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DECARBONISATION THROUGH INNOVATION

Flexible deployment of heat pumps for urban decarbonization in vienna

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Abstract

Vienna has set the goal of becoming climate-neutral by 2040. A decisive lever is the full decarbonization of space heating and domestic hot water (DHW). This paper presents a portfolio of flexible, heat-pump–based solutions that complement a rapidly decarbonizing district heating system with innovative neighborhood-scale concepts. We outline an iterative planning approach – from vision, feasibility, and concept design to implementation and operation – that systematically integrates local resources such as groundwater, geothermal energy, waste heat, photovoltaics, and seasonal storage. Results are illustrated with realized and ongoing projects in Vienna: (i) Donaufeld, where a central chilling plant provides ~20 °C tempering and recovers waste heat to district heating; (ii) Oberes Hausfeld, a 37 °C heat-source network supplied by the district heating return and groundwater heat pumps; (iii) Village im Dritten, Austria's largest anergy network with ~500 geothermal probes enabling seasonal storage; (iv) Meischlgasse, a cold local heating network that supplies heating, hot water, and cooling without fossil fuels or a district heating connection; (v) VioPlaza, which recycles heat from cooling and the sewer; and (vi) Deutschordenstraße, a flagship retrofit replacing individual gas boilers with a central plant based on propane heat pumps, geothermal probes, and PV. The case studies demonstrate how smart performance and load management, source optimization, and integrated heating/cooling raise efficiency, cut peak loads, and accelerate urban decarbonization.

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Keywords: heat pumps; urban energy systems; neighborhood energy; cold heating network; seasonal storage;

1. Introduction

The City of Vienna pursues climate neutrality by 2040. Achieving this objective requires a full decarbonization of the heat supply so that space heating and DHW are provided exclusively from renewable sources. The Vienna Heat Plan 2040 [1] sets the strategic framework and supports the transition of roughly 600,000 gas-fired heating systems to climate-neutral solutions. In addition to reducing energy demand via building retrofits, two pillars are decisive [2]: (i) scaling and decarbonizing district heating with large-scale technologies such as deep geothermal energy and large heat pumps, and (ii) substituting fossil fuels with innovative local and neighborhood solutions that utilize site-specific resources. Wien Energie invests in large-scale solutions (e.g., heat pumps in Simmering using waste heat from power-plant cooling water and treated wastewater) [3-4] and in sector coupling projects where cooling production feeds heat back into the district heating network (e.g. Hauptbahnhof, ÖAMTC Schubertring, Schweidlgasse, etc.) [5-7]. Yet district heating alone is not sufficient. In less dense areas and many new developments, neighborhood systems are needed to exploit local potentials such as geothermal energy, waste heat, and photovoltaics. These solutions provide efficient, flexible, and sustainable heating and cooling while complementing the central district heating system.

Focus of this paper: innovative heat pump concepts for neighborhood solutions that optimally leverage local energy sources to accelerate decarbonization in Vienna. Key advantages include:

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- Performance management: Neighborhood systems enable optimized control of energy flows across multiple buildings. Smart control maximizes heat pump efficiency and strengthens security of supply.
- System-level load management incl. seasonal storage: Aggregating buildings allows peak shaving and the integration of seasonal storage, improving renewable utilization over the year.
- Source management: Local resources such as groundwater, industrial/commercial waste heat, and shallow geothermal energy can be targeted and diversified, reducing dependence on central networks.
- Optimization of site resources: Combining photovoltaics with heating and cooling increases self-consumption and lowers grid stress, creating synergies between the power and heat sectors.
- Integrated heating and cooling: Heat pumps can provide both heating and cooling within one system. Higher annual utilization, lower operating costs, and climate-ready buildings are achieved by using heat recovered in one service for the other.

2. Methods / Approach

Planning district-scale and neighborhood heat pump solutions follows a staged, iterative workflow that progressively increases precision and robustness. Feedback from later phases is used to refine earlier assumptions, ensuring an optimized concept for climate-neutral energy supply. Each site is assessed individually with respect to local requirements and the availability of resources such as geothermal energy, waste heat, and photovoltaics. The process consists of five main stages:

- Vision: Define overarching goals such as decarbonization, quality of life, and innovation. Establish a guiding framework for subsequent planning steps.
- Feasibility: Conduct an initial screening of local resources and potentials. Compare alternative supply concepts and prepare a feasibility study as the basis for concept development.
- Concept Design: Set demand and supply envelopes, define system architecture, and engage in dialogue with developers and investors. Select the preferred energy concept and provide first price indications.
- Detailed Design: Perform simulations and sizing calculations, prepare permit-ready plans and offers, and conclude contracts and obtain approvals.
- Implementation & Operation: Construct and commission the infrastructure. Monitor, optimize, and operate the system in daily practice, applying iterative improvements based on performance data.

3. Results and Discussion

The following section presents practical implementations of heat pump concepts in Vienna, illustrating how theoretical planning translates into real-world solutions. Each case study demonstrates different approaches to leveraging local resources—such as waste heat, groundwater, and geothermal energy—while addressing site-specific challenges. Together, these projects highlight the versatility of heat pumps in urban contexts, from new developments to retrofits, and provide insights into performance, scalability, and lessons learned for future applications.

3.1. Donaufeld

In the Donaufeld urban development area (21st district), an innovative solution provides sustainable cooling for around 2,000 dwellings (Fig. 1). A dedicated network delivers climate-friendly tempering at about 20 °C from a central chilling plant. The resulting waste heat is not rejected to the ambient air; instead, it is efficiently fed into the district heating network for further use. Fourteen building plots are served by district heating, while a further seven plots are supplied via a ~800 m distribution network. With a connected cooling capacity of approximately 1.2 MW, an annual cooling demand of about 1,400 MWh can be met. The concept avoids rooftop heat rejection units, improving urban design and mitigating local heat emissions. State-of-the-art ammonia chillers with modern safety systems are deployed, representing a new approach for residential buildings.

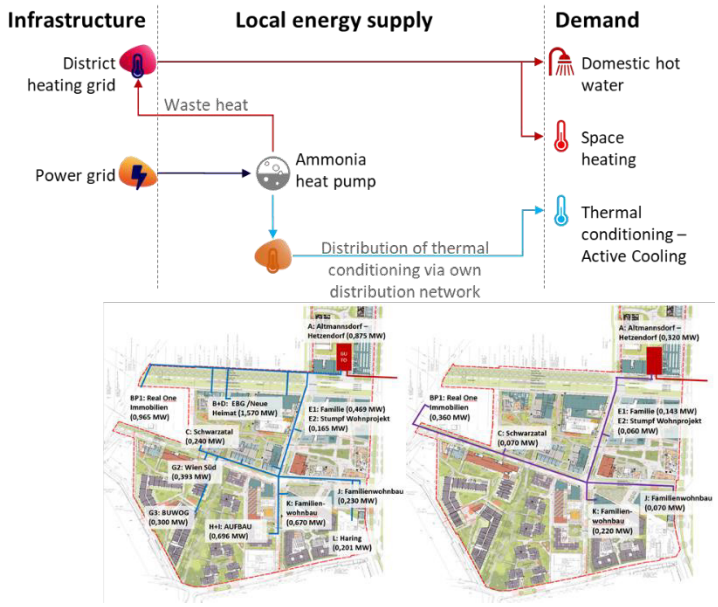

Figure 1. Donaufeld – Sustainable Cooling and Heat Recovery Concept.

3.2. Oberes Hausfeld

The new quarter 'Oberes Hausfeld' (22nd district) implements a novel business model in which developers are provided with a heat-source network (Fig. 2) [8]. A 37 °C source network for space heating is supplied by the district heating return as well as groundwater heat pumps. The district heating pipeline runs up to the future deep-geothermal plant in Aspern Seestadt. Utilizing the return line lowers the return temperature, thereby improving the utilization of deep geothermal energy. The heat output available from the source network is about 4.1 MW, serving roughly 208,000 m² of net floor area for around 2,700 dwellings.

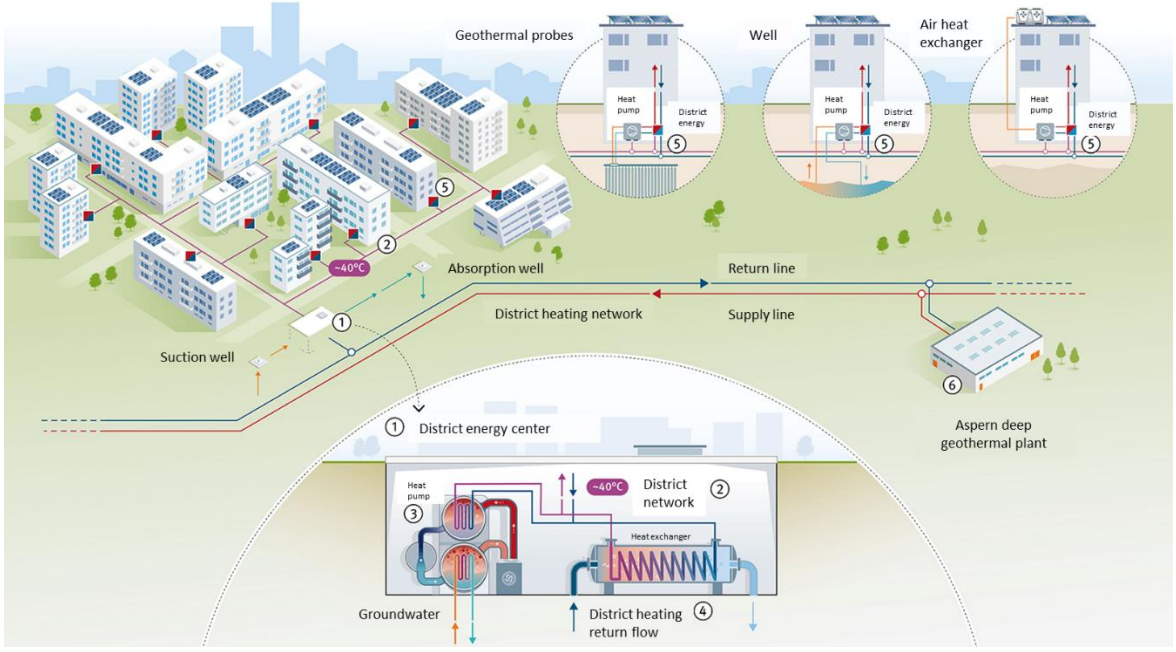

Figure 2. Oberes Hausfeld – Heat-Source Network for Space Heating.

3.3. Village im Dritten

Village im Dritten is among Europe's most innovative infrastructure projects. Approximately 500 geothermal probes are interconnected to create Austria's largest anergy network (Fig. 3). With depths up to

150 m, the probes enable geothermal energy use for both heating and cooling. Temperatures of about 5–19 °C are utilized by brine heat pumps located in the on-site energy center, powered in part by rooftop PV. During summer, excess heat is stored underground via the probes; in winter, the stored energy is recovered and upgraded by heat pumps. This allows a significant share of heating and cooling demand to be covered by local renewable resources.

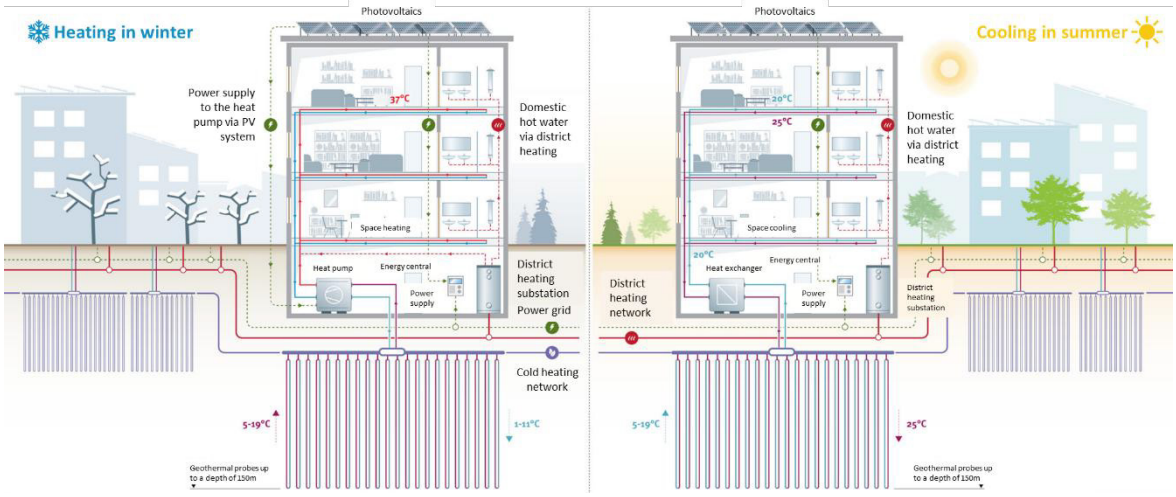

Figure 3. Village im Dritten – Austria's Largest Anergy Network.

3.4. Meischlgasse

In the 23rd district, the 'Meischlgasse' quarter is being developed on a 9.6 ha site with about 1,900 dwellings. Together with several developers, Wien Energie is implementing an intelligent, cross-plot energy system (Fig. 4). A cold local heating network interconnects local resources to supply heating, DHW, and cooling. The mix includes heat pumps, solar thermal collectors, photovoltaics, and air heat exchangers. The subsurface serves as a seasonal store: in winter, heat is extracted via borehole heat exchangers and upgraded by heat pumps; in summer, excess heat is injected underground to provide gentle building cooling. The heat capacity amounts to 3.7 MW (heating and DHW) and the tempering capacity to 1.3 MW, supplying roughly 95,000 m² of net floor area. Notably, the quarter operates without fossil fuels and without a district heating connection, providing a pilot and blueprint for large-scale climate-neutral developments in Vienna and beyond.

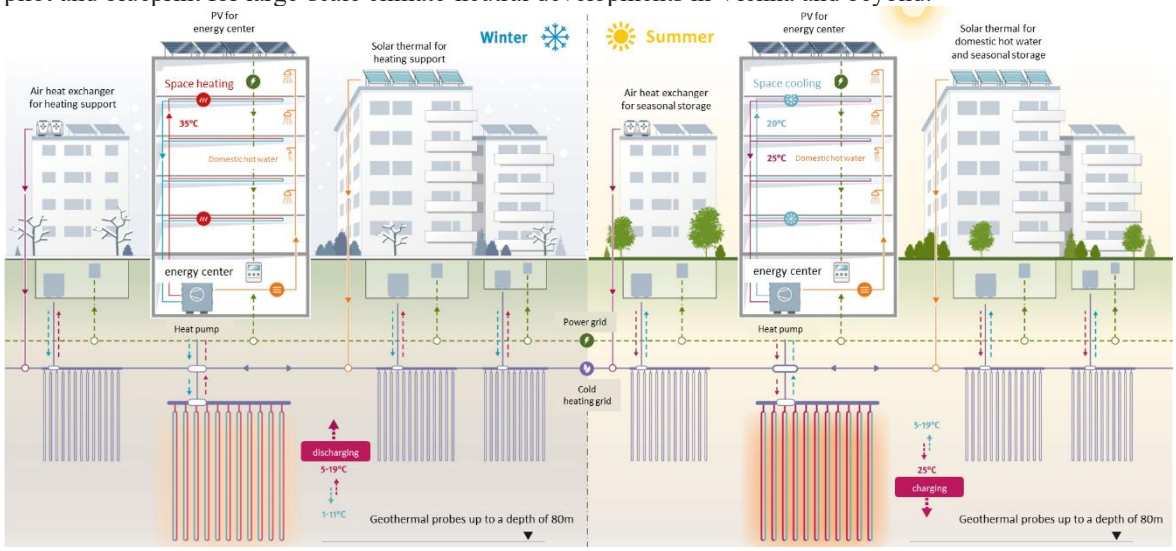

Figure 4. Meischlgasse – Integrated Renewable Energy System.

3.5. VioPlaza

The VioPlaza project is a mixed-use complex for approximately 3,500 people [9]. The concept relies on smart 'heat recycling': local waste heat from cooling production and energy from the sewer are used directly on site (Fig. 5). Wien Energie contributed significantly to the planning and implemented the local heating and cooling plants. A key component is a 180 m sewer heat exchanger integrated during a sewer relocation. The exchanger leverages the nearly constant sewer-water temperature (approx.16 °C); a heat pump in the on-site energy center upgrades it for space heating during the cold season. In summer, waste heat from cooling is not rejected to ambient air; it is either fed into the local district heating network to supply DHW to the surrounding neighborhood or discharged via the sewer. Conventional rooftop condensers are therefore avoided.

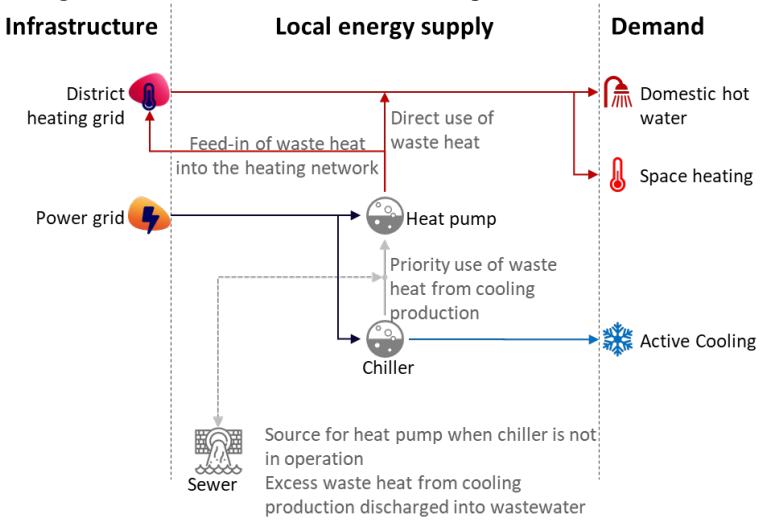

Figure 5. VioPlaza – Heat Recycling from Cooling and Sewer.

3.6. Deutschordenstraße

The Deutschordenstraße housing estate (14th district) is one of the first pilot projects of the 'Get out of Gas' initiative and a showcase for decarbonizing existing buildings [10-12]. It comprises twelve residential buildings with 277 apartments constructed in the 1950s, previously heated by decentralized gas boilers. A comprehensive thermal retrofit reduced the space-heating demand by over 75%. In parallel, the heat supply is being fully converted to renewables. The heart of the new system is a central plant with propane heat pumps using ambient air and shallow geothermal energy as sources, the latter via 24 deep boreholes of 120 m each. A 280 kWp photovoltaic system helps cover part of the heat pumps' electricity demand on site. The conversion is implemented in stages and in agreement with tenants. Existing in-flat heating installations can largely remain; connections are routed via newly built elevator shafts. Technical rooms are housed in two greened auxiliary buildings. The project demonstrates how fossil heating in legacy multi-family buildings without district heating can be replaced by a combination of heat pumps, geothermal energy, and photovoltaics – providing a model for climate-neutral heat supply in Vienna's municipal housing.

4. Conclusions

Heat pumps are a cornerstone of Vienna's pathway to climate neutrality, enabling flexible integration across district heating, neighborhood systems, and building-level applications. While large-scale heat pumps and deep geothermal energy decarbonize central networks, neighborhood-scale solutions play a vital role in less dense areas and new developments. These systems leverage local resources such as geothermal energy, waste heat, and photovoltaics to provide efficient, renewable heating and cooling close to demand. They also allow smart load management and seasonal storage, reducing peak loads and improving system resilience.

However, retrofitting existing building stock remains a major challenge. Technical constraints, space limitations, and tenant coordination require tailored concepts and phased implementation. Projects like Deutschordenstraße show that combining heat pumps with geothermal probes and PV can replace fossil systems even in legacy multi-family housing without district heating.

Looking ahead, scaling neighborhood solutions and addressing retrofit complexity will be key to achieving climate-neutral urban heating. Extending these approaches to commercial and industrial sectors, coupled with advanced waste-heat recovery and sector integration, will accelerate the transition and strengthen energy security for Vienna.

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