DECARB CITY PIPES 2050

H/C plan of Vienna

Part of D3.3

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Introduction

The city of Vienna is the largest city in Austria, the fifth largest in the European Union and the second largest German-speaking city. Like many other cities across Europe, Vienna is facing continuous population growth. Furthermore, rising temperatures due to climate change is another challenge that urgently needs to be dealt with.

Compared to other provinces in Austria, Vienna has the lowest energy consumption per capita. Nevertheless, a lot of fossil energy is still used for the city's energy supply. In the heating sector, natural gas and district heating dominate the market.

Currently, great efforts are being made to eliminate the use of natural gas for heating. In addition, parallel efforts are being made to decarbonise the district heating system. Overall, there are more than 400,000 individual gas floor heating systems in Vienna, making the decarbonisation an even more challenging task.

In the Viennese Climate Roadmap (*Wiener Klimafahrplan*), central fields of climate protection and climate change adaptation were elaborated. These include the following matters in the energy sector (Magistrat der Stadt Wien, 2022):

- Expansion of renewable energy
- Covering the heating and cooling demand in new buildings without fossil energy
- Long-term phase-out of gas heating in existing buildings
- Thermal and energetic refurbishment of the building stock and efficiency improvements in heating systems
- Expansion of the electricity, gas and district heating grid infrastructure as well as storage facilities
- Continuation of integrated spatial and energy planning
- Reduction of cooling demand

Facts & figures: the context

Vienna is the largest city involved in this project, with a population of around 1.935.000 inhabitants in 2022 (Stadt Wien, s.a.a). This number is likely to continue to rise: Between 2018 and 2040, the population is expected to increase by 16.6% (ÖROK, s.a.). To better understand the city, some facts worth knowing are listed in table 1.

TABLE 1 : OVERVIEW FACTS OF VIENNA

Type	Quantity	Source
Inhabitants	1,935,000	https://www.wien.gv.at/statistik/bevoelkerung/bevoelkerungsstand/
Total area	41,487 ha	https://www.digital.wienbibliothek.at/wbrup/download/pdf/3724138?originalFilename=true
Total number of buildings:	164,746 (2011)* [estimate for 2021: 185,000] Ownership: • Local authorities: 25,915; • Non-profit building associations: 17,156; • Other legal entities: 10,347; • Private individuals: 111,328	https://www.digital.wienbibliothek.at/wbrup/download/pdf/3724138?originalFilename=true
Total number of apartments	983,840 (2011)	https://www.digital.wienbibliothek.at/wbrup/download/pdf/3724138?originalFilename=true
Total dwelling area	69,233,000 m^2	https://www.digital.wienbibliothek.at/wbrup/download/pdf/3724138?originalFilename=true
Average living area per apartment	72 m^2	https://www.digital.wienbibliothek.at/wbrup/download/pdf/3724138?originalFilename=true
Length of district heating network	roughly 1,200 km (around 430.000 apartments and 7.700 business customers are currently connected)	Internal city data
Total final energy consumption	37,005 GWh/a	MA 20 (2021)
Total final heat consumption	18,243 GWh/a	MA 20 (2021)
Energy consumption per capita	19,502 kWh/cap*a (Austrian average: 35,564 kWh/cap*a)	MA 20 (2021)

*Remark: The latest register data assessment was published in 2011. (the new register data assessment will be available in 2023)

The total final energy consumption in Vienna accounts for 37,005 GWh/a. As Figure 1 illustrates, half of the energy used in the city is attributed to heat applications, 38% to mobility and 12% to electricity specific applications.

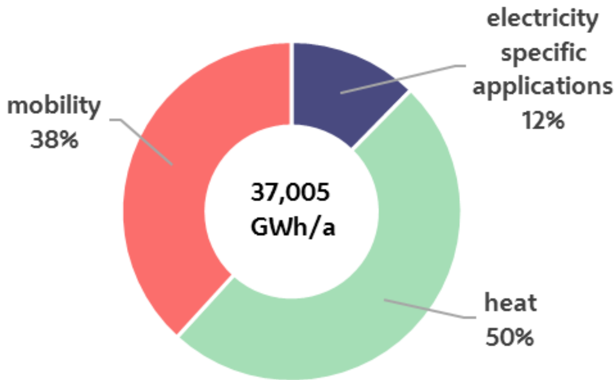


FIGURE 1 : TOTAL FINAL ENERGY CONSUMPTION BY APPLICATION (MA 20, 2021)

Natural gas and oil currently still dominate the total energy consumption accounting for 74%. As Figure 2 shows, the most important energy sources for heating are natural gas (40%) followed by district heating (33%) and electricity (20%) (MA 20, 2021). Oil and coal play only a minor role in Vienna´s heat supply.

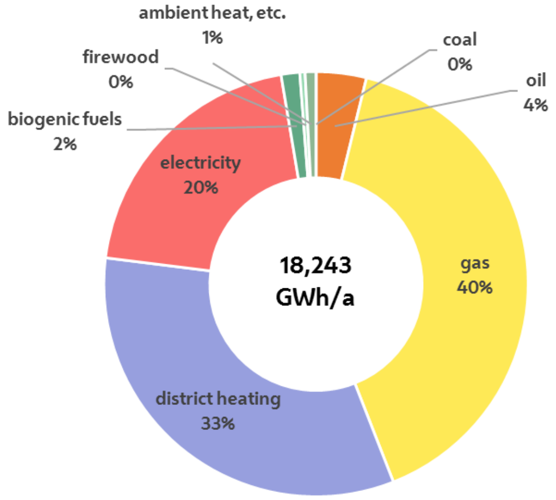


FIGURE 2 : TOTAL FINAL HEAT CONSUMPTION BY ENERGY SOURCE (MA 20, 2021)

The supply of district heating with renewable energy remains a challenge in Vienna. Figure 3 shows the distribution of energy sources used for district heating. Natural gas still has the largest share (39%), followed by cogeneration (35%) and waste incineration (11%). It is, however, important to note that there are strong seasonal fluctuations in heat supply. Waste incineration is used to cover the base load. The peaks, in turn, are covered by gas (especially in the winter months).

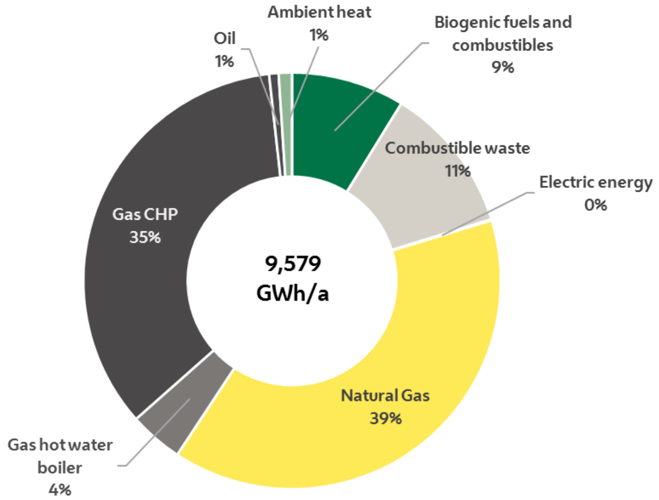


FIGURE 3 : DISTRICT HEATING GENERATION BY ENERGY SOURCE (MA 20, 2021)

Figure 4 illustrates the most essential energy flows in the city of Vienna, starting from its gross inland energy consumption to its final energy consumption by end use.

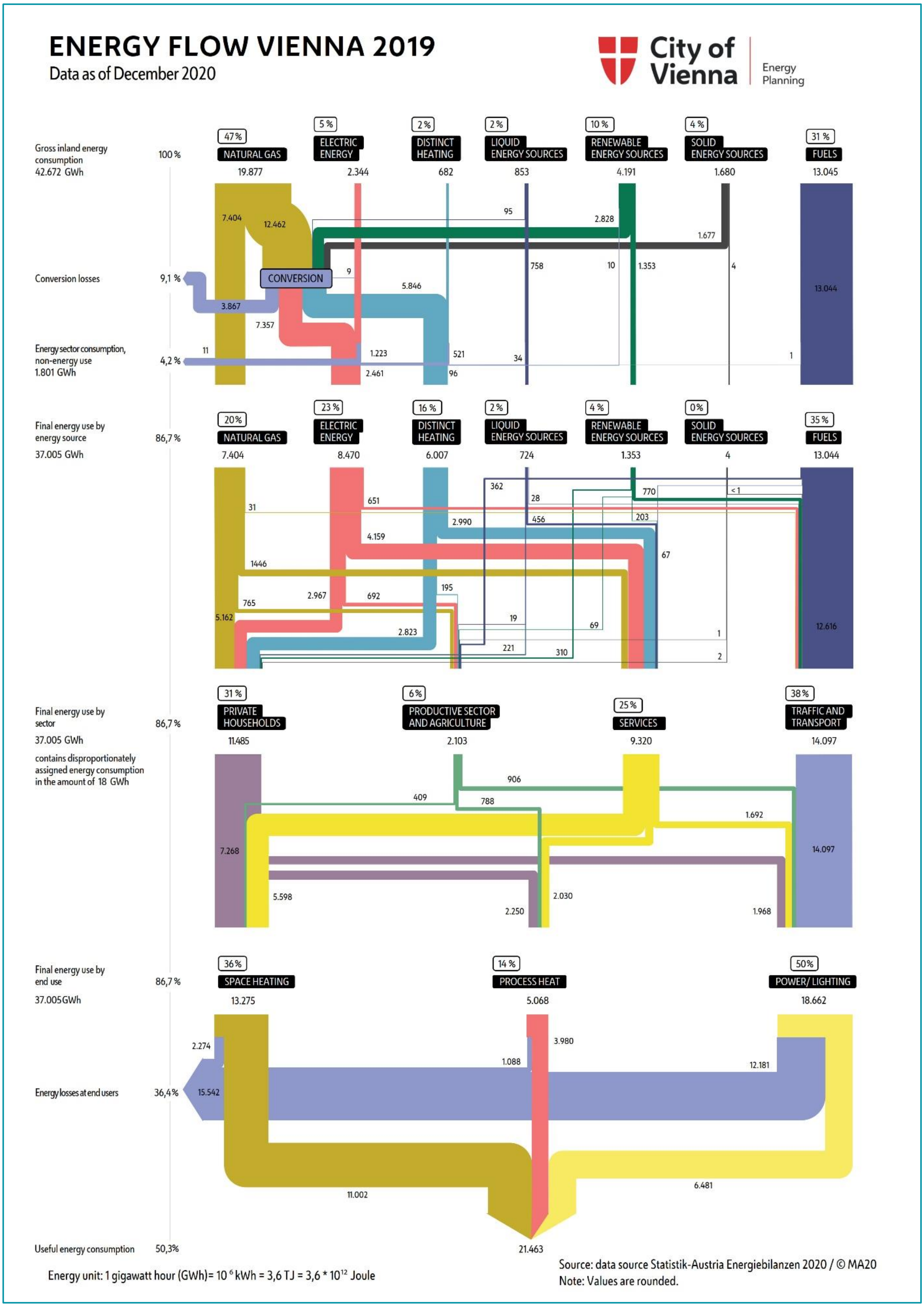


Figure 4 : Energy Flow Vienna 2019 (MA 20, 2020)

With an annual average of 19,502 kWh per inhabitant, Vienna has the lowest energy consumption per capita compared to other provinces in Austria with an average of about

35,564 kWh per inhabitant (MA 20, 2021). But this fact is mainly related to the urban structure compared to the dominant rural structure of other provinces.

Vienna’s gas grid currently covers approximately 90%, its DH grids roughly 50% of the city. The network infrastructure in Vienna is primarily operated by the city-owned net provider Wiener Netze (*Wiener Netze* as part of *Wiener Stadtwerke*).

Wiener Netze owns and operates the primary district heating network (on high temperature level of up to 160 degrees Celsius). The secondary network (between 65 and 85 degrees Celsius) as well as the “business” is maintained and operated by the biggest utility in Austria *Wien Energie*. The energy provider Wien Energie is also in charge of distribution and sales. The district heating network is closed for external utilities – and thus can only be used by *Wien Energie*. However, there are four small district heating networks in Vienna, owned and operated by a public Austrian utility, *KELAG*. The main energy source for these DH networks is gas.

Within the Vienna City Administration, all energy planning competences (e.g. energy zoning, PV programme etc.) and general energy-related issues of decarbonization in the city were consolidated in the Municipal Department 20 - Energy Planning in 2011.

Please note that future developments and scenarios for Vienna on the path to carbon neutrality will be described in detail in Deliverable 2.6 "H/C outlook 2050 in each participating city and cross-city synthesis".

Process

A key component in the process for developing the H/C plans, was the political decision in 2020 on city level on the goal of reaching carbon neutrality by 2040. The city government coalition agreement (of the so called “Fortschrittskoalition”) of 2020 laid out the following main goal for the heating and cooling sector:

> “By 2040, the phase-out of fossil fuels for heating, cooling and hot water production will be completed.” (Stadt Wien, s.a.b).”

Based on this coalition agreement, an extensive process (“Wiener Wärme und Kälte 2040”) on how to decarbonise Vienna’s heating and cooling sector by 2040 was set up within the city. An important role in this decarbonisation process is played by Vienna´s local working group (LWG), which comprises all relevant stakeholders at the city level dealing with energy issues (e.g. city administrations, utility (Wien Energie), DSO (Wiener Netze) etc.). The local working group (which also developed the H/C plans) was set up in 2021. In addition to a steering group, topic-specific working groups (WGs) were established, on the following topics:

- Technical issues (data, building typologies, …),
- Legal issues (how to deal with individual boilers etc.),
- Financial issues (funding, subsidies etc.),
- Communication and stakeholder involvement.

The H/C plans are an interim result of this process. They were developed within and in intensive exchange with the members of the local working group. The procedural steps towards the H/C plans are shown in Figure 5.

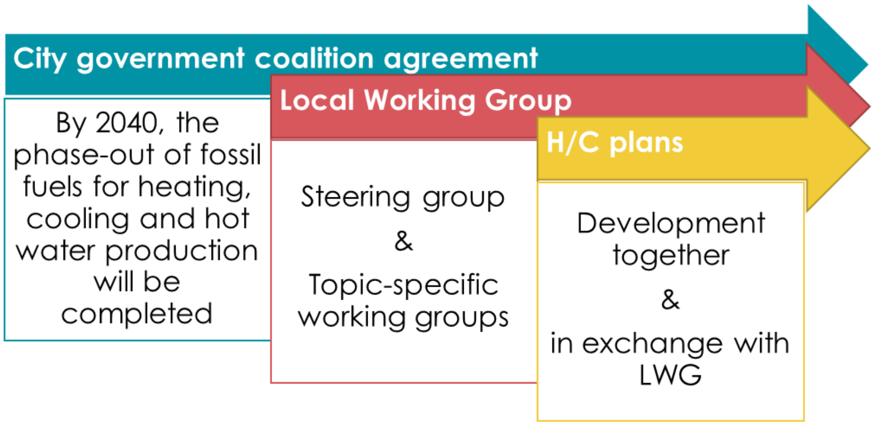


FIGURE 5 : SCHEME OF THE PROCESS TOWARDS H/C PLANS (OWN ILLUSTRATION)

Framework and principles

The following principles and issues were used and addressed in developing H/C plans for the City of Vienna:

District Heating as THE essential backbone

District heating (DH) is an essential backbone of Vienna's future heat supply. Currently, DH already supplies more than 1/3 of Viennese households with heat (this equals roughly 430.000 apartments and 7.700 business customers). Thus areas are assessed, in which DH can either be densified or extended. Scenarios regarding the future of DH can also be found in a recent study published by the main utility of the city: https://positionen.wienenergie.at/studien/decarb-studie/.

The challenge of parallel infrastructure

A particular challenge is the parallel infrastructure of gas and district heating, since there are a lot of buildings currently connected to both. In some buildings, gas is only used for cooking, while DH is used for heating. In some buildings gas is still the source for hot water preparation while DH is used for space heating. The city of Vienna is currently developing strategies to alleviate this unwanted and expensive situation.

Decarbonising DH

Vienna´s DH system currently still heavily relies on natural gas as its energy source. So the question of how to decarbonise the district heating is of utmost relevance for the city. This can be accomplished via large central heat pumps, the integration of waste heat and deep geothermal energy.

Criteria for DH areas and urban typologies

The biggest challenge for the city is the decarbonisation of the existing building stock. Since grid-bound heat supply requires the development of criteria for delimiting individual local DH areas (for instance low-temperature decentralised DH networks), comprehensive data and information is needed regarding the building stock of the city. The main idea behind using energy (geo)data is to deepen knowledge on building and H/C landscape typologies. Such typologies can then be used to develop H/C maps. Furthermore, they help in identifying which and how many buildings will be proper for which technical solutions. This allows

funding programs to be specified and economic impacts and requirements to be derived, including manpower, resources and budget needs.
The typologies and the draft H/C plans as laid out in this document will substantially support the city's path to conceptualise the future of heating and cooling in Vienna. Thus, a commitment was formed between Wiener Stadtwerke (WStW) and the city of Vienna to develop a H/C plan in close coordination. Based on these plans, a specific concept for decarbonisation strategies will be finalised by the end of 2022. The concept is developed together with the LWG.

As already mentioned, one of the main elements towards the decarbonisation of the building stock is DH. District heating will be the preferred option in densely built areas of the city – especially in the inner city, preferably with a connection rate close to 100%.

The *Goals, Framework and Principles* can be summarised as follows:

- Identification of **buildings which are already connected to district heating as well as gas** (parallel infrastructure within the building), with a potential for 100% DH supply (thus, some sort of quick wins towards decarbonising existing buildings).
- Identification of areas for densifying [connecting buildings to existing pipes] or extending [new DH infrastructure] the **central district heating** network (primary network with temperatures up to 160°C and secondary networks with temperatures between 65 and 85°C).
- Identification of areas suitable for **local district heating networks** (from medium to low temperature heating, including anergy grids).
- Identification of areas for **renewable decentral solutions** (heat pumps that use ambient heat, e.g. for single-family houses or detached houses)
- Derivation of solutions on **how to deal with remaining gas consumers** – e.g. use of (green) gas for process heat (high temperature) and/or for peak load coverage of district heating and electricity generation
- **Decarbonisation of central DH network** (with main sources being deep geothermal energy, waste incineration, waste/residual heat [data centers, supermarkets, waste water …], large heat pump applications and green gas) which includes also the need for heat storages in the urban area

Figure 6 visualises the framework and principles used. The central DH network is divided into the primary network (large red bubble) and the secondary network(s) connected to it (smaller red bubbles). Separated local DH networks are pictured in green. These are intended to contribute to the decarbonisation of the building stock through grid-bound heat supply.

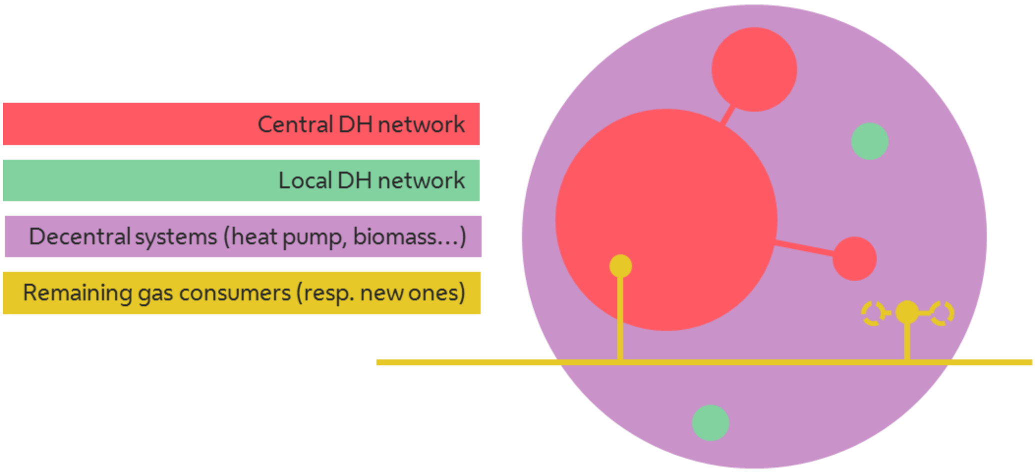


Figure 6 : Vision for decarbonising Viennas' building stock (based on H/C Outlooks 2030/2050)

Decentral solutions such as individual heat pumps are to be implemented in areas where DH is not feasible, e.g. in low-density areas in the outskirts of the city that are mainly dominated by single and detached houses or for buildings where a DH connection is just not possible. An important question that remains to be answered concerns the remaining gas consumers or the new gas consumers and the limited role of green gas in the heating and cooling sector.

The role of cooling in Vienna

In comparison to the heating demand in the city of Vienna, the total cooling demand is comparably low. When preparing the Smart City Strategy of Vienna, among other things, cooling demand quantities were determined. Accordingly, the cooling demand in the building sector was calculated at around 350 GWh/a. In comparison, the heating demand was estimated with 15.5 TWh/a.

It is also important to emphasise that the need for cooling will increase significantly in the future, while heat demand will decrease respectively. At present, however, the decarbonisation of the energy system is a question of heating, not cooling, as cooling is mainly accomplished through electricity. Hence, the decarbonisation of the electricity supply is another important issue, but is however not the focus of the Decarb City Pipes project. In addition, the expansion of PV systems in Vienna up to 800 MWp until 2030 (see https://photovoltaik.wien.gv.at/) will support the renewable operation of cooling generation. Nevertheless, there exists already a new district cooling (DC) network (16 km length and 130 MW) operated by *Wien Energie*. The focus of DC are business customers including hospitals, office buildings and hotels. Especially in the inner city there is a plan to provide a comprehensive DC network. Another focus of the city is climate adaptation, e.g. through greening and sustainable urban planning, which ultimately leads to a reduction of active cooling. This leaves the following main strategies in the city, which are:

- Estimate the expected cooling demand in detail
- Protection against overheating in summer:
  - Passive measures (architectural shading, external sun protection,...)
  - Active year-round conditioning of buildings: low-temperature heating systems and concrete core activation (excess heat in summer in thermal storage mass in combination with geothermal probes)
- No focus on district cooling – nevertheless it will be part of the decarbonisation strategy how to deal with DC in the future
- Find the most efficient technical solutions for different types of buildings

In the context of framework and principles, the cooling demand was not part of the maps presented in this deliverable.

Analyses data and aggregation

The basis for the analyses preceding the development of the H/C plans is a geodata model from the research project *GEL SEP (Spatial Energy Planning for Energy Transition)*, including building specific data such as the building period, type of use, gross floor area, type of heat supply and many more. In addition, the heat demand of each building in Vienna was calculated. Besides building data, the results also include a heat density map in a 5x5 m raster, and heat source layers, e.g. on geothermal energy potentials.
Raw, primary data was first collected from various sources and processed at the *Municipal Department 20 - Energy Planning.* In some cases, the data first needed to be georeferenced or spatially aligned. This processed data was then made available to the research consortium. In order to (better) understand the available data, explanatory and exchange sessions within the consortium took place. The data was further processed by the projects scientific partners, with the intention of generating useful results for practical planning in the administration. Results were then again distributed to the consortium in the form of geodatabase files (GDB). This data is to be regularly updated by consortium members during the project duration.

After screening the data, essential elements were delivered to *Wiener Netze* (network provider). Within the local working group, the working group on technical issued focused on developing building typologies and mapping of geospatial data. *Wiener Netze* further developed economic and technical parameters, derived a scheme and provided data, from which areas to focus on DH and other renewable supply solutions were derived. DH in this context includes solely the central district heating system. For the development of the H/C maps, the following main criteria were taken as a basis:

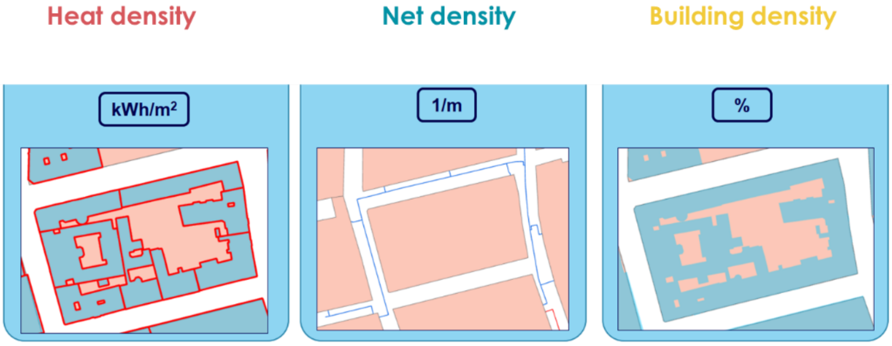


FIGURE 7 : THREE ESSENTIAL PARAMETERS FOR THE MAPPING (OWN ILLUSTRATION BASED ON THE WORK OF WIENER STADTWERKE)

The heat density reflects the modelled annual heat demand per m^2 of each building block, expressed in kWh/m^2a. A simple differentiation is made between high, medium and low heat density. The net density represents the district heating network (pipe) density with the parameter 1/m in reference to a census area (either “high” or “low”). The basis for the calculation is the current district heating network in metres.

The building density is the final parameter, expressed in % of built-up area of the census area (differentiation between “high” and “low building density”). In the future this will be extended by also including the gross floor area density.

In addition, the network operator considered the capacity and condition of the existing DH infrastructure. Further details on the categorisation and the underlying data are provided in the next chapter “H/C planning”.

The corresponding spatial resolution for all parameters is the census area (in most cases it contains 3 to 7 building blocks) and the street level. The aggregation levels for the H/C maps are either the building block or the census area (which is a statistical count area). The H/C maps include areas for:

- Central district heating supply,
- decentral local microgrids/DH and
- areas for single renewable energy solutions such as heat pumps.

The next chapter provides more information on H/C planning, including the current draft H/C maps.

H/C planning

The heating demand is based on the data model provided by the city of Vienna. Details on this can also be found in the Appendix. Essential factors were derived from the research project GEL SEP (Spatial Energy Planning for Energy Transition), including:

- Building period (construction age)
- Type of use
- Gross floor area
- Type of heat supply
- Funded refurbishment activities (also regarding historical building protection zones)
- Geometry of the buildings derived from a digital surface model (DSM) and a digital terrain model (DTM)
- Assignment of energy indicators developed by Technical University Graz (based on real consumption data)

Vienna’s network operators enhanced the model with their calculations on connection density, already connected buildings as well as with information on pipes (including data on hydraulics and capacity, e.g. performance of the primary network as well as aerial converters towards secondary pipe network).

The following three main criteria were used for identifying the preferred option for each census area:

- **Heat density** (for the census area in m²)
  - High: > 100 kWh/m²
  - Medium : 40 – 100 kWh/m²
  - Low : < 40 kWh/m²
- **Network/pipe density** for each census area / street level in 1/m
- Minimum threshold for the **build-up area** of the census area: 34%

Furthermore, minimum thresholds for the dimensions of primary pipes and secondary pipes were defined by *Wiener Netze* internally. A visualisation of the decision process (decision tree) towards district heating areas, heat pump areas and others can be found below:

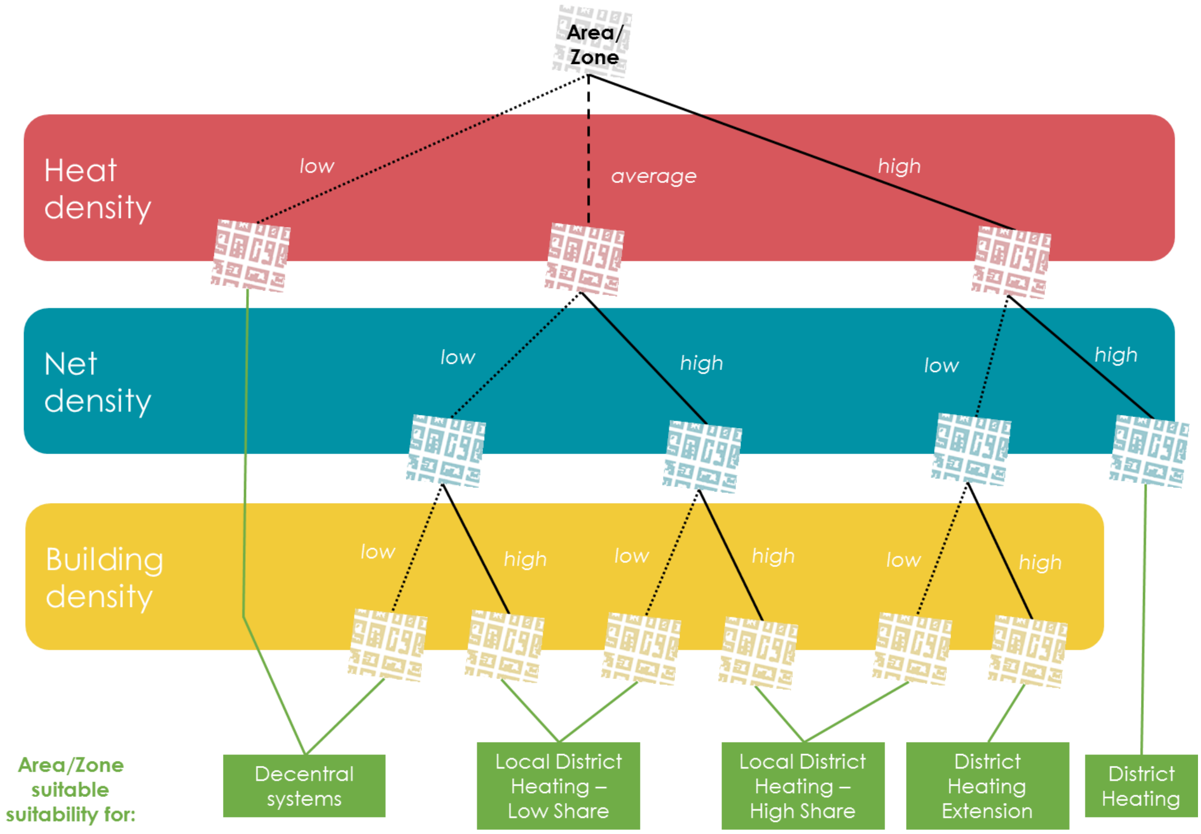


Figure 8 : decision tree for renewable supply solutions used in the H/C maps (own adaptations based on internal draft of Wiener Stadtwerke)

The draft H/C maps include preferable decarbonisation solutions as shown in the maps at the end of the Viennese section in this deliverable.

The first map shows the results on statistical count areas, the second map the ones on building blocks. As a result, the areas were divided into the following categories:

- **District heating** (Dark red areas: Central DH is broadly established; high potential to connect additional buildings to DH)
- **District heating – Extension** (Light red areas: Central DH established but less common; potential for all remaining buildings to be connected)
- **Microgrid/DH – High share** (Dark yellow areas: High share of existing DH, remaining areas are only suitable for central district heating to a limited extent; suitability for microgrids is high)
- **Microgrid/DH – low share** (Light yellow areas: Low share of existing DH, remaining areas are only suitable for central district heating to a limited extent; suitability for microgrids is high)
- **Renewable energy single solutions** (Green areas: Not suitable for grid-bound heat supply; single solutions preferred, such as shallow geothermal energy, groundwater, ambient heat, waste heat)

The following draft maps show the distribution of these spatial categories for the entire city and the inner city. As can be expected, in the dense areas of the inner city, district heating will be of utmost priority.

In most of the “red” areas, DH is already available or quite easy to extend, while the potential for renewable energy sources is low.

The yellow or orange areas are suitable for separate microgrids (local decentral heating networks). This might be because the density is not high enough for the central district heating network, there are lots of new or refurbished buildings, there is a low performance of the DH infrastructure (age and capacity of the pipes and transformation stations) or there are some “special” buildings with individual solutions like hospitals. At the same time, these areas comprise enough potential for integrating waste heat or other renewables. Additionally, district heating could supply only parts of these types of areas or function as a supply backup.

In the remaining green areas, there is a potential for renewable single heating solutions. Nevertheless, in some of the non-red areas some buildings are also already connected to district heating.

Overall, this approach should help to densify the scattered district heating network infrastructure.

In parallel, **decarbonisation types of buildings** were defined (see Figure 9). There are three main categories of residential buildings:

- single family or detached houses
- multifamily houses (3 to 9 apartments)
- apartment complexes (more than 10 apartments)

The most common energy supply solutions for each type were defined according to its building period. In addition, a distinction was made between already refurbished and unrefurbished buildings. In general, it was assumed that buildings constructed after 2001 have not yet been refurbished. Hence, these buildings are included as new buildings. There is an ongoing discussion about the energy demand depending on the construction period. However, this may not be so important because almost all buildings have already undergone many refurbishment measures (new roof, windows or facades/adaptations of the heat supply/insulation). Hence, no building would have the “original” energy demand according to its construction period.

Finally, decarbonisation types (= best option how to decarbonise the building) were derived for each building type. Based on this, the number of buildings and gross floor area for each category was then calculated. The typology was used to better understand the building stock in Vienna and to finally derive criteria to develop the H/C plans as well as calculate needed resources (investment, companies, devices, …).

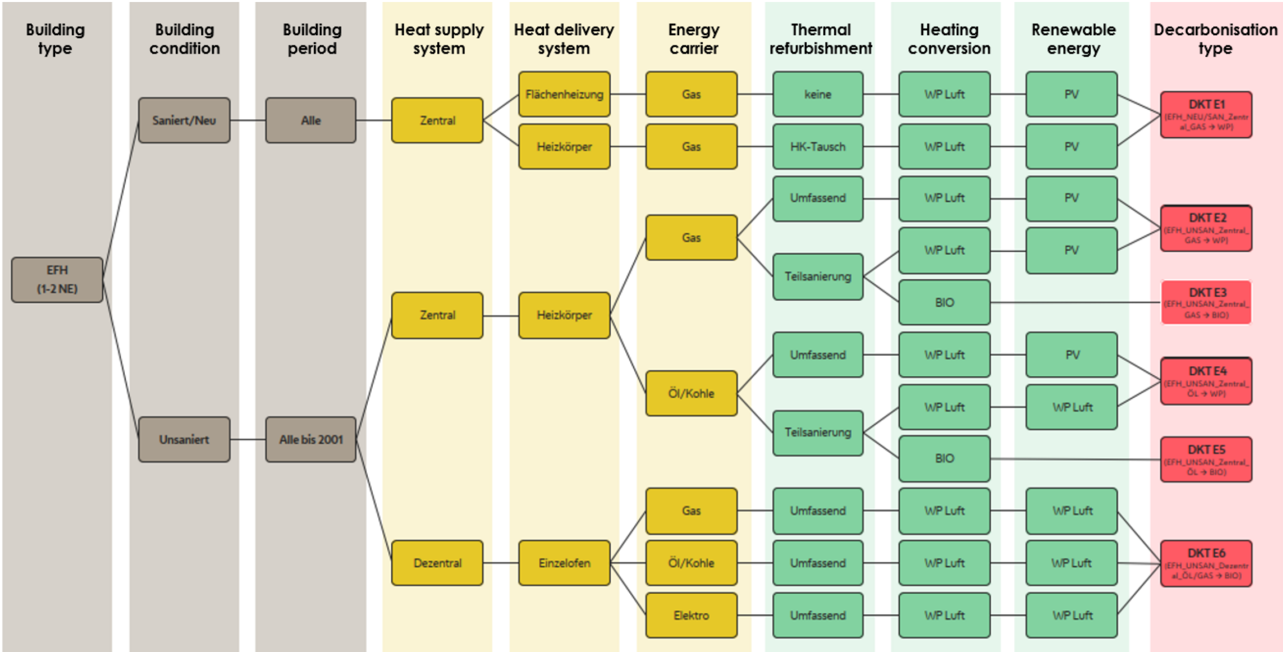


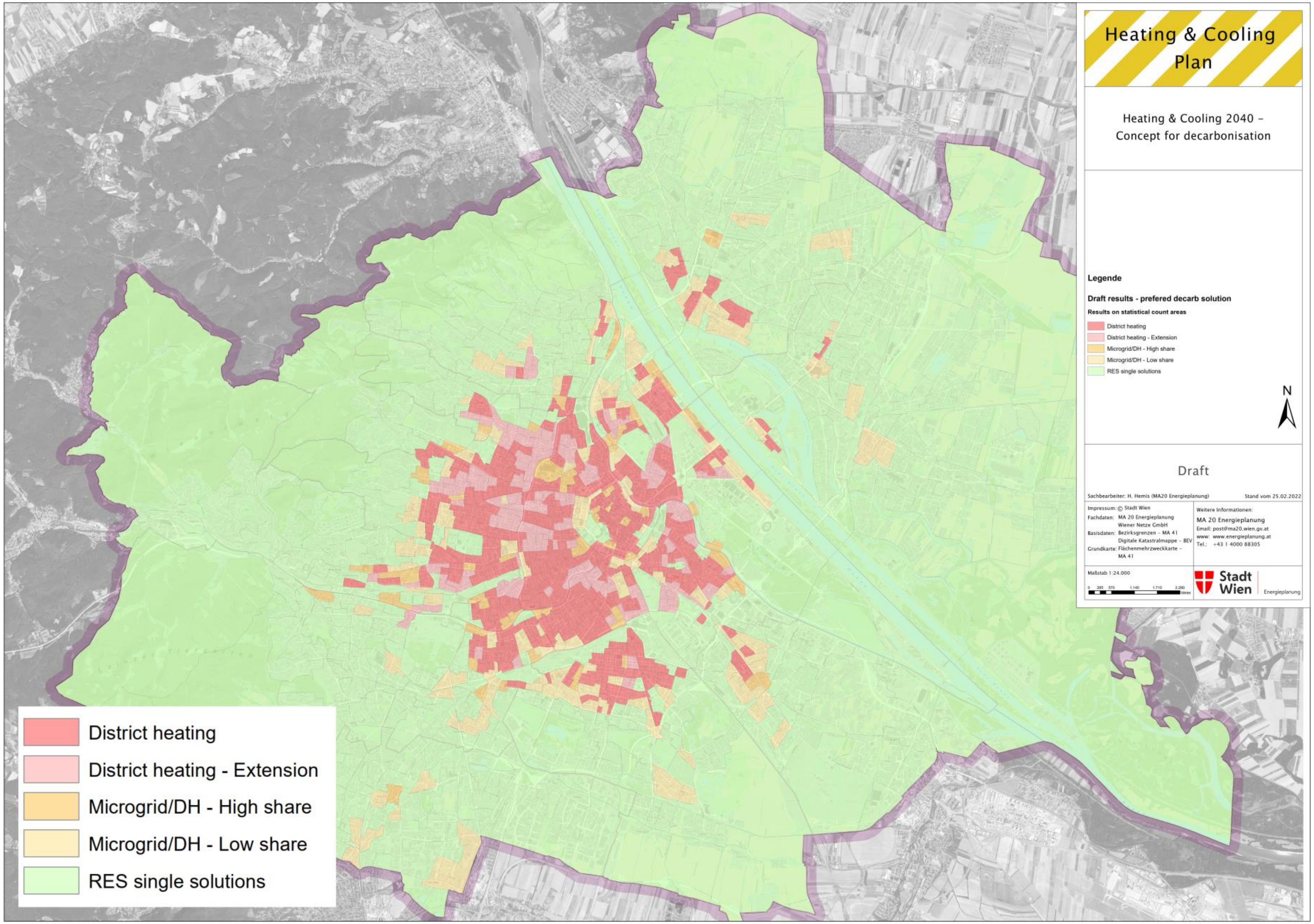
FIGURE 9 : DECARBONISATION TYPES, AS PRESENTED DURING PROJECT WORKSHOP ON H/C MAPPING (CITY OF VIENNA)

It is important to note, that the H/C plans shown below are dynamic. Adjustments are carried out continuously. Built on the already existing plans, the following list shows potential next steps for Viennas' H/C planning:

- Continuous integration of the updated data model (updates of basic data like energy certificates or building register)
- Validation of all data (calculated energy demand versus real consumption data, gross floor area, …)
- Further upgrades/improvements of the data model
- Considering details of the DH capacity for each area (calculation for each separate pipe)
- Calculation of the energy demand for all buildings in the zones of the energy zoning plans, which are not yet connected to DH
- Calculation of the energy demand and needed heat load for all suitable DH areas (matching the potentials of DH to the needed energy of each area)
- Development/improvement of criteria to identify microgrid areas
- Identification of buildings with dual grid-bound supply (district heating and gas)
- Estimation of renewable energy potentials as well as residual/waste heat for each property/building block
- Identification of priorities for decarbonised energy supply options for each area (census area/building block) or building – Revision of existing zones and definition of new zones
- Introduction of time frames: e.g. zone 1: extension of DH till 2027, with simultaneous discontinuation of gas supply, zone 2: installing renewable microgrids until 2035, …

The final results will be processed, amongst others, in new H/C map(s), which will be developed by the end of 2022 or 2023. These new maps will be also related to an implementation program based on the heating and cooling concept.

On the following pages, the first drafts of the H/C plans for Vienna are shown. The first map highlights the preferred decarbonisation solutions aggregated to statistical count areas. Statistical count areas are also shown in the second map, only at a larger scale. The third and final map shows the same results, however visualised on a building block level.


Heating & Cooling Plan
Heating & Cooling 2040 – Concept for decarbonisation
Legende
Draft results - prefered decarb solution
Results on statistical count areas
District heating
District heating - Extension
Microgrid/DH - High share
Microgrid/DH - Low share
RES single solutions
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Draft
Sachbearbeiter: H. Hemis (MA20 Energieplanung)
Stand vom 25.02.2022
Impressum: © Stadt Wien
Fachdaten: MA 20 Energieplanung
Wiener Netze GmbH
Basisdaten: Bezirksgrenzen – MA 41
Digitale Katastralmappe – BEV
Grundkarte: Flächenmehrzweckkarte – MA 41
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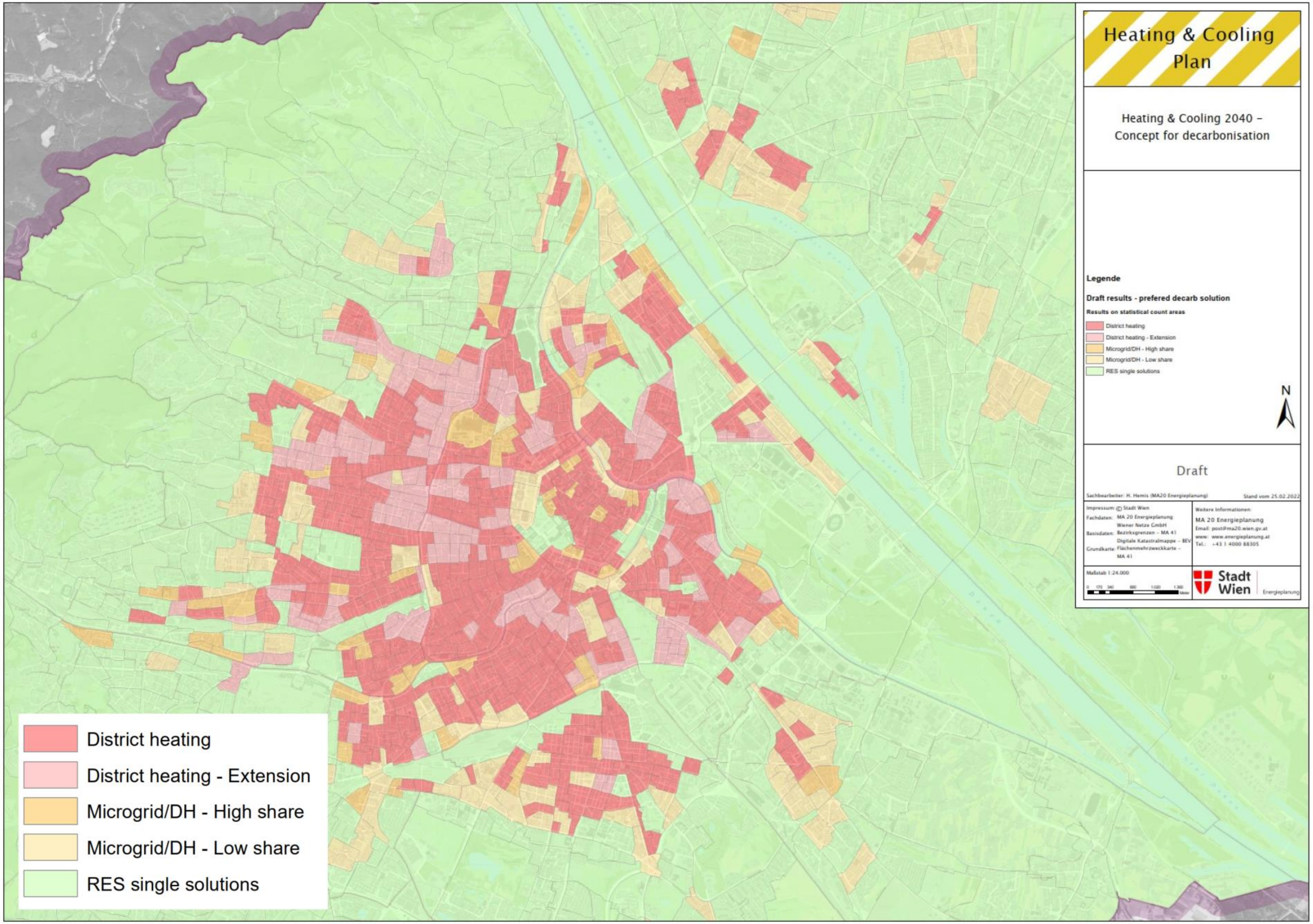
Maßstab 1:24.000
0 285 570 1.140 1.710 2.280 Meter
Stadt Wien
Energieplanung
District heating
District heating - Extension
Microgrid/DH - High share
Microgrid/DH - Low share
RES single solutions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Wiener Netze GmbH
Basisdaten: Bezirksgrenzen – MA 41
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Grundkarte: Flächenmehrzweckkarte – MA 41
Weitere Informationen:
MA 20 Energieplanung
Email: post@ma20.wien.gv.at
www: www.energieplanung.at
Tel.: +43 1 4000 88305
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Stadt Wien
Energieplanung
District heating
District heating - Extension
Microgrid/DH - High share
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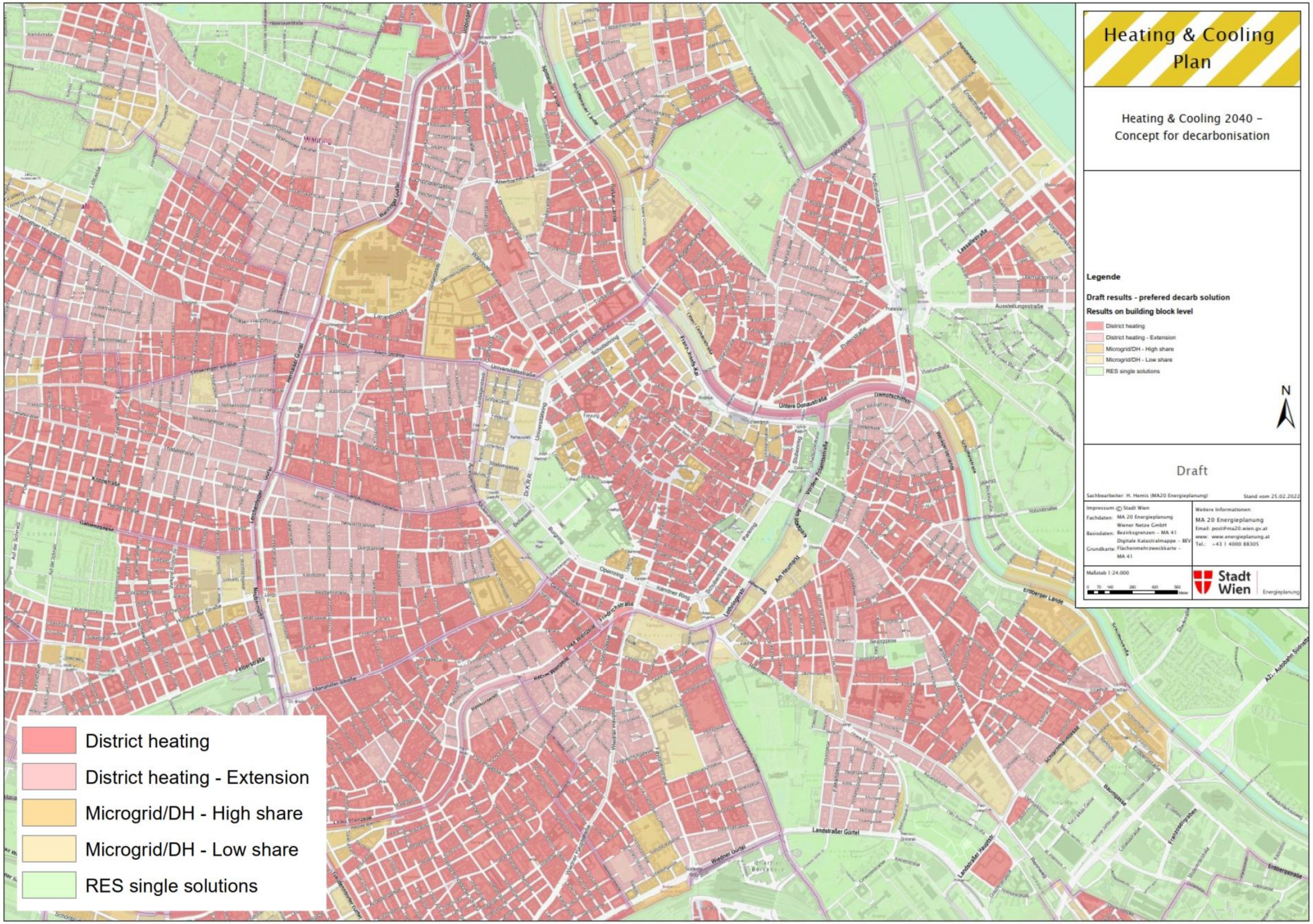
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Heating & Cooling 2040 – Concept for decarbonisation
Legende
Draft results - prefered decarb solution
Results on building block level
District heating
District heating - Extension
Microgrid/DH - High share
Microgrid/DH - Low share
RES single solutions
N
Draft
Stand vom 25.02.2022
Stadt Wien
Energieplanung
District heating
District heating - Extension
Microgrid/DH - High share
Microgrid/DH - Low share
RES single solutions

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Appendix: Data use

Raw data input

The following data was used for calculating the *energy demand* and identifying the energy system for each building:

- Building register (information such as construction period, gross floor area, type of use etc.)
- Energy certificates of buildings (e.g. to identify the type of heat supply)
- POI of open government data (OGD) – important uses like hospitals or schools (complemented or replaced the information of the building register by using priorities of uses)
- Funded refurbishment activities
- List of historical buildings (protection zones)
- Geometry derived from a digital surface model (DSM) and a digital terrain model (DTM)
- Assignment of energy indicators (based on real consumption data)
- Digital cadastral map (building footprints and important building related IDs)

Additionally, the following *infrastructure* data was used:

- Central pipe cadastre for gas supply
- Central pipe cadastre for district heating

Data on *energy potentials* (these need to be completed for the next update of the maps):

- Shallow geothermal energy potentials
- Solar energy cadastre
- Air heat pump potentials
- Wastewater heat potential
- Waste heat potential
- Hydrographic survey point data

The list mentioned in the appendix is an excerpt of the most important data bases, but does not fully represent the elaborated data model. It represents the basic data, which was enhanced by *Wiener Netze*. The network operator complemented the model with internal data, e.g. with the length of different pipe systems and already connected buildings to the district heating network.

The next step will include a detailed calculation for each area using the existing capacity, the condition of each DH station in the buildings and the potential to enhance the pipe infrastructure.

More details on the data used, are to be found in the upcoming Deliverable 2.4. “Report on data availability, data sovereignty, quality and exchange in the participating cities and policy recommendations”.

DECARB CITY PIPES 2050

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