, namely the strategic (Energy System Vision), tactical (City transition vision for Heating) and operational level (district-oriented projects).

Further, the LWG has regular contact with external parties to collect input and expertise or to disseminate information for the Decarb City Pipes project. In this outer circle, DH companies, distribution system operators and the Regional Energy Strategy group contribute to the strategic level, while housing cooperations as well as house owners and citizens support the work of the tactical and operational levels, respectively.

Politics of heating transition

Rotterdam's overall strategy covers three key aspects: **exploring energy potentials**, **creating an efficient and integrated energy system** and **focusing on cost efficiency** where all costs including social costs are accounted for. All heat potentials (mainly from waste heat and geo- and aquathermal sources) should be explored and corresponding investments into heat networks are essential to capture this potential. Achieving system efficiency uses a combination of avoiding energy losses, re-using energy, using high value energy in a high

value way and balancing the system through storage and smart integration. The cost efficiency is addressed through the WHAT map, where for different heat plots across the city, the most cost-efficient sustainable heating solutions are selected based on local conditions such as e.g. building density and heat and infrastructure availability.

Finally, the city's WHEN map designates specific districts, where sustainable heating solutions are implemented with great attention to local conditions, called the "**District-oriented approach**". This approach helps alleviate the major changes caused by transitioning away from natural gas and allows to bundle forces, lower and/or share (social) costs, limit disruptions and keep the city accessible. It is also an opportunity to improve the living environment of residents: at the same time as the heat transition, Rotterdam also tackles other issues, such as flooding, improving the outdoor space and creating jobs.

The district-oriented approaches target all buildings in the assigned districts including buildings owned by housing corporations and private homeowners. It is divided into 10 consecutive steps from district analysis to implementation, and has three parallel work tracks focusing on the spatial planning, financial and technical, and social/societal dimensions. Steps are adapted depending on local circumstances (see Figure 6).

Rotterdam started with six district-oriented approaches in five districts in 2018: Groot-IJsselmonde (Heindijk and Reyeroord), Pendrecht, Rozenburg, Bospolder-Tussendijken and Prinsenland-Het Lage Land, deliberately choosing very different districts in order to maximise learning opportunities.

Based on these initial experiences, in April 2019 the city drew up guidelines for the district-oriented approach that are continuously refined, also incorporating changing national instruments and preconditions. The ultimate goal is to learn from and roll out the district-oriented approaches.

On **concessions**, the responsible department is dealing mostly with the heating companies Vattenfall and Eneco, which are the two main heat providers in Rotterdam. Furthermore, it is also staying in close exchange with housing and owner associations. A special team responsible for the district-oriented approaches is in direct contact with the people of Rotterdam.

The upcoming Municipal Instruments for the Heat Transition Act (WGIW) is set to give municipalities the deciding power to designate areas of the city where they can close off the gas network and issue heat plots.

For new buildings in around 65 districts, **concessions** have been granted to heat companies, who are then responsible for the construction, management and operation of a heat network and selected by means of a tendering process.

The local government recognizes that it cannot achieve the energy transition on its own: The local authority launched the Rotterdam Climate Alliance at the beginning of 2019 which is a partnership with more than 100 companies and civil organizations whose main task was to create the Rotterdam Climate Agreement (Energieswitch, 2019).

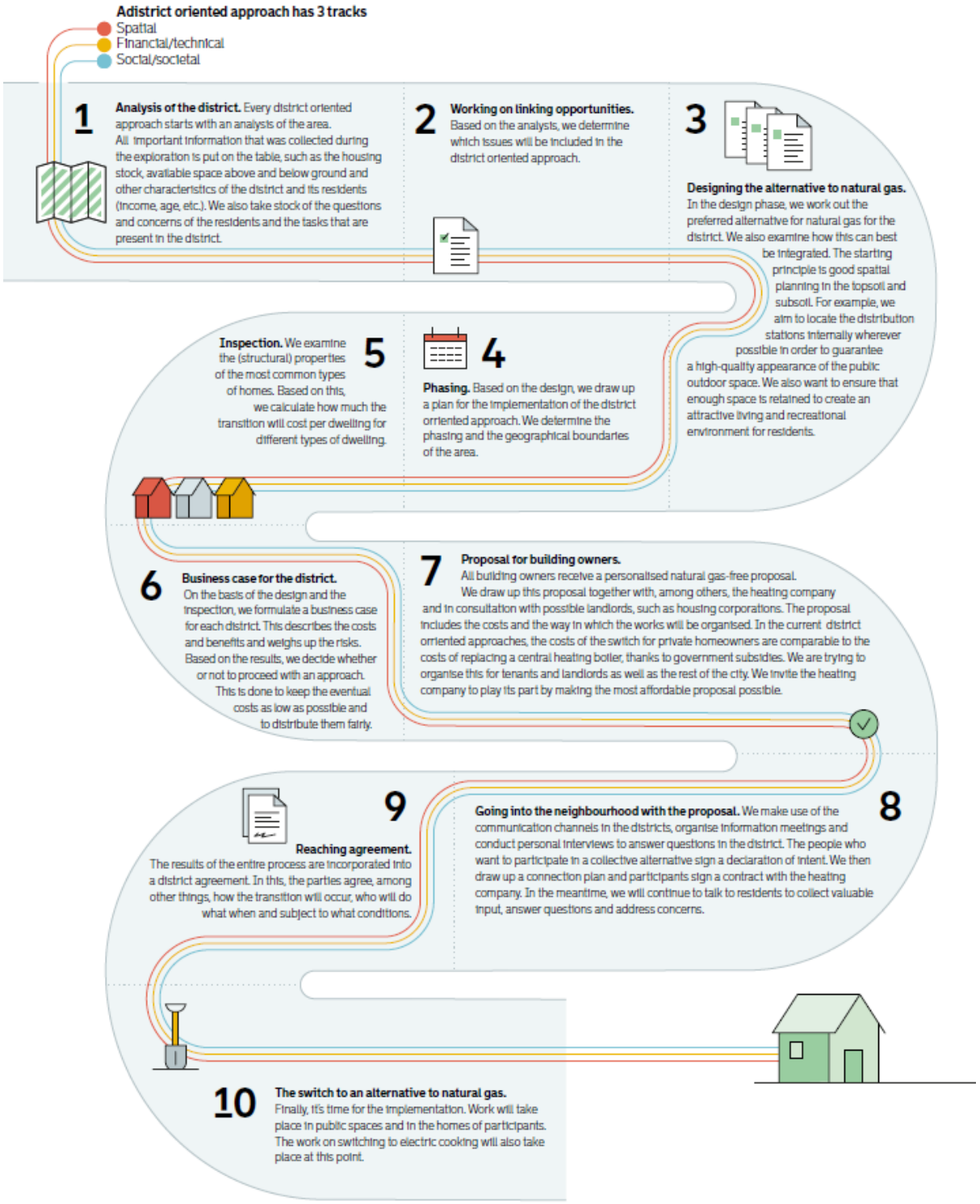


FIGURE 5: THE DISTRICT-ORIENTED APPROACH (SOURCE: ROTTERDAM HEAT TRANSITION VISION 2021B)

Potential for Change Management

Priority urban governance challenges & how to address them

Political commitment is an important issue in Rotterdam. The College of mayor and aldermen wants to wait with district-oriented approaches until funding is assured from the national government. Nevertheless, the current district-oriented approaches that have been started already will be completed.

The **supply of materials, skills, and labour** for the decarbonisation of urban heating systems in Rotterdam can be characterised as a challenge. Currently, speeding up the transition is difficult, even though technology, knowledge, and even energy are available. On the other hand, a lack of transparency, high upfront costs, and relatively low return on investment, combined with high risks, lead to a delay in the realisation of new, much-needed energy systems such as district heating. These barriers hinder the ability to equally share the cost and benefits of the transition and prevent a just approach where affordability, reliability, and sustainability are guaranteed for all citizens.

Specifically, district heating systems are confronted with high upfront costs and long payback periods, resulting in high costs for end users.

A main challenge that remains for the heat transition is affordability **homeowners.** The affordability principle of the Climate Agreement and the requirement for the transition to be 'living cost neutral' for households pose a significant challenge as the financial benefits of natural-gas-free housing often do not outweigh the costs as yet, and not all external costs are currently internalised. District heating suppliers can act as a monopoly whereby district heating can be more expensive than gas. Additionally, the cost of installing alternative heating solutions, such as heat pumps, can require substantial investment costs. Whilst Rotterdam municipality was able to take advantage of the Dutch 'Natural Gas-Free Neighbourhoods' programme for funding and provided additional local subsidies for households of the pilot gas-free neighbourhoods for installation, "it remains to be seen if innovation and scale size will reduce market costs enough to make the heat transition 'cost neutral'".

In addition, energy prices are expected to rise further, requiring even more efforts to keep the energy system affordable. As a municipality, Rotterdam is deploying its resources and instruments, and investigating necessary interventions to ensure citizen participation, to prevent energy poverty and to support energy-related investments in homes.

Conclusion

The city of Rotterdam has adopted a **coordinated, integrative, and participatory governance approach** to strategically plan a comprehensive and equitable H/C transition**,** including financial affordability for residents. The bottom-up, district-oriented approach involving homeowners and social housing associations serves not only to motivate them to connect to the planned district heating network, but also to share knowledge on climate and quality of life issues. The spatial energy strategy for the heat transition is visually documented and planned in a "what" and "when" map. In addition, multi-level coordination, e.g., with the Regional Energy Strategy Group, accompanies the governance process. Regarding the required energy for the district heating system, Rotterdam has a **large potential to use residual heat from the port**. In general, Rotterdam has important characteristics in its favour. The current geopolitical crisis has also led to more people opting for an alternative to natural gas such as the district heating system.

However, the **current lack of a clear national regulation and financing** is slowing down the city's H/C transition. The discussed National Heat Act, which has been under debate for several years, has caused considerable legal uncertainty. According to the current draft, the heating companies that operate the infrastructure of the H/C grid are to be predominantly publicly owned. However, the heating companies in Rotterdam are private companies, primarily Eneco and Vattenfall. It remains unclear which financial and management model, e.g. a public-private partnership, will be applied and provided with sufficient resources to meet this requirement. Due to the uncertain situation, effective negotiations with stakeholders, e.g. on concessions for heat companies or on the supply of residual energy from the port, are being delayed. The recent collapse of the Dutch federal government further complicates the current situation.

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DECARB CITY PIPES 2050

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DECARB CITY PIPES 2050

Vienna

City Report on governance on H/C and potential for change management

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Table of Content

Introduction

This city report provides an overview of the policy context and governance situation in Vienna regarding the decarbonization of urban heating systems. To establish the context, the first chapter provides a recap of Vienna's Heating and Cooling Outlook to 2040, complemented with excerpts from the Vienna Climate Guide (2022) and the recently published "Vienna Heating and Cooling 2040" concept paper (2023), the latter also containing the draft H/C plan elaborated in the course of this project. The second chapter gives an overview of the existing national, regional, and local policy framework as well as an overview of the governance structures within the municipality and the process through which the city is tackling the H/C transition. The third chapter highlights challenges in the governance system and strives to provide solutions to address them, notably also through regulatory and financial tools and improvements.

Vienna is the national capital, largest city, one of nine federal states/provinces of Austria, and with about 2 million inhabitants the most populous city (Statistik Austria, 2023) (2.9 million within the metropolitan area, which equals nearly one third of the country's population (Eurostat, 2023)).

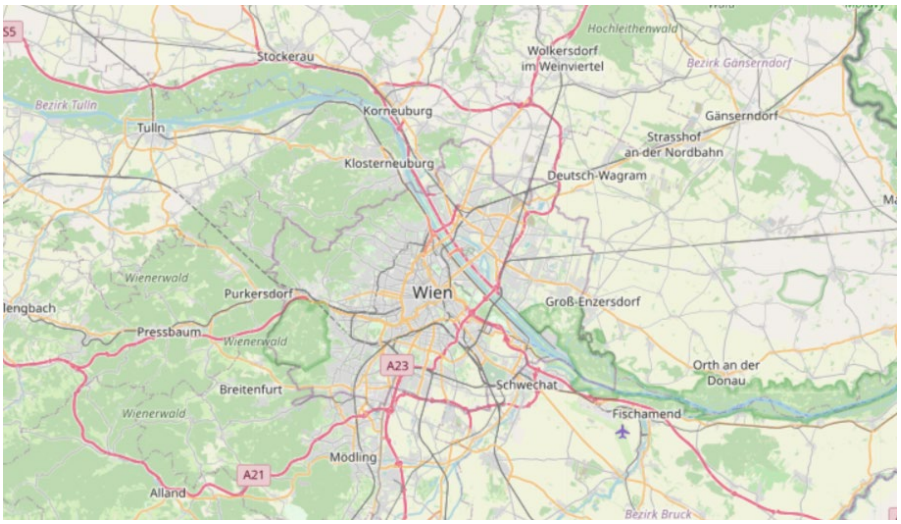

FIGURE 1: MAP OF THE CITY OF VIENNA (SOURCE: OPENSTREETMAP)

Since Vienna obtained province status ("Bundesland") by the federal constitution of 1920, the city council also functions as the state parliament ("Landtag"), and the mayor (except for 1934–1945) is simultaneously the head of the state of Vienna. (Wien Geschichte Wiki, 2023). This puts Vienna in a unique and, in many regards, advantageous position, as it has legal authority that goes beyond what other cities can do in their urban areas.

The current geopolitical crisis caused by Russia's invasion of Ukraine in 2022 has led to greater pressure on building owners and citizens towards the City to offer alternatives to gas, mainly due to price hikes. By February 2022, however, the City of Vienna was already

in the process of addressing the full phase-out of gas. Thus, developments have been accelerated and reinforced.

Nonetheless, extreme price increases of energy coupled with material costs and supply chain disruptions are currently leading to bottlenecks that slow down the transition. Similarly, an already existing shortage of skilled workers has increased.

Vienna's Status Quo

From 2014 to 2018, Vienna's building sector, specifically heating, cooling, and hot water supply, accounted on average for almost 30 percent of its greenhouse gas emissions (excluding ETS emissions from energy generation). While oil- and coal-fired heating systems hardly play a role anymore, **almost 90 percent of CO_2 emissions recorded in the building sector are generated by gas heating systems**. (City of Vienna, 2022a) CO_2 emissions from the building sector have decreased by 37% since 1990 and by 20% since 2005, which is a larger reduction than in the other sectors. Looking at per capita emissions, there have even been savings of 51% and 32%, respectively. (City of Vienna, 2023)

Around half of Vienna's final energy consumption is attributed to heating, with three-quarters of heat demand associated with space heating and around 20% with cooking and domestic hot water preparation. Only a very minor share is consumed by industrial processes. In terms of energy carriers, both natural gas and district heating provide around 40% of heat demand, with very few shares of biomass, coal, and oil. District heating production relies to 57% on gas-powered CHP, nearly 20% on waste incineration, and around 14% on biomass combustion. (City of Vienna, 2022c)

Gas is currently still the most important energy source in Vienna, covering almost half of the city's energy demand, with consumption amounting to 72 PJ / 20 TWh / 2 bcm (TEPS). Nearly 2/3 are used for generating electricity and district heating, while close to 1/4 is used for heating, cooling and hot water generation. Less than 10% are, in turn, used for process heat. Vienna uses 22% of Austria's global gas consumption and uses 41% of all the gas in the sectors of electricity and district heating and cooling (see Figure 3).

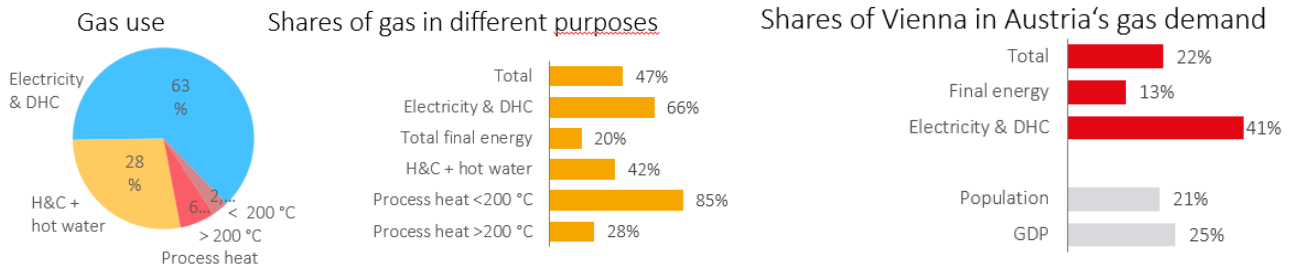

FIGURE 2: FIGURES ON GAS USE AND GAS DEMAND IN VIENNA
(SOURCE: H/C OUTLOOK / STATISTIK AUSTRIA 2019)

Compared to other provinces, Vienna has by far the lowest final energy consumption per capita for space heating and hot water. This is due to the moderate per capita living space (38 m^2 of usable living space per person) and also to the lower heating energy consumption

per square metre - a result of the urban compact structure in Vienna. Further factors are various subsidy programmes for refurbishments, low energy standards in new buildings and the expansion of the central district heating network.

However, new buildings only make up a very small part of the total building stock in Vienna. The majority are existing buildings supplied by natural gas. Of the currently approximately 600,000 gas boilers for heating in Vienna, approximately 474,000 are **decentralised gas heating systems** (located in individual flats), while the other are centralised gas heating systems, i.e. supplying a single-family home or an entire apartment building or multi-storey residential building. In addition, there are about 260,000 cooking gas appliances in Vienna's building stock that also require conversion measures.

It is to be expected that the conversion of these individual gas heating systems will almost always involve the centralisation of heat supply within the building, as this is the best and most cost-effective way to achieve decarbonisation. About 79,000 of these 474,000 units are located in buildings where district heating is already available. (City of Vienna 2023)

Heating & Cooling Outlook 2040

The basis for Vienna's H/C Outlook was its Smart City Framework Strategy of 2019, which defined targets and paths for heating and cooling, including hot water. In 2020, Vienna's new government coalition (the first ever coalition of the social democratic party and the Liberals in Vienna) introduced new ambitious climate and energy targets for the city. In line with the Austrian target, Vienna now strives for climate neutrality by 2040.

In consequence, Vienna adopted its now-called "Smart Climate City Strategy" and additionally developed the Vienna Climate Guide ("Wiener Klimafahrplan") in 2022 to substantiate this new goal and to detail on main levers and measures to be set.

Aiming for a complete phasing out of fossil heating, the City of Vienna defined the following **goals for the building sector** (City of Vienna, 2022a):

- *A complete phase-out of fossil heat supply by 2040.*
- *The final energy consumed per capita by heating, cooling, and hot water systems in buildings will decrease by 20 percent by 2030 and by 30 percent by 2040.*
- *Related per-capita CO_2 emissions will fall by 55 percent by 2030 and to zero by 2040.*
- *Developers' competition in subsidised housing will accelerate social innovations and new solutions for climate protection and climate adaptation.*

In addition, Vienna has set the following **goals for energy supply and infrastructure** (ibid. 2022a)**:**

- *By 2030, renewable and decarbonised energy generation in Vienna equals three times and, by 2040, six times the volume of 2005.*

- *Vienna's final energy consumption will be covered by renewable and decarbonised sources at a rate of 50 percent in 2030 and entirely by 2040.*

The concept paper "Phasing out Gas – Heating and Cooling Vienna 2040", adopted in 2023, gives more detailed information on which solutions will be employed in which areas of the city, and underlines core principles and priorities that were outlined in Vienna's H/C Outlook 2040 for this project in 2021.

According to the Concept paper, in 2040, the **central district heating network** will mainly supply the densely built-up areas and will be re-densified, especially where district heating is already available. District heating will thus supply a high proportion of existing buildings in areas of the city with a high heat demand density. It should be not used in new buildings anymore, except for densification in already high-dense areas. In addition, however, other technical, economic and legal restrictions must also be considered in the future when expanding the grid. Further, district heating will be fully decarbonised through the use of renewables and waste heat sources, so that by 2040, fossil energy will no longer be needed to generate district heating.

Local heating networks will be built for area and neighbourhood solutions in those areas of the city that are unsuitable for the central district heating network despite high heat density. **Renewables-based building solutions** will be used in new buildings and also for existing buildings in areas with a rather low heat demand density. The focus is on heat pumps using shallow geothermal energy (energy probes) or ground water; in individual cases, air heat pumps, electric solutions or biomass-based systems are used.

The renewable on-site potentials will be used in the best possible way and integrated into the respective energy system.

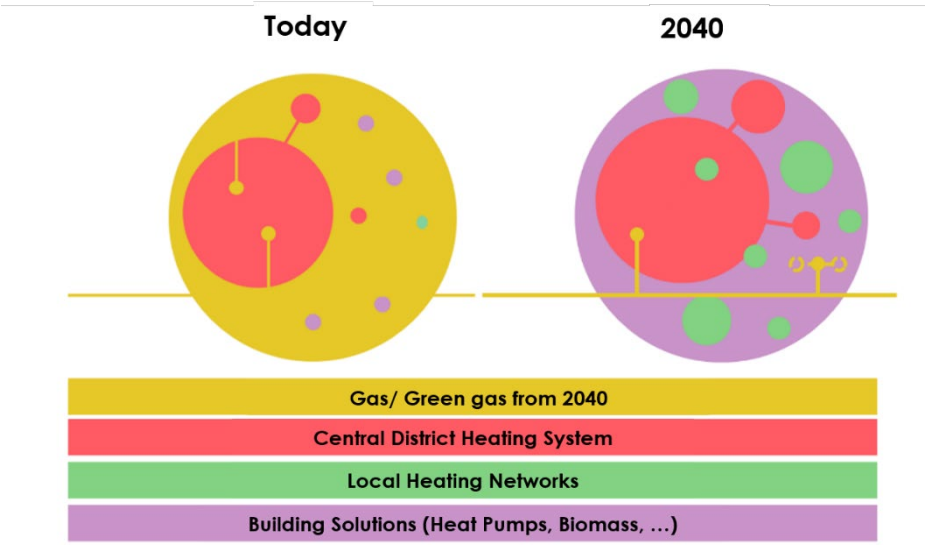

FIGURE 3: HEATING AND COOLING – TODAY AND TOMORROW (SOURCE: CITY OF VIENNA, ENERGY PLANNING)

Based on data provided by previous, national projects, a draft Heating and Cooling Plan for 2040 was created following up on an intense exchange with the Viennese main energy utility and network operator Wien Energie and Wiener Netze (and previously submitted as Deliverable D3.3, see Figure 4). The draft plan roughly outlines the spatial distribution of energy solutions: the dense inner city will be dominated by district heating (dark red = existing DH (focus on densification of the network), light red: extension of the DH) while less

densely populated areas will be more suitable for single solutions. (Decarb City Pipes 2050, 2022)

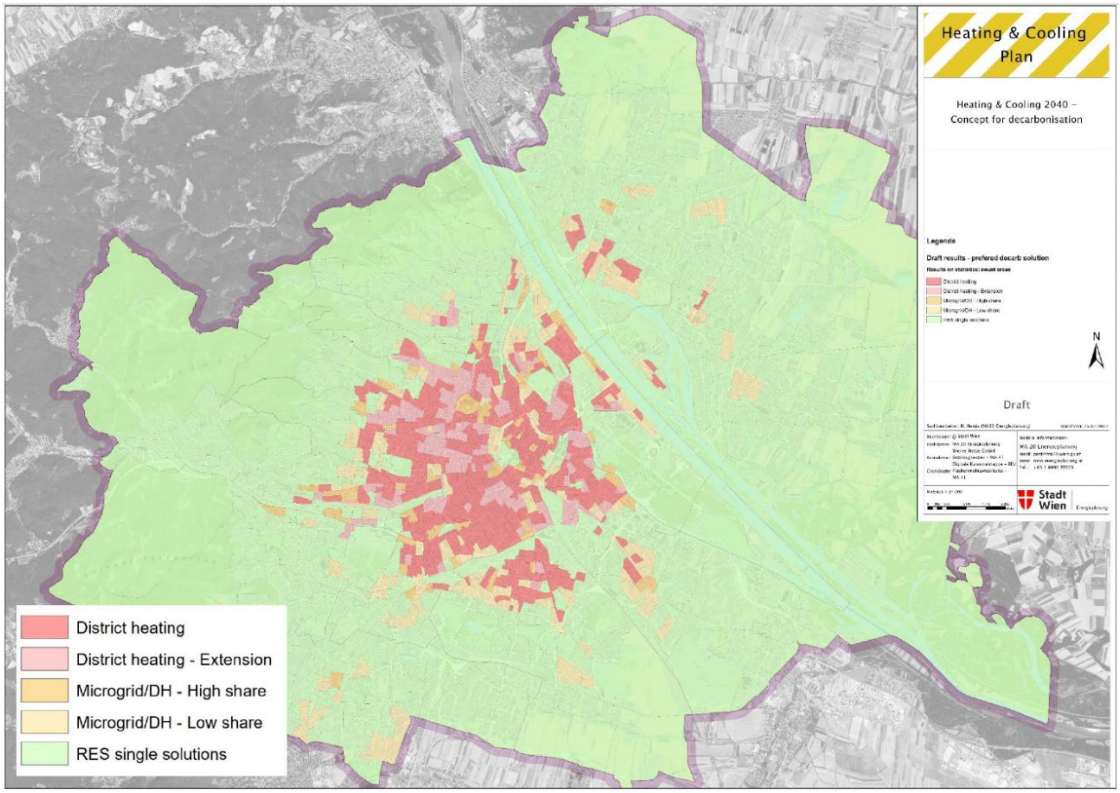

FIGURE 4: VIENNA'S DRAFT HEATING AND COOLING PLAN
(SOURCE: DECARB CITY PIPES 2050, 2022: VIENNA'S HEATING AND COOLING PLAN)

Renewable Energy Sources

Electricity from renewable sources for the heat transition

The increase in heating and cooling supply with decarbonised district heating and heat pumps will significantly increase electricity demand.

Due to the great number of buildings that will be switched from gas-fired supply to **heat pump solutions** (making use of ambient heat from air, water bodies, groundwater or soil [shallow geothermal energy]), it is currently expected that the annual electricity consumption for space and water heating will rise from 1.8 TWh at the moment to 2.7 TWh, corresponding to an increase by 50 %.

As for decarbonised district heating, **heat pumps, large-scale heat pumps and deep geothermal energy** will account for a major portion of district heating in the future and increase electricity consumption. Here, an increase by 0.50 TWh to 0.85 TWh is expected, which corresponds to roughly 10 % of Vienna's total electricity demand.

In order to provide this electricity through renewable sources, **Photovoltaics (PV)** will play an important role for Vienna. Vienna's solar energy campaign launched in 2021 already aims to increase the installed PV capacity from currently about 120 MWp to 800 MWp by 2030, focusing on already sealed surfaces. While wind energy will assume an important role in Austria's power generation, its significance for Vienna's electricity production will be minor

due to the dense building fabric of the city. Likewise, possibilities for extending hydropower generation in Vienna are extremely limited.

Therefore, Vienna will rely on co-operating with the surrounding region to make use of the surplus power from renewables generated in its environs. Therefore, the distribution networks must be continuously upgraded and expanded.

Waste heat as a source of renewable energy

The direct exploitation of available waste heat is essential for phasing out fossil energy sources and switching to district heating at a large scale. Waste heat from high-temperature applications, e.g. waste incinerators or cogeneration plants (i.e. combined heat and power, CHP), can be directly fed into the district heating grid. Low-temperature waste heat, e.g. from sewers or wastewater, can be used for space and water heating with the aid of heat pumps. Other sources of waste heat include office buildings, supermarkets, businesses and data centres or server rooms.

Vienna aims use waste heat onsite by coupling energy demand as early as possible with locally available sources and taking account of these requirements already in planning (for example, when choosing heat generation solutions for residential neighbourhoods). The seasonal storage of waste heat, e.g. in geothermal probe fields, are set to make summer heat surpluses available as sources of heat in the winter months. It could also be combined with solar thermal energy and thermal asphalt collectors for regeneration of geothermal probe fields. There are ongoing discussions to use new parks or adaptation of parks as geothermal probe fields for the neighbourhood or for decarbonising the centralized district heating.

In the future, Vienna's electricity demand for space cooling will likewise augment significantly, by 240 %, i.e. from around 300 GWh in 2019 to over 1 TWh in 2040, according to one study[1]. The city aims to prevent the discharge of larger waste heat volumes into the environment, i.e. through district cooling networks (chiefly for service buildings) or the seasonal cooling of buildings by means of geothermal probes, to prevent increasing urban temperatures during the summer months.

The City of Vienna does not incentivise the (currently minimal) use of biomass for heating, except for individual applications or buildings where district heating or heat pumps are not a viable option. Also the usage of air heat pumps should be limited due to microclimatic effects, impact on the urban design or noise issues.

Vienna refuses the use of green gas for space and water heating of individual buildings due to its limited availability and high prices that can be expected in 2040. Furthermore, the limited quantities of green gas will be needed for sectors where no alternatives exist, e.g. in CHP plants, for high-temperature applications in industrial production or, temporarily, in some areas of public transport.

Indeed, Vienna plans operate gas-fired plants beyond 2040 for reliable operation and coverage of peak loads in electricity and district heating supply, green gas because of its high energy density and suitability for seasonal storage. (City of Vienna 2023)

[1] https://positionen.wienenergie.at/wp-content/uploads/2021/10/WE-DECARB21-Studie.pdf

Governance of the H/C transition

Legal Framework & Policies

National/federal policies, strategies & targets

The national government is determined to reach **climate neutrality by 2040** as per their coalition agreement in 2019. This goal is, however, not yet laid down in law.

A federal Renewable Heat Act has been elaborated in a near-to-finalised form but has, as of June 2023, not yet found the required 2/3 majority in parliament. In its currently available draft version, this law would set the fundamental framework for phasing out fossil-fuelled boilers (solid, liquid and gaseous) in new and existing buildings as well as for the promotion of heat networks. Upon its entering into force, it would greatly influence the legal framework and the actions, which will and can be implemented at city as well as provincial level.

City policies, strategies, plans & goals

As Vienna is both a city and a federal province (= one of Austria's nine provinces), Vienna can pass both state and city-level laws.

In November 2020, following the national climate neutrality commitment, Vienna's new city government in its **Coalition Agreement 2020** committed itself to (City of Vienna, 2020):

- CO_2-neutrality by 2040,
- provide "oil- and gas-free" heating (space and domestic hot water) and cooling by 2040,
- stronger DH expansion to accelerate the switch away from fossil heating system,
- acceleration of the decarbonization of DH through tapping of deep geothermal and through waste heat integration.

Vienna's climate goals, as laid down in the government agreement of 2020, were adopted by the City Council in the updated **Smart Climate City Vienna Strategy**. This strategy comprises goals for both climate protection and climate adaptation. (City of Vienna, 2022b)

The **Vienna Climate Guide** of 2022 describes the City's path towards reaching its climate goals until 2040. It thus corresponds to a compact implementation strategy that identifies the main levers for climate protection (and climate adaptation). The measures to be given priority and the tools behind them are, however, not specified in detail, nor are they finalised. (City of Vienna, 2022a)

As announced in the coalition agreement of 2020, the concept paper "**Raus aus Gas - Wiener Wärme und Kälte 2040"** ("Phasing Out Gas – Heating and Cooling Vienna 2040"), published in early 2023, specifically takes on the heating and cooling sector. It outlines the path towards a climate-neutral city according to the motto "Raus aus Öl und Erdgas" ("quitting oil and natural gas") in the building sector. Furthermore, this concept specifies the goals and levers put forward in the Vienna Climate Guide. The details laid out in the concept

paper are currently under implementation under a City-wide “Phasing Out Gas” programme (further elaborated below). (City of Vienna, 2023)

The Building Code is the central law regulating spatial planning and building activities within the city. A subsidiary instrument anchored in the Building Code are the **energy zoning plans**, which were first implemented for some districts in 2020. Developed by the Energy Planning Department of the City of Vienna, these specific ordinances define so-called “climate protection areas”, in which heating and domestic hot water in new buildings must be operated based on renewable energy sources or district heating. (City of Vienna, n.d./a)

The City is intensively working on spatial energy planning for existing buildings and heating systems. This will also increase the need for further analysis of the building stock, primarily concerning locally available sources of energy and structural parameter of each building, to make statements about potential energy and, in particular, heating & cooling solutions across the city. (City of Vienna, 2023)

Process of H/C planning in the city & stakeholders involved

The **Municipal Department for “Energy Planning”** is in charge of heating and cooling & energy planning, energy data collection and analysis, spatial energy planning etc., for the City of Vienna. On the level of H/C planning, the “energy zoning plans” are the fundamental instrument of energy planning. These ordinances effectively mandating the use of renewable energy sources for space heating and hot water preparation in new buildings within designated areas. By the end of 2023, such energy zoning plans will be available for all districts in Vienna (23 in total). The future options of this instrument are currently in elaboration. For the building stock different kind of instruments are possible and it is not decided yet which binding character they will have. Finally, a mix of different instruments will be needed. The Energy Planning Department has approximately three people dedicated to H/C planning.

The largest part of the City of Vienna’s energy supply and grid infrastructure is managed and owned by Wien Energie (energy provider/utility) and Wiener Netze (grid operator), both owned by the City of Vienna. This fact and the fact that Wien Energie is an integrated utility (both production and distribution of all three grid-bound forms of energy: electricity, gas and district heating) makes the planning of the decarbonisation of the urban heating system easier compared to cities with several private utilities, which often prioritize financial gains.

The Executive Group for Construction and Technology (“Stadtbaudirektion”), located within the Chief Executive Office of the City of Vienna, coordinates the **“Phasing Out Gas” implementation programme**. This programme comprises several city departments as well as other city-owned companies and organisations, among others the Municipal Departments for

- “Housing Promotion and Arbitration Board for Legal Housing Matters” (responsible i.a. for defining decarbonisation types on building level),
- “Construction, Energy, Railway and Aviation Law” (for the regulatory framework),
- “Testing Centre, Inspection and Certification Body”,
- “Energy Planning”,

- "Technical Urban Renewal",
- "Financial Affairs".

Further, it includes the city-owned companies:

- Wiener Stadtwerke (head organisation for different public utilities including the grid operator Wiener Netze, public transport provider Wiener Linien and the energy utility Wien Energie amongst others),
- Wien Energie (energy utility),
- Wiener Netze (grid operator)
- Wiener Wohnen (City of Vienna - Housing in Vienna, Vienna's social housing cooperation), and
- Urban Innovation Vienna (Vienna's climate and innovation agency).

Asides, other departments like the one in charge of Kindergartens and schools take part in this programme. (City of Vienna 2023)

The "Phasing Out Gas" programme currently has a management team of 3 people, with up to this date, around 20-30 people working on different programme phases, and a wider circle of over 100 people engaged in this programme in total.

The first project phase (2022-2025) will be used mainly to deal with setting the legal framework, extending the energy zoning approach for the building stock, engaging all relevant stakeholders, adapting subsidy programmes, and carrying out pilot projects. The second phase of the implementation programme (2026-2040) will then be tasked with the widespread roll-out of transitioning the urban H/C system. See the following figure:

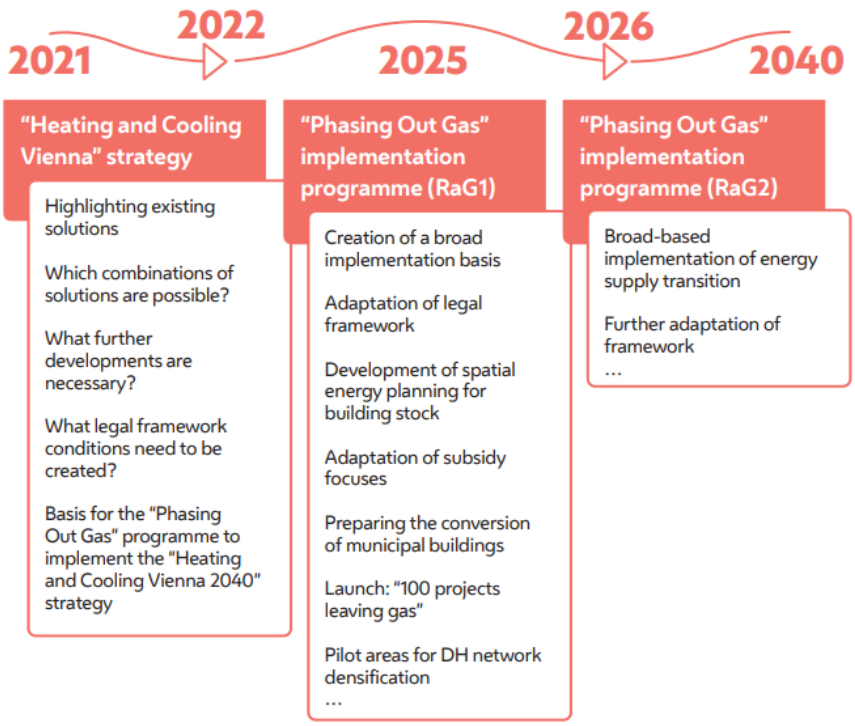

FIGURE 6: PHASES OF THE IMPLEMENTATION PROGRAMME « PHASING OUT GAS » (SOURCE: 2023: CONCEPT PAPER "RAUS AUS GAS - WIENER WÄRME UND KÄLTE 2040")

In terms of pilot initiatives and experimentation, the programme “100 projects free of gas” establishes how existing technical solutions for renewable H/C supply can be applied in practice to buildings or quarters of different building periods and with varying building-level decarbonisation challenges. These reference projects will provide an overview and a catalogue for the wider roll-out of the H/C transition.

On the district and neighbourhood level, pilot district heating expansion and/or densification areas have been designated as test roll-outs, oftentimes in the framework of the “WieNeu+” city renewal programme. These areas are also the focus of Decarb City Pipes 2050’s Work Package 5 on “experimenting with solutions”.

These pilot and demonstration projects aim to identify the need for human and financial resources, how funding schemes need to be designed, and which technical difficulties can arise in the roll-out of the H/C transition. Similarly, it will be used to define how the transition can be communicated towards the public, how acceptance can be fostered and how different stakeholders (building owners, tenants, building developers, …) can be “activated” to become part of the transition.

To engage the public and create acceptance of the H/C transition, the City of Vienna aims to continuously offer **consulting services**, such as the "Hauskunft" (a combination of “Haus” (home) and “Auskunft” (advice or information)) for questions on topics such as renovations and heating system switches, or the Renewable Energy Competence Centre (“Kompetenzzentrum Erneuerbare Energie”) as information and counselling centre for all topics related to renewable energy.

The concept paper “Heating and Cooling Vienna 2040” also foresees that the “Phasing Out Gas” implementation programme should establish and adapt the **funding and subsidies** framework to support the transition in a socially just manner. The core principles it aims to consider are (City of Vienna, 2023):

- *Long-term budget planning coordinated with the implementation plan and a related successive increase in the subsidy budgets for thermal renovations and heating conversions.*
- *Creating possibilities for pre-financing infrastructure expansion in order to reduce the costs for "first-time converters" and to ensure the economic viability of the expansion.*
- *Additional funding or support for cross-property initiatives (gas-free building blocks or streets) that want to "get out of gas" together.*
- *There is a need for targeted subsidies with a high degree of social accuracy.*
- *Better coordination of federal and provincial subsidies.*
- *Further development of funding to include measures relating to the deconstruction of cooking gas.*

Politics of heating decarbonisation

In comparison to other provinces in Austria, Vienna has unique challenges, as well as aspirations that differentiate it from other provinces and the federal level.

Recognizing that green gas will be available only in limited quantity until 2040 and beyond, the City of Vienna aims to reserve the use of green gas for applications that are otherwise hard to decarbonize, such as industry and electricity- and heat-production at times of peak demand and low renewable energy production. In consequence, the City is committed that green gas is not to be used in low-temperature applications such as decentralised or centralised heating boilers in buildings. (City of Vienna, 2023)

Vienna is also facing the challenge of a large number of gas-heated apartments (approximately 600.000 gas boilers). Thus, the City pushes for strong legislation concerning the gas phase-out. This legislation could ban the installation of gas heating systems in buildings in general, not just the use of fossil gas as a fuel, which would consequently also prevent the use of green gas in low-temperature applications. Additionally, it is pushing for an obligation for centralising heating systems in buildings with individual systems, not just in DH areas. (Decarb City Pipes, 2023)

The adoption of the still pending **Renewable Heat Act** on the federal level is considered key to accelerating the transition of heating systems in existing buildings and creating more certainty in planning.

If passed, it will prohibit gas heating systems in new buildings. In addition, for existing buildings, the draft law addresses gas as a fuel not the heating system per se: the use of *fossil* gas for heating will thus be forbidden after 2040, which means that switching to *green* gas for heating in 2040 remains allowed, in principle and with one exception:

For buildings with *decentralised gas boilers* in every apartment, located in so-called “district heating zones”, the Renewable Heat Act foresees that they will have to be replaced with a centralized, non-fossil heating system, i.e. district heating or any other renewable heating system. In turn, the tenants or owners of the flats in these buildings will have to connect to such a centralised heating system within 5 years. As a centralisation would, in any case, be necessary for connecting to a heat network, this provision would give cities greater leverage to steer the expansion of district heating and to ensure a high connection rate.

These “district heating zones” are areas where [decarbonised] district heating is already available or where its expansion is planned and will be carried out until 2035. Such zones will probably have to be designated by public authorities (e.g. the City of Vienna). (Decarb City Pipes, 2023)

As the competencies for property and tenants regulations lie with the federal government, Vienna will need to rethink is approach to phasing out gas in the case that the Renewable Heat Act will not be passed. This would mean focusing on the mandates within its own legal competencies, such as: Building Code amendments, subsidy programmes to push for refurbishments (in a spatially differentiated manner) and boiler exchanges, support of the labour markets and the build-up of a skilled workforce for the H/C transition.

A role-model effect can be achieved through refurbishing city-owned buildings. For example, Vienna has a large share of social housing with more than 200,000 apartments owned by the City of Vienna. However, refurbishments in these buildings usually take a lot of time (because so many stakeholders need to be consulted and involved and because financial reserve funds are often low). Therefore, one starting point is the refurbishment and

decarbonisation of the public owned buildings of the city administration like offices, schools, swimming halls amongst others.

A core difficulty for switching heating systems e.g. away from decentralised gas boilers in individual apartments is that it has to be done by the building owner who needs the approval of all of owners (of each flat). In the light of a lacking regulatory framework, even the connection of flats to an already existing centralized and decarbonised heating system cannot be enforced easily by the building owner, but the approval has to be awaited from each flat owner and tenant. There are some Viennese examples (e.g. Sozialbau AG / Miesbachgasse), where the connection rate is still relatively low for that reason, although a central heating system is already in place to which it would be easy to connect.

Potential for Change Management

Priority urban governance challenges & how to address them

A key challenge for Vienna to address will be the sufficient availability of a workforce to carry out the heating transition. A lack of skilled workers and resource bottlenecks in the affected sectors currently jeopardise the implementation of the ambitious plans. A training initiative is needed, and appropriate apprenticeship and teaching programmes need to be established.

The heating transformation, however, also offers great opportunities to create additional jobs, such as craftsmen, plumbers, planners, skilled workers, etc., with appropriate quality training for the renovation of buildings and retrofitting of heating systems. People who are currently outside the Viennese labour market could, for instance, be reintegrated through specific training and further education. A corresponding study was commissioned in cooperation with the City of Vienna - Economy, Labour and Statistics Department (MA 23) and the Vienna Employee Promotion Fund (“waff”), where the status quo as well as the challenges and opportunities of the Viennese labour market are to be analysed.

Based on this study and as stipulated in the Vienna coalition agreement, different policy measures and a strategic labour market instrument, a so-called skilled labour centre where training is provided, are to be established at the Vienna Employee Promotion Fund.

Beyond being a training centre for skilled workers, it is set to provide quantitative and qualitative analyses regarding the demand for skilled workers in Vienna, develop strategic options for action to solve the problem and elaborate concrete measures together with decision-makers. The official establishment of the Centre for Skilled Workers will take place in 2023 with the presentation of the first Skilled Workers Report for Vienna. (City of Vienna 2023)

Especially with regard to the training of qualified workers, the typically long duration of training must be taken into account. The provision of further training facilities also requires preparation time. As a result, the necessary training policy interventions must be made at an early stage to secure the supply of skilled labour in the future. In addition, the labour

market challenges must also be addressed at the federal level, through updating curricula in vocational schools and anchoring renewable energy systems, thermal renovations or the installation of photovoltaic systems in the educational system. (City of Vienna 2023)

There is currently also some uncertainty on where to put the focus for building refurbishments. On the one hand, the refurbishment of the buildings with the lowest energy performance, often located in the inner city, will yield higher energy savings. On the other hand, refurbishment is needed also for the less densely built areas, because the installation of individual heating solutions such as heat pumps often requires a high energy performance in the first place.

Regulatory improvements

The federal Renewable Heat Act will, once adopted, put forward a concrete framework and timeline for the H/C transition. Its unclear status (it is uncertain whether it will find the required 2/3 majority), however, currently creates uncertainty for the H/C transition at the city level.

The Fire Police Act, which is to be revised soon, is to oblige property managers, chimney sweepers and grid operators to provide data on the energy supply of buildings, to provide reliable and detailed information on the heating systems in the city.

Finally, the energy zoning plans addressing the existing building stock should put forward legally binding provisions for the gas phase-out. It is up to now not fixed which can of binding character energy zoning will have in future. Due to the complex issue of transformation of the building stock a mix of different instruments will be needed.

Financial instruments

The extension of district heating is quite expensive and requires high upfront investments from the grid owner. I order to redeem these investment costs, grid operators i.a. require a high connection rate of customers.

Currently, in Vienna, a building owner does not only need to bear the costs for connecting their house to the DH system, but additionally also for the extension of the DH network pipes through the street/across the site up to the building itself. This scheme disincentivises building owners to initiate a DH connection, because the costs of the DH expansion will have to be borne by the first building to be connected, while the costs for all buildings connecting later to the DH will be substantially lower as the pipes are already available.

Here, new finance models should be developed, to incentivize building owners to connect their building if they are the first to do so in a given street or an area. For the four pilot areas of the DH extension there will be one connection cost rate for everyone independent of the distance. This cost scheme should be extended for all other areas where DH will be available. In the densely built urban areas, heat pumps are not expected to substantially compete with DH, as they are either technically not feasible or very costly. However, they can compete with DH in less dense areas. Consequently, it would be beneficial to have overarching clarity, which solution will feed which areas, so that a sufficient connection rate for DH can be ensured.

Conclusion

Being both a municipality and a federal province, the City of Vienna is in a favourable position to pass its own legal framework for buildings and has several policies and strategies in place that support the heating and cooling transition. A particularly important policy instrument in this regard is spatial energy planning through energy zoning plans that designate areas in which gas connections in new buildings are not allowed. Additionally, the publicly-owned municipal utilities allow steering the energy supply side of the H/C transition. Outstanding in Vienna is the coordination of multiple actors through the “Phasing Out Gas” implementation programme and the institutionalisation capacity-building, i.e. through a planned skilled labour centre. Furthermore, the “100 projects leaving gas” project as well as the pilot areas will push innovative RES solutions and accelerate the DH extension. A major challenge the city faces is the lack of regulations at the national level, as the city has no legal competencies regarding regulations on property and tenants rights. This regulatory gap hinders the exchange of heating systems, e.g., for rented flats. Especially in this context, funding for the exchange of heating systems and the acceleration of refurbishment is not clarified yet. Similar to other partner cities in the Decarb City Pipes 2050 project, Vienna is confronted by a scarce, skilled workforce and the urgency of the transition through a tight timeframe. Finally, how far cooling will be addressed in the transition is not clarified yet.

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DECARB CITY PIPES 2050

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DECARB CITY PIPES 2050

Winterthur

City Report on the governance of heating and cooling and the potential for change management

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Table of Content

Introduction & Context

This city report provides an overview of the planned decarbonization of urban heating and cooling (H/C) systems in Winterthur.The first chapter introduces to the city, followed by a concise summary of Winterthur's H/C status quo and outlook to 2040 in chapters two and three. Chapter 4 gives an overview of the relevant policy frameworks as well as governance structures and processes. Chapter five discusses the challenges and potential solutions for the H/C transition in Winterthur. Chapter six highlights and summarizes favorable conditions and remaining challenges for the city.

The city of Winterthur is located in northeastern Switzerland, about 20 km northeast of the City of Zurich, close to the German border. The city area of 68,1 km² (City of Winterthur 2015a) lies between seven wooded hills and is surrounded by the Töss River in the south. The upper Töss valley, popular as a recreational area, stretches towards the southeast, while the north is bordered by an area used predominantly for viticulture. The city's climate is characterized as warm and temperate, with significant rain precipitation throughout the year. Switzerland is divided into 26 Cantons, representing federal states. Winterthur is part of the Canton of Zurich, and with its 1.5 Mio. inhabitants the largest Swiss Canton (BFS 2022). With 120,595 inhabitants (City of Winterthur 2023), the city is the second largest in the Canton, after the city of Zurich, and the sixth largest in Switzerland. Winterthur is comprised of seven districts (*Stadtkreise*) that are divided into 42 neighborhoods (*Quartiere*). Winterthur's economic context changed from the machinery industry to the service industry, including insurance and banking, and lately to new industries like medicine, and small and medium-sized enterprises in the high-tech sector. The city has traditionally been governed by center-left coalitions, except for a center-right majority from 2014 to 2018. The executive is the so-called city council (*Stadtrat,* henceforth city government), consisting of seven members and elected every four years. The city president has been center-right since 2012.[1] Since 2002, the Social Democratic Party has held most seats in the city parliament (*Stadtparlament*).

Originally designed based on the garden city model and characterized by many allotment gardens, Winterthur is a very green city. It was awarded from 2006 to 2022 the Swiss price for the most bike-friendly large city in Switzerland (City of Winterthur 2022). Since 2007, the city has carried the "Energy City" label with the addition of the "European Energy Award GOLD" (City of Winterthur 2015b). In 2012, the population voted in favour of becoming a 2000-watt society in the priority action areas of electricity, heat, and mobility.

The current geopolitical crisis that implied moving away from Russian gas as an energy source accelerates the H/C transition in Winterthur. Although the crisis has brought the issue more into focus in the public debate, climate-neutral forms of H/C have had already gained

[1] City presidents in Switzerland are subject to the principle of collegiality, which means that the government or the authority consists of equal mandate holders, who represent the decisions taken by secret ballot to the outside world with one vote.

strongly in importance before (Energy Office 2022). Moving away from gas is much less controversial today than a few years ago. For example, in 2016, the city announced to shut down the gas supply of a small suburb in 2026, which was followed by large protests at the time. In comparison, nowadays, the phasing out of fossil fuels was confirmed by a public referendum.

Winterthur´s H/C status quo

In Winterthur, the number of buildings amounts to 25.089, with 66.5% of buildings in residential use (H/C Plan 2021). Buildings are, on average, 70 years old (ibid.). In 2019, the final energy demand of all heated buildings in the city was 1.2 terawatt hours (Persson and Sánchez-García 2021). The demand was covered at 68% by fossil sources constituting 770 GwH (ibid., see figure 1).

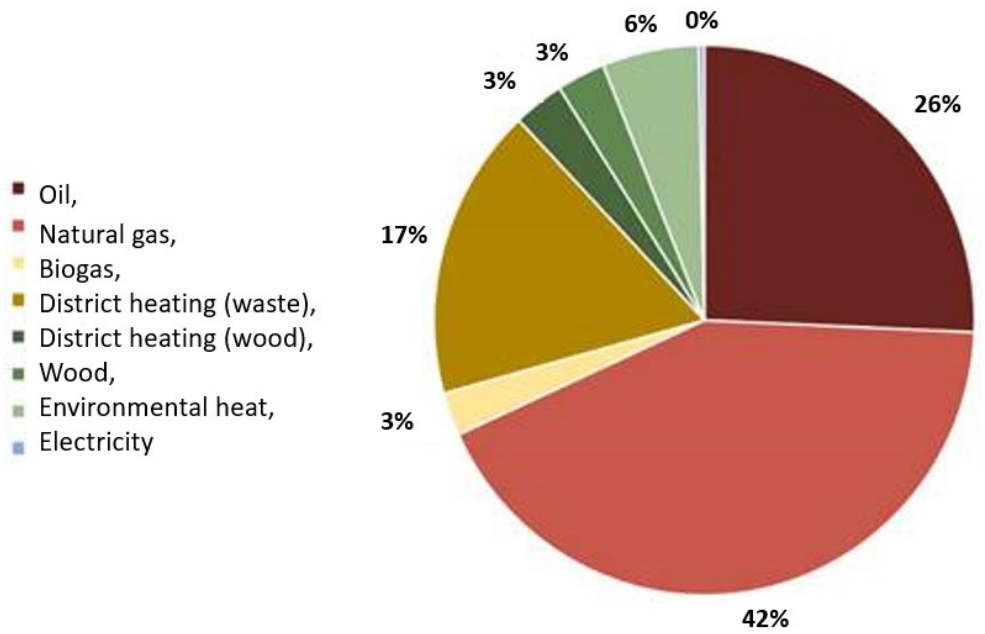

FIGURE 1: FINAL ENERGY DEMAND FOR HEATING AND COOLING BY TYPE OF HEAT SUPPLY IN 2019 (EMISSIONSKATASTER STADT WINTERTHUR 2020)

The city has an existing district heating system which was already built in 1985 and currently covers 18% of the city's demand (see figure 2, H/C Plan 2021). The spatial coverage of the district heating system is illustrated in the map below (figure 2). The high-temperature network utilizes excess heat from waste incineration as well as wood. The network uses gas and oil only to cover peak demand (Energy Office 2022).

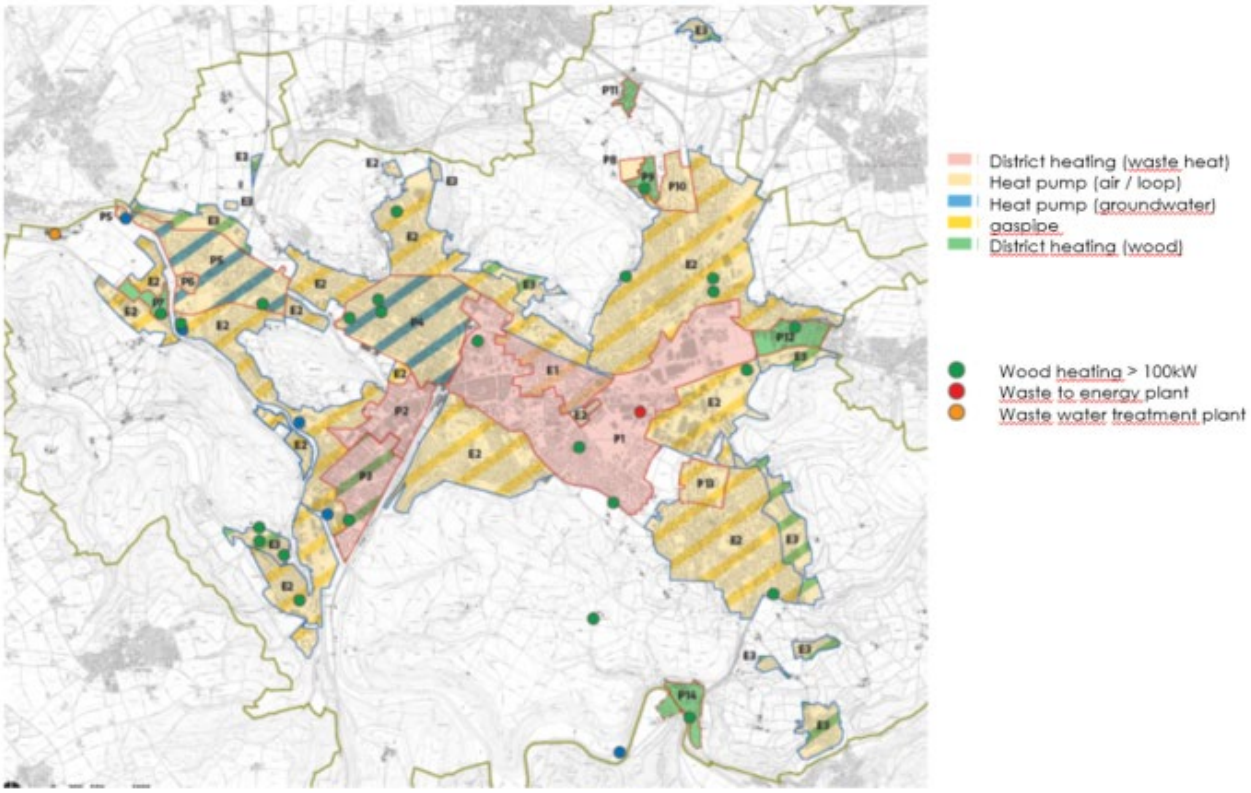

FIGURE 2: CURRENT HEAT SUPPLIES BY DIFFERENT CITY DISTRICTS (PERSSON AND SÁNCHEZ-GARCÍA 2021)

Winterthur´s H/C Outlook 2040

The city intends to achieve zero carbon emissions and a 100% renewable energy supply in 2040. Based on today's demand, the reduction and transformation path for heat in figure 3 shows how the heat supply can be transformed in the coming years.

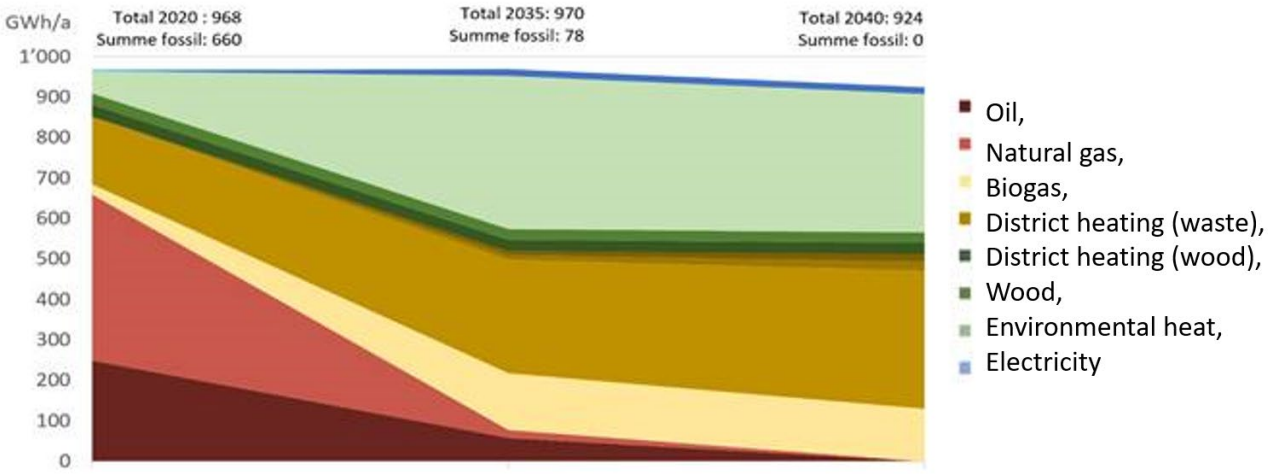

FIGURE 3: WINTERTHUR'S REDUCTION PATH FOR THE NET ZERO 2040 EMISSION TARGETS (PLANAR 2021)

The city's goal is to transition to almost zero oil and natural gas usage for low-temperature uses by 2035. The plan is that natural gas for high-temperature, industrial applications will

still be in place, nevertheless, only with a share of 10% (and 30% renewable gas). The total anticipated energy demand of all heated buildings in Winterthur for the year 2035 is projected to be at 970 terawatt hours (see figure 3). By relative shares, district heating is estimated to have the largest share, followed by heat pumps in 2035 (environmental heat in figure 3), accounting in total for more than two-thirds of the H/C energy demand. The current main energy sources of existing district heating in 2019 have been identified and the potential heat demand density in 2035 calculated and divided into certain areas (see figure 5). Figure 6 shows the envisioned energy sources for the district heating system in 2035.

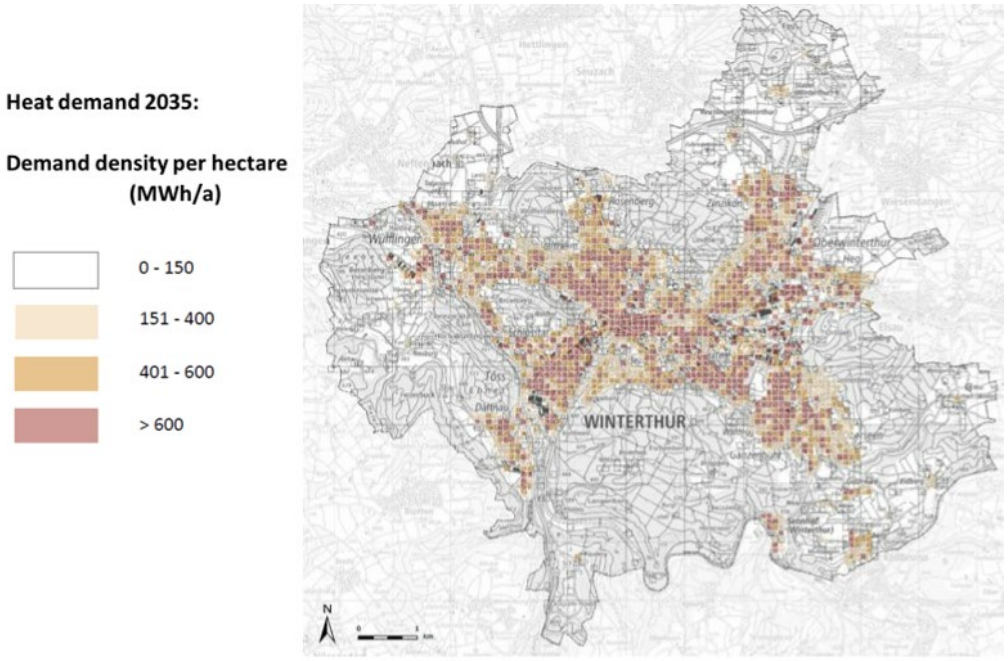

FIGURE 5: ESTIMATED HEAT DEMAND DENSITY PER HECTARE IN 2035 (H/C OUTLOOK 2021)

FIGURE 6: ENVISIONED DISTRICT HEATING SYSTEM BY HEAT SUPPLY IN 2035 (H/C OUTLOOK 2021)

Governance of the H/C transition

Legal Framework: Policies

National/federal policies & targets

The Federal Act on the Reduction of CO_2 Emissions, short CO_2 Act, characterizes the centerpiece of Swiss climate policy. It was first introduced on May 1st of 2000 and has since been in force for commitment periods, the first one ending in 2012. In the version, which has been in force since 1 January 2013, the act requires that GHG emissions in Switzerland, compared to 1990, are reduced by 20% by 2020 and by at least 35% in the years 2021 to 2030 (CO_2 Act, Art.3 §1). For buildings, GHG emissions had to be reduced by 40 per cent by 2020. Already in 2008, after it became clear that the mainly voluntary measures of the first act would not suffice, a CO_2 tax on fuels (heating oil, natural gas, coal) was introduced (Burkhardt 2016). Since 2010, one-third of the revenue from the CO_2 tax has gone into the Buildings Programme. The Buildings Programme promotes the energy retrofitting of buildings, the use of renewable energies, the increased use of waste heat, and the optimization of building technology (ibid.). After the Paris Agreement of 2015, the law was amended to reduce CO_2 emissions by 50% by 2030 compared to 1990 and to achieve zero GHG emissions and 100% renewable energy sources by 2050. In 2020, the national parliament accepted the revised act for the third commitment period staring in 2021; however, the Swiss voters rejected the new version via a public referendum in June 2021 by 51.6 %. Therefore, the CO_2 Act remained in its 2011 version, which particularly affected the planned building regulations: the 2020 CO_2 Act had proposes stricter regulations for energy retrofitting to reduce energy demand and GHG emissions from heating and cooling. In addition, the act proposes new building codes and regulations to ensure that new buildings are constructed with low-emission building materials, energy-efficient H/C systems, and high insulation levels. Overall, these regulations aim to encourage building owners to reduce their H/C energy demand and GHG emissions from heating and cooling, and to promote the use of renewable energy sources and low-emission building materials in new construction and renovation projects. Recently, in June 2023, Swiss voters decided again on the CO_2 Act, and this time accepted the law with 59%. It is projected to come into place in January 2025.

After the rejection of the CO_2 Act in 2021, the relevance of national legal frameworks decreased in driving the urban H/C transition. Whereas the Swiss Energy Act (EnG) provides the national framework for energy demand and supply, every Canton issues its own energy law in the area of building policies. To homogenize the legal situation for homebuilders, the Cantons' energy directors coordinate and produce model regulations for cantonal energy laws at the national level. These regulations include an obligatory and a voluntary part that the Cantons can use for their energy acts. The latest model regulations are from 2014 and had to be integrated into Cantonal energy laws by 2020.

Regional policies & targets

In the Canton of Zurich, a new government interpreted the model regulations from 2014 rather ambitiously in their draft of the new Cantonal Energy Act, which was accepted by the parliament. A key change to its former version is the mandatory replacement of oil and gas heating systems with climate-neutral heating at the end of their service life. There are exceptions, for example if the climate-neutral heating solution is technically not possible or is more expensive than 5% in total life cycle costs than the fossil-based alternative (§ 11).

Nonetheless, additional measures must be taken to complement fossil-based heating, such as installing solar PV (EKK 2022). As a result, the law did not issue a factual ban on fossil-based heating but made alternative, climate-neutral heating solutions, such as heat pumps, the most affordable and viable option (Interview 1). Particularly this foreseen regulation invoked a public referendum held on the 28th of November 2021 (ibid.). However, a large majority of voters (62.6 %) accepted the law, and the new Cantonal Energy Act came into effect in September 2022 (City of Zürich 2023). The Canton also presented the so-called "Long-term Climate Strategy" in 2022. The strategy sets the net-zero emissions goal by 2040, the latest by 2050. Buildings represent the sector in which GHG emissions are planned to be mainly reduced; in total, 65% by 2030 and 95% by 2050 (Cantonal Climate Strategy 2022, p.9).

City policies and targets

Already in 2012, Winterthur´s inhabitants decided to reduce primary energy consumption and greenhouse gas emissions by 2050 and to achieve the objectives of the 2000-Watt society. The latter characterizes an energy policy model in which the energy demand of every person should correspond in average 2000 Watts at a primary energy level. The decision entailed that Winterthur's GHG emissions are to be reduced to 2 tons of CO_2 equivalents per capita and year by 2050 and that, subsequently, a further reduction to 1 ton of CO_2 equivalents is to be targeted with high priority. To this end, the following interim targets have been defined: by 2020, 5.8 tons, and by 2035 3.5 tons of CO_2 equivalents per capita and year (EKK 2022). The goals are based on the 2011 report "Fundamentals of the Energy Concept 2050", which, in addition to the goals and interim goals, also shows the most important directions for measure implementation in the areas of electricity, heat, and mobility. To achieve these goals, an action plan for the Energy Concept 2050 was developed and adopted by the city government in 2014.

The city develops such an energy action plan every ten years. The plan represents an innovative instrument in Swiss policies for coordinating spatial and energy planning focusing on heating and cooling. Spatial energy plans map priority and suitability areas for measures, e.g., thermal networks, and the further procedure for implementation, including responsibilities, to ensure the spatial coordination of future H/C supply (Interviews 1 and 8). Because the energy action plan is a central H/C instrument, Winterthur decided that the city parliament must agree upon it. The updated plan was discussed and confirmed by the city parliament and has been in place since the 20th of January, 2023.

The city government issued the energy action plan for 2021 to 2028 based on the "Energy and Climate Concept 2050" (EKK) in February 2021 (EKK 2021). A couple of months later, the net zero target for 2040 was introduced for the city. The new climate target was up for popular vote together with the Cantonal Energy Act on the 28th of November 2021, in which Winterthur residents decided on net zero in 2040 instead of 2050 (around 60% of votes, EKK 2022). Together with the city of Zurich, Winterthur now has the most ambitious climate targets of the Canton (Interview 8). Because of the changed climate target, the energy action plan was modified. The interim target of an average of 1.0 tons of CO_2 equivalent per person by 2035 has been pushed forward by two years to 2033 in the urban area. In general, the goals specified in the individual measures now apply to 2040, and the interim goals to 2033. The individual measures are not changed. They were defined in the areas of (1) heating and energy supply, (2) mobility, (3) local economy, consumption, and recreation, and (4) communication and participatory processes.

Process of H/C planning in the city

The city administration of Winterthur is comprised of seven departments. Three of them are mainly involved in the H/C transition: (1) the Department of Security and Environment with its Office for the Protection of Environment and Health, (2) the Technical Operations Department with its subordinate municipal utilities (*Stadtwerke*), and (3) the Construction Department with the Energy Office. The Office for the Protection of Environment and Health is concerned with general strategic oversight and the monitoring of climate targets. The municipally owned multi-utility company manages drinking water, electricity, district heating, and gas, and runs the local wastewater treatment and waste incineration plants. The Energy Office is responsible for implementing the energy action plan and the new Cantonal Energy Act. Apart from these key players, additional departments are involved in the heating transition, such as the finance department and the mayor's office (Interview 1). Besides these municipal key stakeholders, consultants represent additional important actors involved in the heating transition. The current and former energy plans were developed by an external consultancy (Interviews 1 and 8). Parallel to the plan development, municipal utilities conducted a feasibility study to determine in which areas when to proceed with the network expansion and potential energy sources. Expansion plans focus first on the city center and thereafter on the periphery (Interview 8).

Three working groups were set up among the key stakeholders for planning and implementing the H/C transition: The first one examines administrative structures and ways how to accelerate bureaucratic procedures. One central question discussed was, for example, whether the city government, city parliament, and the public need to confirm every decision for implementation. A second working group coordinates the collaboration between the Construction Department and the municipal utilities for underground spatial planning. The third working group is responsible for financing. One of the key problems discussed was that city business units are legally not allowed to be in debt for more than five years. However, the grid construction for the district heating expansion requires major initial investment as heat grids are capital-intensive and have long payback periods.

Stakeholder involvement and the politics of the heating transition

In comparison to many other European countries, Winterthur has favorable context conditions for the heating and cooling transition because of the existing legal and regulatory framework at the cantonal and city level as well as the publicly owned municipal utilities. With municipal utilities, the gas supply and H/C district network expansion is entrenched in the same company, so there is no "loser" of decarbonization strategies (Energy Office 2022). Moreover, even though there were initially challenges, interview partners highlighted the smooth coordination across different city departments in the working groups (Interview partners 1, 8). Another advantage for progressing the H/C transition in Winterthur is national funding schemes for heating owners, which are complemented or executed by the Canton. For example, the exchange of fossil-based heating for climate-neutral alternatives is supported through the national CO_2 tax. A website (www.energiefranken.ch) provides information on funding schemes and counseling opportunities in all Swiss cities free of charge. The national project "Impulse Consulting" (*Impulsberatung*) provides advice for owners of heating systems older than ten years. Experts propose new heating options based on an inspection and analysis of energy consumption as well as viable energy sources. The city implements this program free of costs through two consultancy teams, one of the municipal utilities and one of the Energy Office (Interview partner 1).

Lessons Learned

Generally, the heating and cooling transition requires major time resources and organizational capacity. However, there are limited personal resources in the city of Winterthur (Energy Office 2022, Interview partner 8). The city entered an exchange with the cities of Zurich and Basel for this task; organized by the energy consultancy. A major learning from this exchange and own experience was that administrative procedures have to be accelerated for the transition (Interview partner 8). The installed working groups and their interdepartmental coordination resulted from this learning.

The limited timeframe for building decarbonized H/C systems and, therefore, the urgency of construction led the city to define priority tasks. Integrative planning for the road construction works, necessary to install the district heating network, was considered as potentially hindering the entire process. As discussed in the next section, the H/C transition was therefore prioritized over other planning areas, such as green mobility and urban, green spaces.

Potential for Change Management

Key urban governance challenges & how to address them

The Cantonal Energy Act and the net zero target of 2040 represent a policy instrument and goal of major importance to garner political will, provide direction, and pressure implementation of the H/C transition in the city. Under Winterthur's favorable governance conditions, the main difficulties are technical and financial. As mentioned above, the initial investments in extending district heating networks are high: Costs of the H/C transition are estimated at 200 to 300 Mio. Swiss Francs (CHF) in total (Interview partner 1). This budget requires confirmation by public vote allowing the city to give a loan of 100 Mio. CHF for the first five years to municipal utilities. This procedure was one of the incentivized solutions of the local working group on accelerating administrative processes. The Energy Act and climate target introduced urgency to plan and manage the transition. If fossil-based heating systems have to be replaced at the end of their lifecycle, but heating connections are not yet built, users have to choose an alternative, climate-neutral solution, e.g., a heat pump (Energy Office 2022). These lost customer connections undermine the connection density needed for cost recovery of network investments. Geothermal heat pumps could be an interim solution, but in most of the areas with planned district heating, geothermal connections cannot be realized because of the proximity of a groundwater aquifer to buildings (Interview partner 3). Mandatory, individual connections to the district heating network are only possible if the lifecycle costs of heating systems are comparable with other climate-neutral solutions (ibid.).

The H/C transition has been prioritized over other areas of climate mitigation and adaptation in the context of road construction works, as mentioned above. Residents can object to road construction projects, which can delay implementation by 5 to 7 years (Interview partner 1). As a solution, certain streets have been determined in which the H/C grid will be expanded without simultaneously considering potential climate mitigation and adaptation measures, such as green spaces or expanded public transport. Technically, the new H/C grid requires larger pipelines than the gas grid, whereas the available underground space is limited in

some areas of the city (Energy Office 2022). Instead of road construction, building and connecting heat networks via cellars is considered in areas of high building density and limited underground space (Interview partner 1). Moreover, the availability of materials, skills, and labor in the supply chain is currently limited (Interview 3). Training is not seen as problematic, but again the urgency to extend the network with at present 18% coverage to the goal of up to 50% coverage is recognized as a challenge (ibid.).

The H/C transition is also prioritized to the refurbishment of buildings. The energy retrofitting rate of buildings of 1% in Winterthur undermines climate mitigation ambitions. Given the lack of a national legal framework so far, it is considered difficult to increase and accelerate this rate (Interview 1). The plan is to (slightly) increase the retrofitting rate of buildings to 1.2% (H/C Plan 2021). However, not only financing but also the altered look of buildings is perceived as an issue by homeowners (ibid.). Older people often do not see the need to invest in refurbishment given the long amortization period of about thirty years.

The main challenge for the district heating expansion in Winterthur is to secure sufficient energy during winter because PV panels generate less electricity. A potential solution is the storage of green gas, e.g., through thermal power coupling (Interview partner 4), but its technical feasibility is not yet conclusively explored. Green gas is currently produced through biogas (compost gas plant and waste water plant) and could potentially be produced by agriculture and through excess PV electricity during summer in the future (Interview partner 1). Similar to green gas, it is not clear yet to what degree geothermal energy as a preferred renewable energy source can be used in Winterthur. Different estimations exist regarding the energy supply for district heating: on the one hand, heat from groundwater, shallow geothermal heat, and heat of the wastewater treatment plant might suffice as energy sources (Interview partner 1). On the other hand, energy imports from other countries might be necessary during winter (Interview partner 4). Furthermore, renewable electricity required for heat pumps and green gas for district heating systems will likely compete with future demands for e-mobility and digitalization.

Currently, the main energy source for heat is the waste incineration plant. At the same time, waste prevention, its prepartion for reuse and recycling is becoming a priority over waste incineration in the context of the circular economy approach and related regulations; for example for countries of the European Union (EU) through the EU Waste Framework Directive (Directive 2008/98/EC)[2]. As such, generating heat through waste is not a sustainable solution (Interview partner 2, 6). Winterthur's waste is comprised at an equal share by households, industry, and construction (Interview partner 1). Industrial and construction waste is not only produced in Winterthur but regionally and sometimes internationally (ibid.). Domestic waste volumes are projected to decrease; yet, this decrease is expected to be compensated through population growth (ibid.). Construction and industrial waste are not projected to decrease in the future. Industrial waste is targeted as a new energy source available for incineration. In addition, waste incineration is mainly planned during summer to save wood for incineration during winter. To implement this plan, the city's waste incineration and wood provision business units will need to merge: the heat from waste incineration is less expensive than wood because the waste incineration business model is profitable. With the merged model, the goal is to offer universal heat tariffs (ibid.).

[2] The directive is not binding for Switzerland since it is not part of the EU.

The city of Winterhur has strategies for accessing sufficient renewable energy in the future. However, the energy sources for the H/C transition are not finally determined, and the current H/C transition strategy hardly tackles energy efficiency through retrofitting (see also next chapters). It is noticeable that, in general, while heating was given priority, the increasing demand for cooling is hardly discussed and addressed in Winterthur. Even though cooling might not have been a severe issue in the past, raising temperatures due to climate change are likely to put this issue on the map for Winterthur. Interdepartmental working groups are already installed; they could be used to address these issues.

Regulatory improvements

In principle, Switzerland and the Canton of Zurich, in particular, have a favorable regulatory framework for the heating transition (Energy Office 2022). As described before, providing sufficient renewable energy in the long term will be challenging. In this respect, it would be desirable to more strongly prioritize refurbishment (ibid., Interview partner 3). Building refurbishment for greater energy efficiency in Switzerland has been promoted since 2010 by the federal government's Buildings Program (*Gebäudeprogramm*). The building program, which the Cantons implement, promotes the insulation of buildings as one of its energy measures. Since it is a program for financial support of homeowners, it is described in the next chapter.

Financial instruments

The Buildings Program is financed through the CO_2 tax and the Cantons. The 2023 Insulation Support Programme (*Förderprogramm 2023 Dämmen*) of the Canton of Zurich provides information on insulation, consultation opportunities, and funding. The program can subsidize max. 50% of the investment (40 CHF per m² roof and floor, 70 CHF per m² wall). According to the program, homeowners can also apply for subsidies to replace their heating system and receive subsidies from municipal funding programs simultaneously. Additional funding programs exist, e.g., the Klik Foundation, *Energie Zukunft Schweiz* AG, and CO_2 target agreements with the federal government. Problematic for accelerating refurbishment is the high cost compared to exchanging heat systems; e.g., a geothermal heating pump for a family building costs around 60.000 CHF, and renovation amounts to around 150.000 CHF (Interview partner 1). Nonetheless, these costs refer to the initial investment and not to long-term operational costs for electricity, maintenance, repair and renewal of heating systems. Before the changed Cantonal Energy Act, the necessity of renovation was low because of relatively cheap fossil fuels. However, increased energy efficiency and lower demand through refurbishment increase the affordability of renewable energy solutions. Higher energy prices can incentivize refurbishment, so capping the currently high gas and electricity prices could be counterproductive (Interview partner 1). Voices at the national level, such as representatives from academia and industry, stress that many consumers in Switzerland are not informed yet about the funding possibilities and the additional benefits of retrofitting, for example, more living comfort and better air quality in the building, and that funding should increase (Jorio 2020). At the city level, actively providing and disseminating information provision on funding opportunities could represent an additional measure to incentivize the refurbishment of buildings. However, potential trade-offs between retrofitting and high-temperature heating networks should be considered, as low-temperature networks are currently not part of Winterthur's H/C transition. Also, through the new CO_2 Act, which was accepted in June 2023, funding for the exchange of heating systems will increase.

Conclusions

The city of Winterthur has a tradition of ambitious climate goals and governance, exemplified by the Energy City label the city carries and the goal of a 2000-Watt society the residents voted for a decade ago. Even though the ambitious climate policy in the form of the CO_2 act did first not succeed at the national level, the Cantonal Energy Act and the successful referendum on the net-zero climate target for 2040 have provided a favorable legal and regulatory framework for the H/C transition. Likewise, the municipal energy action plan, which the city parliament agreed on, characterizes a favorable and innovative policy instrument for spatial H/C planning. Winterthur also installed interdepartmental working groups to facilitate and accelerate governance processes. The municipal utility representing a multi-utility company further supports accelerated implementation, as coordination with most other infrastructure networks can be done in-house.

Challenges the city faces are the determination of climate-neutral H/C energy sources for district heating, the reliance on waste incineration as main energy source, the limited timeframe to expand the district heating network, and the low consideration of refurbishment as well as of cooling in general.

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List of Interviews:

Interview partner 1	Energy Office(2 interviews)
Interview partner 2	Energy Office
Interview partner 3	Municipal energy provider (2 interviews)
Interview partner 4	Municipal energy provider
Interview partber 5	Construction Department
Interview partber 6	Office for the Protection of Environment and Health
Interview partber 7	Technical Operations Department
Interview partber 8	Consultancy

DECARB CITY PIPES 2050

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