15TH IEA HEAT PUMP CONFERENCE
MAY 26–29, 2026 | HOFBURG
VIENNA 2026
DECARBONISATION THROUGH INNOVATION

District Cooling Network

DI Michael Meyer[a], DI (FH) DI Georg Geißegger[a], Michael Nassberger[a],
MMst. DI Harald Erös[b],

[a]Wien Energie GmbH, Thomas Klestilplatz 15 1030 Vienna
[b]Österreichische Gesellschaft der Kältetechnik, Althanstr. 1-3/1/30, 1090 Vienna

Abstract

The new F-Gas regulation and the potential ban on refrigerants that produces everlasting chemicals like PFAS are a particular challenge for operators with long-term plans. Energy efficiency, long-term availability, CAPEX vs. OPEX are just some of the issues to consider. These considerations are highlighted in the first part. Actual implementations are presented in the second part.
The "District Cooling Network" outlines the vision and strategic development of district cooling in Vienna, underscoring the city's ambition to become the District Cooling Capital of Europe. The initiative aims to make district cooling a daily experience for all Viennese residents by using renewable energy sources, river water, waste heat, and storage solutions.
The development strategy for the city's cooling network focuses on customer potential, production facilities, and main hydraulics. By 2025, the network expanded to include multiple systems, with a projected customer connection capacity of approximately 234 MW. The network is designed to accommodate historical buildings, ensuring that district cooling is both modern and respectful of Vienna's architectural heritage.
Key components of the cooling network include the use of ice storage systems, which improve energy efficiency by utilizing discharging during peak demand periods and charging during off-peak hours using low-cost electricity.
The MedUNI cooling plant, featuring centrifugal chillers, absorber, ice storage and waste heat recovery systems, exemplifies the integration of advanced technologies in the network.
An example of the use of heat pumps with natural refrigerants is the local heating network in Oberlaa. Here, thermal water is used to supply 1,900 households with a heat pump using ammonia.
In summary, the use of efficient technology coupled with natural, sustainable cooling and heat pump technology can contribute to the decarbonization of the city of Vienna.

Keywords: F-Gas Regulation, PFAS, District Cooling, Energy Efficiency, Heat Pumps (Natural Refrigerants), Decarbonization;

1. Introduction

The European Union, under its “European Green Deal”, has established a comprehensive strategy to create a fair and prosperous society with a modern, resource-efficient and competitive economy. The main objective of this strategy is to make Europe the first climate-neutral and pollution-free continent by 2050. A central element of this endeavour concerns the management of fluorinated greenhouse gases (F-gases), which currently account for approximately 2.5 % of the total greenhouse-gas emissions within the European Union. While emissions of other greenhouse gases have declined since 1990, emissions of fluorinated gases have nearly doubled during the same period. These developments prompted the European Commission to carry out a complete revision of the existing F-gas framework. The new F-Gas Regulation (EU) 2024/573[1] provides for a gradual but complete ban on the placing on the market of F-gases by the year 2050.

These regulatory changes present significant challenges for operators of refrigeration, air-conditioning and heat-pump systems. The new F-Gas Regulation, together with ongoing initiatives under the REACH

Regulation[2] that aim to restrict or prohibit substances capable of forming persistent chemicals such as per- and polyfluoroalkyl substances (PFAS), requires a strategic reassessment of both existing and future systems.

In recent years, there has been a clear shift toward refrigerants with lower Global Warming Potential (GWP). Natural alternatives such as air, carbon dioxide (CO_2), ammonia, hydrocarbons and water are gaining increasing importance. These refrigerants not only offer ecological benefits but also provide long-term supply security, since they are not affected by future bans on fluorinated substances. However, their use often requires modifications in system design, safety provisions and maintenance procedures. Where safety or technical requirements cannot be fulfilled by the use of natural refrigerants, hydrofluoroolefins (HFOs) such as R-1234ze may represent a viable alternative in line with the provisions of the F-Gas Regulation.

For operators with long-term investment and operational planning horizons, these developments give rise to complex questions that extend far beyond simple regulatory compliance. The selection of the appropriate refrigerant becomes a multidimensional decision that must balance ecological, technical and economic aspects. In addition to sustainability and environmental compatibility, important factors include energy efficiency, the long-term availability of suitable refrigerants and components, capital expenditure (CAPEX) and operational expenditure (OPEX). Other considerations involve the development of market prices in the context of the F-gas phase-out, the availability of qualified maintenance personnel and the performance of the systems in terms of volumetric cooling capacity and efficiency indicators such as the Coefficient of Performance (COP) or Energy Efficiency Ratio (EER).

These diverse considerations demonstrate that the European refrigeration and air-conditioning sector is undergoing a profound structural transformation. The transition toward sustainable, long-term available and efficient refrigerant solutions requires a balanced combination of ecological objectives, technological innovation and economic feasibility. The following chapters discuss these challenges in detail and highlight technical and strategic approaches that appear viable for operators in the long term.

An additional contribution to CO_2 reduction comes from the heating sector, particularly through the intelligent integration of heating and cooling technologies into coherent system networks. The following chapters examine these aspects in detail and present technical and strategic examples that demonstrate how such approaches can be successfully implemented in practice.

2. Vienna's district Cooling Network – Vision, Strategy

Vienna is emerging as a European frontrunner in sustainable urban cooling, with the ambitious goal of becoming the District Cooling Capital of Europe. The city's District Cooling Network is not only a technical infrastructure project but a strategic urban transformation initiative. It aims to make district cooling a daily experience for all residents, integrating seamlessly into offices, homes, museums, and public buildings.

2.1. Vision and Urban Integration

The vision for district cooling in Vienna is rooted in accessibility, visibility, and sustainability. By 2025, the network reached a customer connection capacity of approximately 240 MW, with multiple interconnected systems across the city. The initiative emphasizes that everyone in Vienna should know and feel district cooling, making it a tangible part of everyday life.

This transformation is powered by green cooling technologies, including:

- Renewable electricity
- River water from the Danube Canal
- Waste heat recovery
- Integrated thermal energy management systems
- Ice storage systems

The network is designed to respect Vienna's rich architectural heritage, with cooling solutions tailored to historical buildings such as those in the city centre. This ensures that sustainability and cultural preservation go hand in hand.

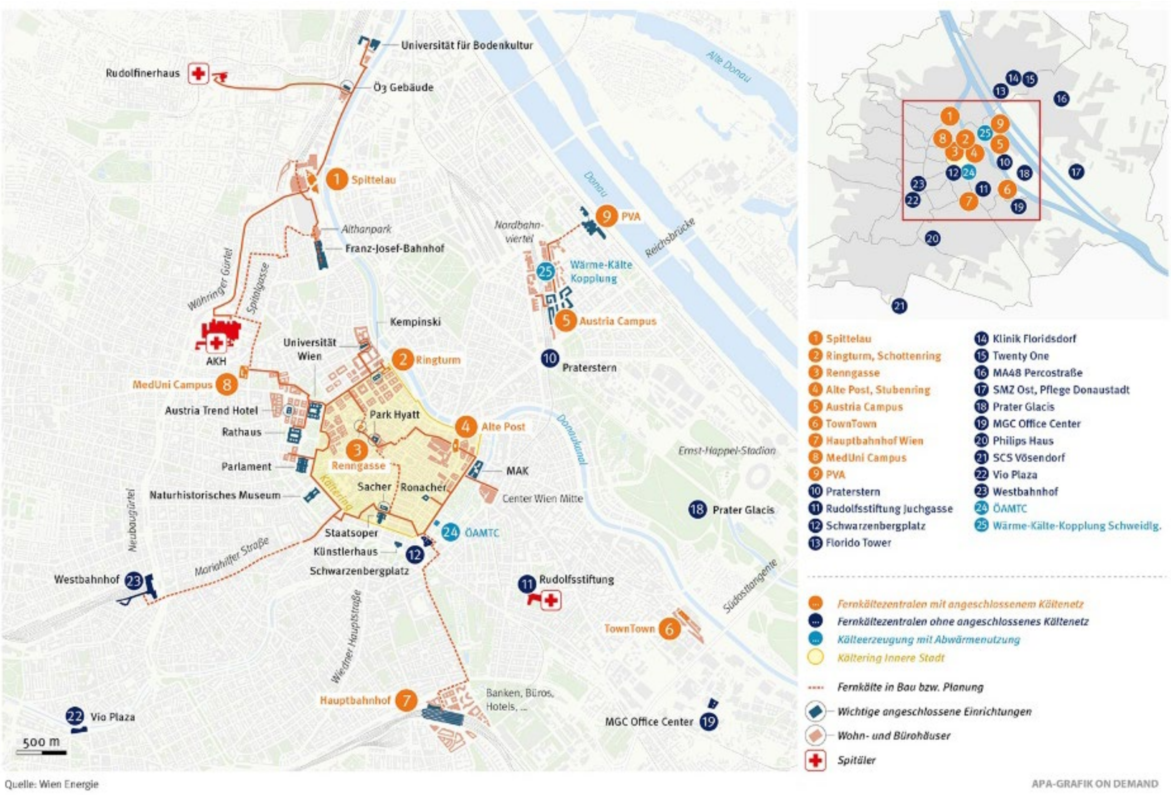

Figure 1. District Cooling Network

2.2. Strategic Development

The development strategy focuses on three pillars: customer potential, production facilities, and main hydraulics. By 2025, the network expanded to multiple systems with a total customer connection capacity of approximately more than 240 MW. The goal for 2030 is to expand to 370 MW and establish a comprehensive network in the city centre. The system is designed to serve both modern commercial buildings and historic structures, preserving architectural heritage while meeting contemporary cooling demand.

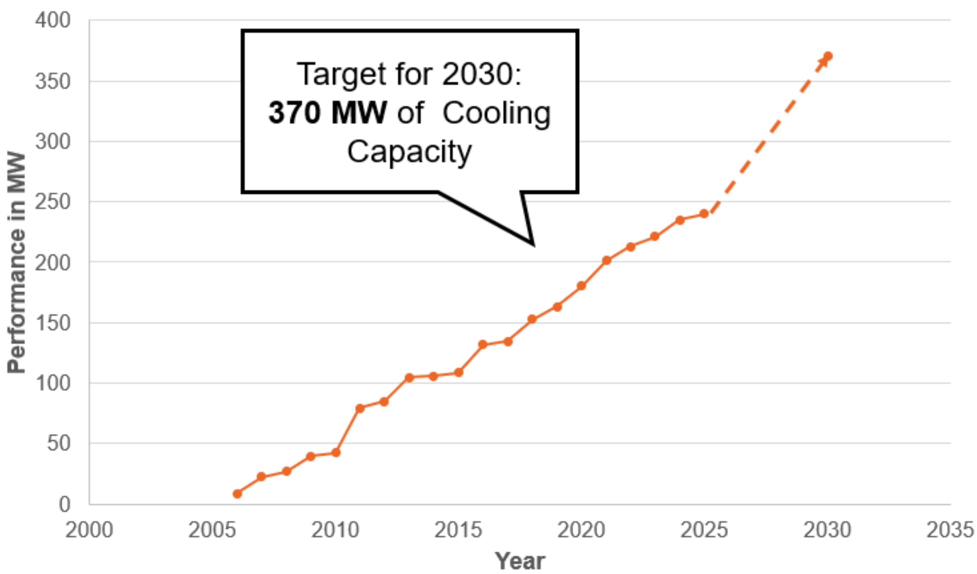

Figure 2. Cooling capacity in MW over the years

2.3. Energy Efficiency and Ice Storage Innovation

A cornerstone of Vienna's strategy is the use of ice storage systems to optimize energy use. These systems:

- Charge during off-peak hours using low-cost electricity
- Discharge during peak demand periods, reducing grid strain

This approach balances peak-load management with economic energy use, demonstrating a sophisticated understanding of energy economics.

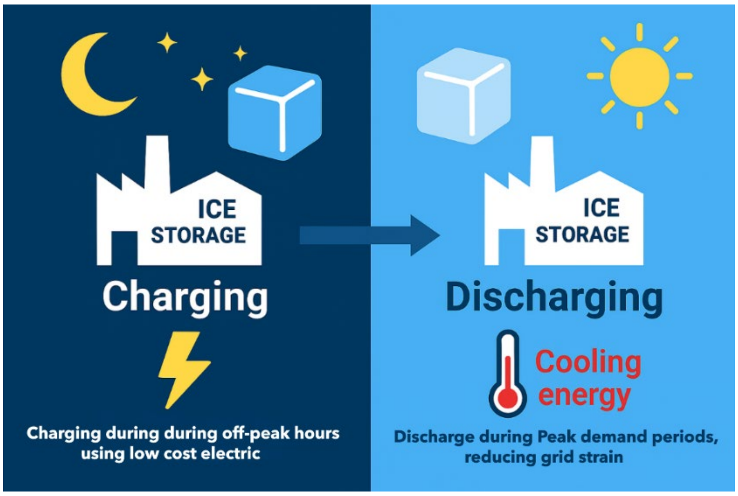

Figure 3. Ice Storage

2.4. Digitalization and Performance Management

To coordinate multiple plants and optimize operations, Vienna is developing a Performance Management System. Since 2024, a Digital Twin has been trained to forecast cooling demand for the next 24 h with up to 92 % accuracy, based on weather data. This predictive capability enhances operational efficiency and supports dynamic load balancing across the network.

2.5. Environmental Impact and CO_2 Reduction

District cooling significantly reduces carbon emissions compared to conventional systems. For example, a connected load of 1,36 MW with 800 full-load hours and consumed energy 1,088 MWh/a annually results in:

- 67,860 kg CO_2/year for conventional systems
- 38,980 kg CO_2/year for district cooling
- 43 % CO_2 savings

This aligns with Austria's OIB Richtlinie 6[3] and supports national climate goals for CO_2 Emissions:

- 156 g CO_2 per kWh electricity
- 35.83 g CO_2 per kWh district cooling

3. Heat Pump Thermal Bath Oberlaa

The Thermal Bath Oberlaa heat pump project in Vienna demonstrates an innovative approach to utilizing thermal wastewater as a renewable heat source for district heating. The system recovers waste heat from thermal spa effluent, which remains available even during winter.

The system employs two ammonia-based large-scale heat pumps (NH_3, R717) with a combined thermal capacity of 2 MW and a COP between 4 and 5.5. They are installed in an extended technical room at Thermal Bath Oberlaa. These heat pumps extract residual heat from thermal wastewater at approximately 30 °C and upgrade it to district heating temperatures of up to 85 °C. The generated heat is directly fed into the local district heating network in Oberlaa.

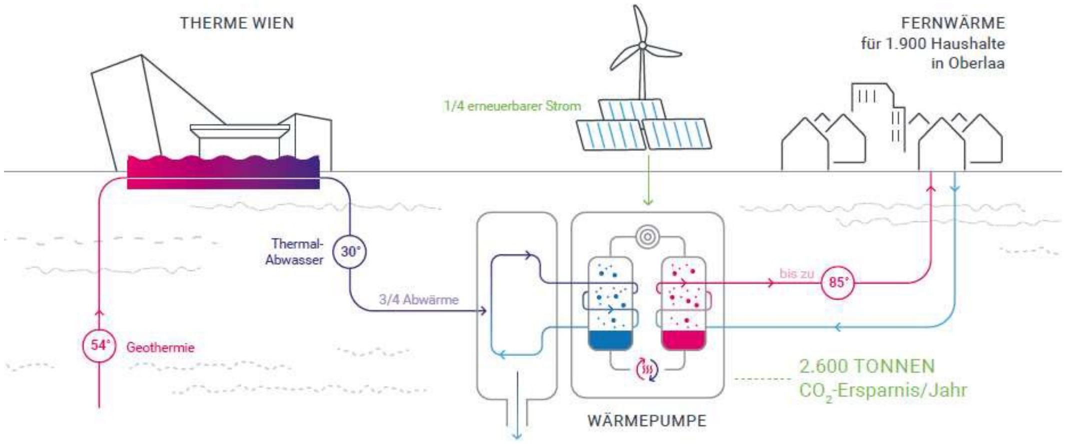

Figure 4. Conceptual principle - Utilization of waste heat from thermal wastewater

3.1. Key Performance Indicators

- Installed Capacity: ~2 MW
- Annual Heat Production: 11 GWh
- Households Supplied: 1,900
- CO_2 savings: 2,600 tons/year

3.2. Strategic Importance

This project is part of the Therma FLEX research initiative, funded by Austria's Climate and Energy Fund. It aims to enhance flexibility in district heating networks by integrating diverse renewable sources such as geothermal energy, large-scale heat pumps, and local waste heat recovery. The initiative supports Vienna's target to supply 56 % of the city with district heating and achieve full climate neutrality by 2040.

3.3. Environmental Impact

By utilizing thermal wastewater, the project significantly reduces greenhouse gas emissions and demonstrates how local waste heat recovery can complement other renewable technologies in urban heating systems.

4. Integrated Thermal Energy Management - MedUNI Cooling Plant

An advanced thermal energy management strategy is implemented at MedUNI, utilizing a high-efficiency heat pump system in conjunction with an ice storage unit. The system is designed to provide year-round climate control, integrating summer cooling, winter heating, and thermal energy storage for peak load management. The approach demonstrates significant potential for energy optimization and operational flexibility in large-scale public and commercial facilities.

4.1. System Overview

The core of the MedUNI thermal management system is the heat pump, operating with R515B refrigerant and equipped with a variable-speed screw compressor. This configuration enables multiple operating modes:

- Summer Cooling Mode: Provides chilled water for air conditioning and recovers heat for low temperature heating.
- Winter Heating Mode: Supplies low-temperature heat for building heating requirements.
- Ice Storage Charging Mode: Produces ice at sub-zero evaporator temperatures for thermal energy storage, enabling load shifting during peak cooling demand.

4.2. Seasonal Operation Strategy

- Summer Cooling: In summer, the system provides chilled water at 5 °C for air conditioning while simultaneously rejecting heat via rooftop condensers.
- Winter Heating: During winter, the heat pump extracts heat from the evaporator circuit and delivers it to the condenser at elevated temperatures (50 °C – 55 °C), achieving a heating capacity of approximately 1,300 kW . This heat is utilized for low temperature heating at MedUNI.
- Ice Storage Integration: The ice storage system (IceBat UW) offers a latent storage capacity of 6,200 kWh, enabling the system to store cooling energy during off-peak hours and discharge it during peak demand periods. The ice is generated at evaporator temperatures between –1.5 °C and –5 °C, with a cooling capacity of 800 kW by the heat pump.

4.3. Dynamic Heat Pump Utilization

The heat pump serves as a bidirectional energy hub:

- On the condenser side, heat can either be used for winter heating or rejected to the atmosphere via rooftop condensers during summer.
- On the evaporator side, the system can charge the ice storage or directly supply chilled water to the district cooling network, depending on operational requirements.

This flexibility allows MedUNI to optimize energy use, reduce peak electrical loads, and enhance system resilience.

4.4. Energy Efficiency and Load Shifting

The integration of ice storage provides significant benefits:

- Load Shifting: Cooling energy is stored during low-demand periods and utilized during peak hours, reducing strain on the electrical grid.
- Operational Efficiency: The system achieves high COP and EER values across operating modes, ensuring minimal energy waste.
- Sustainability: By leveraging thermal energy storage and heat recovery, the system reduces greenhouse gas emissions and operational costs.

The MedUNI system exemplifies a holistic approach to thermal energy management, combining advanced heat pump technology with ice storage to deliver efficient, flexible, and sustainable climate control. This strategy is particularly relevant for large-scale public and commercial buildings seeking to optimize energy consumption and integrate renewable energy sources.

5. Conclusion

Vienna’s District Cooling Network exemplifies how cities can integrate renewable energy, smart infrastructure, and cultural sensitivity into a cohesive urban cooling strategy. With its scalable design, innovative technologies, and strong environmental performance, Vienna sets a benchmark for sustainable urban cooling in Europe.

References

[1] Regulation (EU) 2024/573 of the European Parliament and of the Council of 7 February 2024 on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) No 517/2014 (Text with EEA relevance)

[2] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

[3] OIB – Richtlinie 6 | Global Buildings Performance Network – Austria