Interreg Alpine Space

Co-funded by the European Union

ALPHA

D1.1.2

Transferability and localisation report on best, up-to-date H&C practices

This project is co-funded by the European Union through the Interreg Alpine Space programme
Project ID: ASP0500354

Executive Summary

This report examines best practices for decarbonising the heating and cooling (H&C) sector and advancing 5th-generation district heating and cooling (5GDHC) networks within the ALPHA project participating regions. It synthesises insights from the knowledge transfer workshop, integrating regulatory, financial, and community engagement strategies identified across partner regions.

The report first compiles and analyses best practices from the case studies that were presented and the discussions that were held during the workshop, highlighting key approaches such as public-private land use agreements, cooperative ownership models, streamlined permitting for renewable energy and waste heat integration, and innovative financing mechanisms. These are then assessed in terms of scalability and transferability, ensuring their relevance across diverse regional contexts.

Building on these findings, the report provides targeted guidance on how ALPHA partners can adapt and implement these best practices within their specific territories. By aligning recommendations with local governance structures, economic conditions, energy infrastructure, and public engagement cultures, the report ensures that H&C decarbonisation efforts are both feasible and effective.

Ultimately, this report equips project partners with a structured framework for integrating cutting-edge H&C solutions, supporting the Alpine region's transition to a low-carbon, resource-efficient energy future.

TABLE OF CONTENTS

INTRODUCTION **4**

ACTIVITY A1.1 OVERVIEW 4

ACTIVITY'S TIMELINE 5

ONLINE WORKSHOP ON INNOVATIVE H&C SOLUTIONS **6**

WORKSHOP AGENDA 6

EVALUATION OF THE WORKSHOP ACTIVITIES 7

WORKSHOP OUTCOMES **9**

CASE STUDIES PRESENTED 9

BEST PRACTICES IN REGULATORY AND OWNERSHIP FRAMEWORKS FOR 5GDHC SYSTEMS 17

ADDITIONAL BEST PRACTICES EMERGING FROM WORKSHOP'S DISCUSSION SEGMENT 21

CONCLUSIONS: INTEGRATED STRATEGIES FOR 5GDHC SUCCESS 25

ASSESSING AND VALORISING IDENTIFIED 5GDHC BEST PRACTICES FOR TRANSFER AND ADOPTION **26**

REGULATORY SUPPORT MECHANISMS AND GOVERNANCE STRUCTURES 27

FINANCING 29

COMMUNITY ENGAGEMENT 30

CONCLUSION: STRUCTURING A SYSTEMATIC FRAMEWORK FOR 5GDHC EXPANSION AND REPLICATION 30

INSTRUCTIONS ON THE TRANSFER AND LOCALISATION OF THE IDENTIFIED BEST PRACTICES **33**

INTRODUCTION

Activity A1.1 overview

This document is part of ALPHA's Activity A1.1. Titled "Elaborating on partnership territories' regulatory and administrative gaps vis-à-vis a) Alpine Space and local decarbonisation targets, and b) identified best practices for H&C planning and deployment", the activity is designed to assess existing challenges that hinder the decarbonisation of the H&C sector across project territories and identify best practices for the promotion and facilitation of 5GDHC systems.

The activity's first component consisted in a methodology that was developed by FLA with the aim to help partners identify regulatory and administrative gaps in their territories. On the basis of that methodology, ALPHA partners gathered territorial data to document the regulatory and administrative framework governing H&C decarbonisation, highlighting policy gaps, administrative hurdles, and structural inefficiencies that impede 5GDHC implementation. The collected information provided a foundation for identifying key challenges such as fragmented permitting procedures, insufficient financial incentives, and a lack of integration between spatial and energy planning. These challenges were compiled by FLA in a subsequent analysis report titled D1.1.1b.

The next phase of the activity involved a knowledge transfer workshop on February 12, 2025, where partners engaged in an in-depth exchange of best practices from their respective regions and the broader EU context. Starting with a brief presentation of the report D1.1.1b, this workshop allowed then participants to discuss policy challenges, financing models, and community engagement strategies that have facilitated or hindered 5GDHC adoption in their territories. The insights

gained from this session were instrumental in identifying practices that could be transferred, localised, and adapted to different territorial contexts.

This report presents and systematises the findings from the workshop, offering a structured framework for transferring and adapting best practices to advance H&C decarbonisation in participating regions. It provides actionable recommendations tailored to regional characteristics, ensuring that partners can effectively integrate lessons learned into their policy planning and implementation efforts. This work lays the groundwork for subsequent project activities, supporting the development of harmonised regulatory and financial mechanisms to accelerate the deployment of 5GDHC networks across the Alpine region.

Activity's timeline

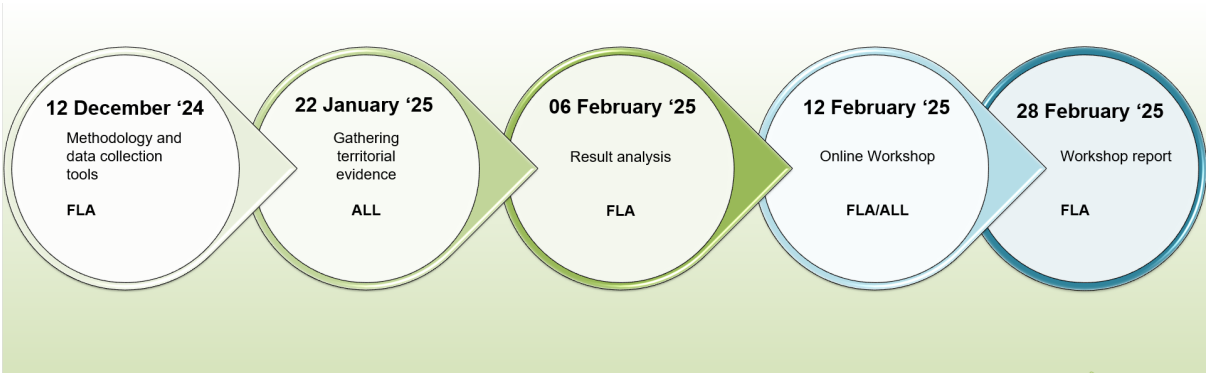

Figure 1: ALPHA Activity A1.1 timeline

Online workshop on innovative H&C Solutions

Workshop agenda

The online workshop took place on Wednesday, February 12, 2025, via MS Teams platform. It was hosted by FLA and attended by all partner organisations. The agenda of the workshop, which was shared with the partners ahead of the meeting, is provided below:

Time (CET)	Topics	Speakers
02:00-02:10	**Welcome and Opening Remarks**	**Massimo di Domenico FLA**
02:10-02:40	**Survey Insights: How Regulatory and Administrative Gaps Hinder H&C Network in Alpine Regions**	**Massimo di Domenico FLA**
02:40-02:50	**Case Study Presentation 1** • Administrative procedure of construction of geothermal probes on public areas in the city of Vienna.	**ÖGUT moderated by Antonio Ballarin**
02:50-03:00	**Case Study Presentation 2** • The 5GDCH system in Königsmoos (Bavaria): technological concept and ownership structure	**TUM moderated by Antonio Ballarin**
03:00-03:10	**Case Study Presentation 3** • Overview of the Ospitaletto 5th generation district heating network	**EURAC moderated by Antonio Ballarin**
03:10-03:20	**Case Study Presentation 4**	**Liguria moderated by Antonio Ballarin**

	• Genoa district heating: Green repowering of cogeneration power plant	
03:20-03:35	**Q&A Session**	**Moderated by Antonio Ballarin**
03:35-03:55	**Discussion 1** Policy challenges and opportunities for regulatory revisions	**All Partners and stakeholders**
03:35-04:15	**Discussion 2** Innovative financing models for heating and cooling	**All Partners and stakeholders**
04:15-04:35	**Discussion 3** Community engagement and acceptance strategies	**All Partners and stakeholders**
04:35-04:45	Discussion: Collaborative Opportunities	**All Partners and stakeholders**
04:45-04:55	Closing Remarks	**Massimo di Domenico FLA**

Evaluation of the workshop activities

The evaluation of the knowledge transfer workshop reflects a high level of satisfaction among participants, particularly regarding the relevance of topics discussed and the quality of speakers and presentations, both of which received top ratings. The effectiveness of interactive sessions was also well received, with ratings of 4 and 5 out of 5, indicating a strong engagement in discussions. However, networking opportunities were rated lower, suggesting room for improvement in fostering participant interaction.

Feedback from participants highlighted a few areas for potential refinement. One suggestion was to include a short break during the lectures to maintain concentration, especially in a long-format workshop. Additionally, while the structure and content were praised, motivating external experts to attend for an extended period proved challenging. A noted barrier was the concern among some potential participants about having to speak in English. To improve engagement, it

was suggested that future workshops incorporate an introduction round (name, organisation) at the beginning to provide a clearer sense of who is attending. Overall, the workshop was well-prepared and highly relevant to the project, with minor logistical adjustments recommended to enhance participation and engagement in future sessions.

Workshop outcomes

Case studies presented

Administrative Procedure for the Construction of Geothermal Probes on Public Areas in Vienna (ÖGUT)

Gerhard Bayer from the Austrian Society for Environment and Technology (ÖGUT) presented on the administrative processes that allow private building owners in Vienna to use public space for the installation of borehole heat exchangers. His presentation addressed both the technical feasibility and the regulatory framework supporting the expansion of 5GDHC systems in dense urban areas.

Bayer began by posing the central question of whether it is possible to heat and cool Vienna's urban areas entirely through 5GDHC networks. His analysis, based on survey results and mapping of potential borehole heat exchanger sites, demonstrated that while the available private property space within building blocks —primarily in courtyards— is insufficient, the inclusion of public space such as sidewalks, roadways, and parking lots makes it feasible to meet the heating and cooling demands of all buildings. However, this is contingent upon the buildings being retrofitted to standard energy efficiency levels.

To illustrate this regulatory and administrative framework in practice, Bayer presented two best-practice examples of buildings that have successfully implemented geothermal energy systems using public space. The first case, located in Vienna's 15th district, involved a retrofitted building whose heating demand was significantly reduced from 127 kWh/m² per year to 18 kWh/m². The switch from individual natural gas heating systems to a centralised geothermal probe system required seven boreholes, but only four could be accommodated in the courtyard. The new regulations, introduced in 2022, allowed for the installation of the

remaining three probes on the adjacent sidewalk, making it possible for the entire building to rely exclusively on geothermal energy.

A second case in the 10th district demonstrated a similar scenario. The building, located on a street corner, reduced its heating demand from 106 kWh/m² to 31 kWh/m² through thermal insulation and replaced its heating system with a geothermal solution. Since only two boreholes could fit within the courtyard, the remaining three were drilled into the sidewalk, ensuring sufficient geothermal capacity for the building's full heating and hot water needs.

Bayer then outlined the key provisions of Vienna's regulatory framework. Building owners may use the section of the public street that directly adjoins their property, extending at a right angle up to the middle of the street. This ensures that buildings on opposite sides retain their own rights to utilise half of the roadway. A minimum distance of 2.5 meters from property borders must be maintained to protect future development rights of neighboring properties. Additionally, geothermal probes must be installed in a way that does not interfere with underground infrastructure such as water, gas, and electricity lines.

Despite these advances, Bayer noted two remaining challenges. First, building owners must pay a fee of 15 to 30 euros per meter of geothermal probe installed on public land, increasing overall project costs by approximately 30%. Second, the current regulations do not permit the drilling of groundwater wells in public areas, even though parts of Vienna have strong potential for thermal groundwater use. Bayer concluded with a recommendation for the city to eliminate this fee and allow groundwater well drilling, arguing that such measures would further support the expansion of geothermal energy in urban areas.

His presentation underscored the importance of regulatory flexibility in enabling urban 5GDHC development and provided a compelling case for how public-private coordination can facilitate the decarbonisation of heating and cooling in dense city environments.

The 5GDHC System in Königsmoos (Bavaria): Technological Concept and Ownership Structure (TUM)

Christopher Schifflechner from the Technical University of Munich (TUM) presented an example of a recently implemented 5GDHC system in Königsmoos, a small municipality in Bavaria. His presentation focused on the technological setup of the network, as well as the ownership structure, highlighting how small municipalities can overcome financial and organisational barriers to implementing such systems.

Königsmoos, a municipality of approximately 5,000 residents, is characterised by a dispersed settlement structure rather than a single historic center. Heat demand is concentrated along the main roads, making it an ideal setting for decentralised heating and cooling solutions. Publicly available data from the Energy Atlas Bavaria revealed both existing geothermal energy use in the area, including groundwater heat pumps and ground-source collectors, as well as the limitations of current potential maps in accurately reflecting the availability of geothermal resources.

The 5GDHC networks in Königsmoos were developed in newly built residential areas, where energy efficiency standards are already high. Two separate but similar networks have been installed over the past two years, together supplying around 40 residential buildings. These networks rely on a total of 112 geothermal probes, drilled to depths of approximately 70 meters, with the system maintaining seasonal temperature fluctuations — around 8°C in winter and 15°C in summer. While the network provides both heating and cooling, its operation remains heat-dominated, a characteristic that is common in Bavarian climates.

A central challenge for small municipalities like Königsmoos is the absence of a publicly owned municipal energy company, which in larger cities is typically responsible for the planning and operation of district heating infrastructure. Without such institutions, smaller municipalities often lack both the financial and technical resources to develop new heating networks. Schifflechner highlighted the growing role of local public energy cooperatives in filling this gap. These cooperatives allow local residents to invest in energy infrastructure by purchasing shares, granting them both financial participation and voting rights in decision-making. Originally

established for renewable electricity projects such as photovoltaic and wind energy, these cooperatives are increasingly expanding into the heating and cooling sector. Their involvement provides not only a financing mechanism but also increases public acceptance by ensuring local ownership and fostering trust in the development process.

The case of Königsmoos illustrates how energy cooperatives can facilitate the expansion of 5GDHC networks in smaller municipalities by pooling financial resources and developing local expertise. While such networks are beginning to spread in Bavaria, their deployment remains slow. Schifflechner emphasised the need for further decision-support tools and policy mechanisms to accelerate adoption. To this end, he concluded by underscoring the importance of continued dialogue with network operators and policymakers to refine regulatory frameworks and financing models.

While 5GDHC networks in Bavaria are still in the early stages of expansion, the Königsmoos example demonstrates that innovative ownership structures, such as public energy cooperatives, can provide a viable pathway for smaller municipalities to transition towards sustainable heating and cooling solutions. By enhancing knowledge-sharing and fostering closer collaboration with existing cooperatives and municipalities, the ALPHA project can help refine planning processes for 5GDHC systems and encourage the replication of successful models like Königsmoos across other regions.

Overview of the Ospitaletto 5th generation district network (EURAC)

Marco Cozzini from EURAC presented the 5GDHC system in Ospitaletto, a small municipality in Lombardy near Brescia. His presentation covered the technological concept, ownership structure, and regulatory aspects of the network, which serves as an example of how waste heat recovery can be integrated into a 5GDHC system.

The network was developed in 2018 by Cogeme,[1] a publicly owned company managing multiple municipal utilities, including district heating, water and sewage services. The system relies on two primary heat sources: waste heat from a local foundry (called ASO) and aquifer wells. The foundry's cooling towers provide low-temperature waste heat (around 25°C), making it a convenient and non-intrusive energy source that does not interfere with industrial operations. However, since the foundry's melting processes do not run continuously, additional support was required, leading to the integration of groundwater wells that provide a secondary heat source at approximately 15°C. These sources ensure a steady energy supply, although the network experiences fluctuations, particularly on weekends when industrial activity decreases.

Initially, the system was designed primarily for heating, but through participation in the LIFE4HeatRecovery project,[2] improvements were made to allow bidirectional energy exchange. The project, funded by the EU's LIFE programme, involved demonstration cases in Ospitaletto, Aalborg (Denmark), and Heerlen (Netherlands), all focused on low-temperature waste heat recovery. As part of this initiative, a prefabricated heat pump skid was installed at the foundry, enabling the plant to become a prosumer — both supplying and consuming heat. This enhancement allowed the factory to cover its own heating needs for office spaces, the canteen, and hot water production, ultimately eliminating its reliance on gas. Prefabrication was a key factor in ensuring a minimally disruptive installation, as the entire system was delivered in containers and fully connected within a single day.

The network follows a neutral-temperature design, a concept EURAC prefers over the term "5GDHC" to emphasise its bidirectional flexibility in balancing heating and cooling demands. The system distributes low-temperature heat, requiring heat pumps at user substations to upgrade temperatures for specific needs. Currently, the network supplies four main users (including schools and a multifamily building) with a total power capacity of 1.5 MW over a 2 km pipeline network. Some sections

[1] https://www.cogemenuoveenergie.it/
[2] https://www.life4heatrecovery.eu/

of the network use non-insulated pipes, a design choice that remains an open question in the optimisation of these systems.

The performance of the system is measured through the coefficient of performance (COP) of heat pumps and the seasonal performance factor (SPF) at the network level, which includes pumping energy consumption. In 2019, heat pumps operated at an average COP of 3.6, while the network-level SPF was 3.1, indicating good heat pump efficiency but also highlighting that pumping energy remains a significant consumption factor. This challenge is linked to the low heat demand density of the town, a common issue in small municipalities that can impact network viability.

From a regulatory and ownership perspective, the public ownership model via Cogeme played a crucial role in the system's implementation. Additionally, a cooperative approach between public and private entities was key — the foundry provided waste heat, motivated by environmental responsibility and corporate image considerations. The synergy with public buildings such as schools also facilitated the network's initial deployment, as municipal support helped establish a reliable user base.

Despite its success, several challenges remain. The high initial investment costs of 5GDHC networks continue to be a barrier, particularly in areas with low heat demand density. Additionally, network design principles and control strategies for this new generation of district heating are still evolving, requiring further refinement.

Cozzini concluded by emphasising that while the Ospitaletto network represents a positive example of 5GDHC implementation, its replication in other locations will depend on addressing cost barriers, optimising system control, and ensuring adequate heat demand densities. The case demonstrates the potential of waste heat recovery and neutral-temperature district heating, but also underscores the need for further regulatory and financial support to make such projects more widespread.

Genoa district heating: Green repowering of cogeneration power plant (Liguria)

Monica Lin from Iren Energia presented the green repowering project for the Sampierdarena cogeneration power plant in Genoa. The project aims to modernise the existing infrastructure by improving energy efficiency, integrating renewable energy sources, and reducing carbon emissions. The presentation focused on the technological upgrades, ownership structure, and regulatory process involved in the transformation of the district heating system.

Iren Energia, based in Italy, is a subsidiary of Iren S.p.A., which is a publicly traded company but with significant public-sector ownership. Iren S.p.A. is listed on the Italian stock exchange, but its majority shareholders are municipalities, primarily in the regions of Piedmont, Liguria, and Emilia-Romagna. The company's main stakeholders include local public authorities, making it a publicly controlled company rather than a fully private one. Iren Energia specifically focuses on energy production, district heating, and electricity distribution. Despite being part of a listed entity, it operates under strong public-sector influence, as its parent company remains largely owned by local governments. Therefore, while it has characteristics of a private enterprise in terms of market competition and structure, its strategic direction is shaped by public ownership.

The Sampierdarena power plant, originally built in the 1990s by Ansaldo and later integrated into Iren Energia's operations, has played a central role in Genoa's district heating system. The network is divided into two circuits: one industrial network near the power plant and one urban network primarily serving residential users. The plant's existing combined-cycle system, which relies on natural gas, supplies 30 MW of electricity to the grid and 21 MW of heat to the district heating network. Additionally, two backup boilers provide 43 MW for emergency and peak demand.

In recent years, a major challenge emerged when Ansaldo, a key industrial heat consumer, disconnected from the network. This led to a reduced heat demand, prompting Iren Energia to redesign the plant to better align with the city's evolving

energy needs while increasing sustainability. The repowering project proposes to replace the combined-cycle unit with a new internal combustion engine, reducing electrical capacity by 110 MW but maintaining heat supply efficiency.

A key feature of the new configuration is the integration of heat pumps to recover waste heat from multiple sources. The system will utilise:

- Heat pumps to recover energy from the cooling section of the new engine
- Heat pumps to capture waste heat from the flue gas
- A separate heat pump to extract thermal energy from seawater, leveraging the same seawater currently used for cooling the existing thermal cycle

Additionally, one of the existing large boilers will be replaced with four smaller, more flexible boilers, improving peak demand management. A heat storage system with two tanks (500 cubic meters total) will further optimise heat production. To enhance sustainability, solar photovoltaic panels (240 panels) will be installed on the plant's roof, and a solar thermal installation will be developed nearby to generate 1 MW of thermal energy.

These upgrades significantly improve the plant's energy efficiency and sustainability, reducing natural gas consumption by 40% while increasing the share of renewable energy to nearly 25%. The use of advanced combustion technologies will also lower emissions, contributing to a reduced carbon footprint for Genoa's district heating system. The overall efficiency of the system is projected to exceed 100%, with significant improvements due to heat recovery and renewable integration.

From a regulatory and administrative standpoint, the project is currently undergoing the permitting process, with Iren Energia having submitted the necessary authorisation requests in 2024. The company is awaiting approval from the relevant authorities while simultaneously securing contractors for the implementation phase. The timeline for execution is ambitious, with installation of new heat pumps and the engine planned for 2025, followed by full commissioning in 2027.

Lin concluded by emphasising the importance of the project for Iren Energia, positioning it as a major milestone in sustainable urban energy development. The transformation of the Sampierdarena power plant into a low-emission, high-efficiency hub showcases the potential for repurposing existing fossil-fuel infrastructure to accommodate renewable and recovered energy sources, paving the way for a more resilient and environmentally friendly district heating system in Genoa.

Best practices in regulatory and ownership frameworks for 5GDHC systems

The case studies from Vienna, Königsmoos, Ospitaletto, and Genoa illustrate a diverse range of regulatory adaptations, ownership models, governance structures, and technological applications that can facilitate the development and expansion of 5GDHC systems. These examples highlight key best practices that enable sustainable investment, public-private collaboration, and regulatory evolution to support low-carbon energy transitions.

1. Ownership models and governance structures

The case studies illustrate a spectrum of ownership models, ranging from purely municipal utilities to publicly controlled commercial entities and cooperative structures. Each model presents different advantages in terms of financial autonomy, public trust, and market responsiveness.

- Municipal or public ownership (Vienna, Ospitaletto via Cogeme Energia): Municipal or publicly controlled entities play a dominant role in district heating system development, ensuring public accountability while allowing for long-term urban energy planning. In Vienna, municipal authorities oversee the integration of geothermal systems into public spaces, with regulatory amendments allowing private landowners access to public land for borehole

installations. In Ospitaletto, the network is managed by Cogeme Energia, a fully publicly owned company controlled by a consortium of 60 municipalities in Lombardy. Unlike mixed-ownership utilities, Cogeme operates under direct municipal control, meaning its financial and investment decisions are shaped primarily by public administration rather than market dynamics. This ensures strategic alignment with local policy goals but may also limit its flexibility in accessing external capital compared to hybrid ownership models.

- Public-private hybrid utilities (Genoa via Iren Energia): Genoa's case demonstrates how a large, publicly controlled multi-utility company can drive technological modernisation and decarbonisation efforts while maintaining some degree of market exposure. Given that Iren Energia is majority-owned by municipalities, but it is also a publicly traded company on the Italian stock exchange, it operates with both public oversight and private-sector financial mechanisms. This mixed model allows Iren Energia to access private capital markets for large infrastructure investments while aligning with public decarbonisation strategies. Unlike Cogeme, Iren operates with greater financial autonomy and market-driven efficiency, but its governance structure still ensures that local governments retain strategic influence over long-term energy transition goals.
- Cooperative ownership (Königsmoos): The energy cooperative model offers a community-driven alternative to municipal or commercial district heating utilities, particularly for small and medium-sized towns. In Königsmoos, residents collectively invest in and govern the 5GDHC network, ensuring local participation and financial sustainability. This model is particularly beneficial in areas where municipal utilities do not exist or lack the resources to expand district heating infrastructure. By allowing citizens to purchase shares in the network, cooperatives foster strong local engagement and trust, while also providing a decentralised governance model that reduces reliance on external financing.

Each of these ownership structures offers different benefits and challenges. Fully public municipal ownership, as seen in Vienna and Ospitaletto, ensures long-term strategic planning but may face financial constraints. Hybrid public-private models, such as Iren Energia in Genoa, allow for greater investment flexibility and technological innovation while maintaining municipal oversight. Finally, cooperative models, such as Königsmoos, offer a localised and citizen-driven solution that can be particularly effective in small municipalities lacking large public utilities.

2. Regulatory adaptations enabling 5GDHC deployment

Across all four cases, regulatory amendments have played a decisive role in enabling investment, optimising land use, and encouraging private-sector engagement.

- Facilitating public-private land use agreements (Vienna): One of the most innovative regulatory adaptations seen in these case studies comes from Vienna, where the city revised its permitting framework to allow private building owners to install geothermal boreholes in public spaces (sidewalks, roadways, parking lots). This regulatory shift significantly expanded the feasibility of deploying 5GDHC networks in dense urban environments where private land alone was insufficient. However, Vienna still imposes fees on public land use and prohibits groundwater drilling, which remain areas for further regulatory refinement.
- Enabling energy cooperatives (Königsmoos): While not a direct regulatory amendment, the growth of energy cooperatives in Bavaria highlights how a supportive legal and financial framework enables community-driven initiatives. By allowing citizen investments in district heating infrastructure and granting cooperatives control over planning and decision-making, this model ensures local accountability while leveraging grassroots financing mechanisms.
- Waste heat utilisation and bidirectional energy exchange (Ospitaletto): The Ospitaletto case demonstrates how regulatory frameworks can facilitate the integration of industrial waste heat into 5GDHC networks. Regulatory flexibility allowed for a partnership between Cogeme (a public-controlled utility) and ASO (a private foundry), enabling waste heat recovery without interfering with industrial operations. Additionally, participation in EU-funded projects (LIFE4HeatRecovery) provided further support and resources for the enhancement of the network, allowing for bidirectional energy exchange where industrial sites could both supply and consume energy from the network.
- Permitting and decarbonisation incentives for large-scale repowering (Genoa): In Genoa, Iren Energia's repowering project underscores the importance of clear permitting processes and state-level decarbonisation incentives in modernising legacy district heating systems. The project integrates heat recovery, seawater thermal energy, solar PV, and high-efficiency cogeneration, demonstrating how regulatory certainty and long-term energy policies can facilitate major infrastructure upgrades. The permitting process remains a time-sensitive hurdle, but the project showcases

how multisource integration is becoming a regulatory priority in coastal urban settings.

3. Multi-source energy integration and network optimisation

A trend shared in some of the cases is the importance of combining multiple energy sources to enhance reliability, efficiency, and sustainability.

- Vienna and Königsmoos: Rely primarily on ground-source heat pumps and geothermal probes, illustrating how shallow geothermal energy can play a fundamental role in 5GDHC systems, especially when supported by regulatory amendments allowing public land use.
- Ospitaletto and Genoa: Demonstrate the viability of hybrid systems combining industrial waste heat, groundwater, and renewable sources (solar, seawater thermal energy). The ability to integrate multiple sources requires regulatory support, particularly for industrial partnerships, environmental permitting, and financial incentives for heat recovery projects.

4. Conclusions and policy recommendations

These case studies provide a broad spectrum of regulatory best practices that can be adapted for future 5GDHC policy frameworks:

1. Facilitating public-private land use agreements: Vienna's geothermal permitting reform is a best practice for other cities looking to expand ground-source energy access.
2. Encouraging cooperative ownership models: Königsmoos shows how local energy cooperatives can fill investment and governance gaps in small municipalities lacking public utilities.
3. Integrating industrial waste heat via public-private partnerships: Ospitaletto demonstrates how regulatory incentives and EU-funded programs can encourage waste heat recovery and bidirectional energy exchange.
4. Permitting and regulatory certainty for large-scale system repowering: Genoa highlights the importance of streamlined permitting and financial support mechanisms for the modernisation of aging district heating infrastructure.
5. Aligning market flexibility with public oversight: In different ways and proportions, both Cogeme and Iren illustrate how publicly controlled but market-oriented entities can ensure financial sustainability while advancing decarbonisation objectives.

In sum, successful 5GDHC regulatory frameworks must be adaptive, technology-inclusive, and supportive of diverse ownership models — ranging from public and cooperative models in smaller towns to private-sector-driven innovations in urban centers. As will discussed in more detail below, the question of scale is also crucial in these processes. These cases provide critical lessons for policymakers seeking to accelerate the transition to sustainable, decentralised, and multi-source district heating and cooling systems.

Additional best practices emerging from workshop's Discussion segment

The workshop discussion following the presentations provided critical insights into the challenges and opportunities related to the development of 5GDHC networks. The exchange of experiences among participants highlighted further key best practices in policy and regulatory frameworks, financing mechanisms, and community engagement strategies. These discussions not only revealed obstacles but also pointed toward solutions that could enhance the scalability and transferability of 5GDHC systems.

Challenges and best practices for effective policy and regulatory support

One of the most prominent topics in the policy discussion was the disparity between long-term decarbonisation goals and the lack of binding regulations. For example. Vienna has a well-defined strategy to phase out all fossil fuel-based heating and cooling by 2040, yet this remains a political commitment rather than a legally binding obligation. This was identified as a major weakness, as many building owners remain skeptical, assuming that future political shifts might lead to changes in priorities. Without legally binding national frameworks, ambitious municipal-level goals are difficult to enforce, limiting investment confidence. The discussion suggested that in order to truly drive adoption, governments must move beyond voluntary strategies and introduce clear regulatory mandates, such as phasing out

fossil fuel heating systems in urban areas or requiring new buildings in designated zones to connect to district heating networks.

Another major regulatory issue discussed was the complexity of permitting and land-use regulations, particularly in urban areas where space for geothermal boreholes and other infrastructure is limited. Vienna's policy revision allowing private owners to install geothermal probes in public spaces was recognised as a positive step, but the associated fees (15-30 euros per meter) increase project costs by up to 30%, making it a financial burden for building owners. Moreover, groundwater drilling remains prohibited in public spaces, despite the strong potential for thermal groundwater use in parts of the city. Participants suggested that municipalities should consider reducing or eliminating land-use fees for geothermal installations, while also revisiting restrictions on groundwater drilling, provided that environmental protections are in place.

The discussion also addressed how regional energy planning and funding strategies can impact the adoption of 5GDHC systems. In Austria, strong national funding schemes in the early 2000s helped to establish biomass-based district heating networks, but when subsidies were phased out, some cogeneration plants were forced to close, illustrating how unstable policy frameworks can undermine long-term planning. Participants from Lombardy and Liguria noted that while their regions have energy transition programs, these do not yet fully prioritise 5GDHC, meaning that the sector lacks tailored policy support. In response, several participants stressed the need for stable, long-term financial incentives that do not fluctuate with political cycles. One suggestion could involve embedding district heating goals directly into national climate action plans, ensuring that financial support and regulatory mechanisms are maintained over the long term.

Best practices for securing long-term investment

In discussing financing models, several participants emphasised that high upfront costs remain a key barrier to 5GDHC expansion. Bavaria was cited as a positive example, as the central government in Berlin provided 30-50% subsidies for pilot

projects, significantly reducing investment risk. However, the conversation also pointed out that even with subsidies, long-term revenue streams are uncertain, as there are no legal mandates requiring consumers to connect to district heating networks. This makes it difficult to predict future earnings, as some building owners may opt for individual heat pumps instead of joining the network. Municipalities in Bavaria have attempted to gauge consumer interest by sending letters to property owners, but these often lack sufficient cost and technical details, making it difficult for consumers to make informed decisions.

To address this uncertainty, the discussion highlighted several innovative financing strategies that could be used to secure investment and increase adoption rates:

- Connection mandates & incentives: Municipalities could require new buildings in designated zones to connect to district heating networks, ensuring a guaranteed consumer base. For existing buildings, financial incentives such as discounted connection fees for early adopters could encourage participation.
- Energy cooperatives & citizen investment models: The Königsmoos case was highlighted as an example of how community-owned cooperatives can provide a sustainable financing model for small municipalities. By allowing residents to buy shares in the heating network, cooperatives both secure funding and improve local engagement.
- EU and national funding mechanisms and financial instruments: Despite not being a funding mechanism per se, the LIFE4HeatRecovery project in Ospitaletto demonstrated how European grant programs and related financial instruments can support 5GDHC adoption. In terms of national funding mechanisms, the Fonds Chaleur (Heat Fund) scheme in France was mentioned; however, participants noted that funding mechanisms such as this are often difficult to access due to bureaucratic complexity, while excluding SMEs and other categories of possible beneficiaries.

Best practices for increasing public buy-in and adoption

The final topic of discussion revolved around community engagement and public acceptance of 5GDHC networks. Participants widely agreed that technical and financial feasibility are meaningless if public resistance prevents adoption. One key observation was that (next to the question of access to funding) lack of awareness

and information —and not regulatory barriers— was often the main obstacle. In Austria, municipalities that actively engaged with citizens early in the planning process found that public acceptance was significantly higher compared to cases where networks were introduced with little public consultation. Similarly, in Genoa, Iren Energia used to conduct in-person visits to buildings to promote district heating, a strategy that appears more effective than brochures or online campaigns.

Participants discussed several best practices for engaging communities and securing consumer buy-in:

- Personalised outreach and door-to-door engagement: Rather than relying solely on broad communication strategies, some municipalities found success by sending trained experts to meet directly with building owners, answering questions and addressing concerns in one-on-one conversations.
- Transparent cost communication and early engagement: In Bavaria and Austria, efforts to survey property owners about their interest in district heating were often undermined by a lack of concrete cost details. Providing clear pricing models and financial incentives upfront could make these initiatives more successful.
- Case study visits and demonstration projects: Public skepticism about new heating and cooling technologies can be reduced if potential consumers can see successful examples firsthand. Municipalities could organise guided visits to existing 5GDHC systems, where residents can talk to current users and see how the technology works in real-world conditions.

Similar to the best practices presented in the previous segment of the workshop, participants emphasised the need for flexible policy frameworks that can accommodate diverse local conditions, rather than a one-size-fits-all approach.

In conclusion, the discussion reinforced the idea that successful 5GDHC deployment requires an integrated approach combining regulatory certainty, financial incentives, and proactive community engagement. Regulatory frameworks must provide binding commitments to phase out fossil fuels, land-use regulations should facilitate access to geothermal and waste heat resources, and financing models need to balance upfront investment support with long-term revenue security. Above all,

direct and transparent communication with consumers is essential, as no system — no matter how advanced— will succeed without public trust and participation.

Conclusions: Integrated strategies for 5GDHC success

The workshop discussions revealed that policy, financing, and community engagement must work together to ensure the successful deployment of 5GDHC networks. The following integrated recommendations emerge:

Regulatory Support

- Establish binding decarbonisation targets to ensure long-term investment certainty.
- Streamline permitting for geothermal and industrial waste heat recovery projects.
- Facilitate land-use agreements to expand 5GDHC adoption in urban areas.

Innovative Financing

- Provide stable, long-term national subsidies for district heating.
- Encourage municipal co-financing and cooperative investment models.
- Leverage EU funding for pilot projects and network expansion.

Community Engagement

- Implement direct outreach strategies such as door-to-door campaigns and community workshops.
- Use case study visits and testimonials to build consumer confidence.
- Ensure early cost transparency to secure consumer commitments.

Assessing and valorising identified 5GDHC best practices for transfer and adoption

To ensure that the best practices identified so far can be effectively scaled, transferred, and localized, it is essential to analyse their applicability in different regional and municipal contexts. While some practices are better suited for large cities, metropolitan regions, or areas with high heat demand density and complex infrastructure **(big scale)**, others thrive in small municipalities decentralised communities, or regions with lower energy demand and administrative capacity **(small scale)**. Of course, some practices are suitable for both cases.

Additionally, the ease of transferability varies, as some best practices can be directly implemented with minimal adjustments, while others require significant regulatory, financial, or infrastructural adaptation. In the following classification, **high transferability** refers to practices that require minimal or no adaptation; **moderate transferability** describes practices whose transfer requires considerable adjustments; and **low transferability** pertains to highly context-specific practices, which face significant structural, financial, or regulatory barriers to replication.

By evaluating regulatory support mechanisms and governance structures, financing models, and public engagement strategies, the following assessment systematises how these best practices can be adapted, replicated, and expanded across diverse regions and municipalities.

Taking into consideration best practices that emerged both form the case studies and the workshop discussion, the following structured evaluation of each identified practice assesses (a) its scalability (the ability to be implemented to larger cities or or smaller municipalities or both) and (b) its transferability (how easily it can be applied across different regions and governance models).

Regulatory support mechanisms and governance structures

1. Facilitating public-private land use agreements

- **Scalability: Big scale**

This practice is particularly relevant in urban areas where space is scarce, and competition for land is high. In large cities, district heating networks often need to expand beyond private properties, making agreements between municipalities and private landowners critical.

- **Transferability: Moderate**

While the concept is adaptable, its success depends on the local legal framework for land use and zoning, as well as municipal authority over urban planning. In regions where public-private partnerships are not well-established, additional legal and procedural adaptations are required.

2. Encouraging cooperative ownership models

- **Scalability: Small scale**

Cooperative energy models work best in small municipalities where public utilities are absent, and local communities are more involved in decision-making. The ability of residents and businesses to co-invest in district heating systems ensures financial sustainability while fostering public trust.

- **Transferability: High**

Energy cooperatives are easily transferable, provided there is legal recognition of cooperative structures and financial incentives for local energy initiatives. The model has been successful in several European countries and can be replicated with the right regulatory framework.

3. Integrating and streamlining industrial waste heat recovery projects

- **Scalability: Big scale**

This practice is most effective in industrialized urban regions where large-scale factories and manufacturing plants produce excess heat. In cities with established district heating infrastructure, integrating waste heat into the system is both feasible and economically beneficial.

- Transferability: Moderate

The feasibility of waste heat recovery depends on the presence of industrial facilities and municipal support for heat recovery policies. Some regions may require legal incentives to encourage industrial participation, while others might lack the technical infrastructure needed for integration.

4. Permitting and regulatory certainty for large-scale system repowering

- **Scalability: Big scale**

Modernising existing large district heating networks requires regulatory clarity and streamlined permitting procedures. Cities with aging infrastructure stand to benefit the most from clear, stable regulatory conditions that facilitate long-term investments.

- **Transferability: Low**

The regulatory landscape varies significantly across regions, making direct transfer challenging. Successful implementation depends on national or regional legislation that supports district heating modernization and provides stable permitting frameworks.

5. Aligning market flexibility with public oversight of utilities

- **Scalability: Big scale**

Municipal utilities in large cities often operate in competitive energy markets, requiring a balance between market-driven efficiency and public oversight to protect consumer interests. This is less relevant for small municipalities, where fully public or cooperative models are more common.

- **Transferability: Moderate**

This approach is best suited for cities with mixed public-private energy markets. It requires strong regulatory frameworks to ensure fair pricing and competition while maintaining service reliability.

6. Establishing binding decarbonisation targets to ensure long-term investment certainty

- **Scalability: Both big and small scale**

Legally binding decarbonization targets are relevant for **all territories**, regardless of size. They provide **long-term investment certainty** for both large cities and small municipalities transitioning to sustainable heating and cooling.

- **Transferability: High**

While the political commitment to binding targets varies, the concept itself is highly transferable. National or regional governments must enact enforceable policies with clear milestones for phasing out fossil fuels in heating and cooling.

Financing

7. Providing stable, long-term national subsidies for district heating

- **Scalability: Both big and small scale**

Financial support is essential for both large-scale district heating projects and smaller, decentralised networks. Long-term subsidies help offset upfront costs and make sustainable heating systems financially viable.

- **Transferability: Moderate**

The success of subsidy programs depends on national budget allocations and political will. While the concept is transferable, actual implementation requires tailored financial mechanisms that fit each country's economic structure.

8. Leveraging EU funding for pilot projects and network expansion

- **Scalability: Both big and small scale**

EU funding can support both large infrastructure projects and smaller pilot initiatives in municipalities aiming to develop 5GDHC networks.

- **Transferability: Moderate**

Financial instruments and funding mechanisms are accessible across multiple regions. However, municipalities must have the technical and administrative capacity to apply for and manage these grants effectively.

Community Engagement

9. Implementing direct outreach strategies (door-to-door campaigns, community workshops, case study visits)

- **Scalability: Small scale**

Public engagement is particularly effective in small municipalities where community involvement is high. Direct outreach strategies, such as town hall meetings and workshops, can help educate residents and secure local support for 5GDHC projects.

- **Transferability: High**

Easily transferable, but effectiveness depends on local cultural attitudes toward citizen participation. Successful outreach requires dedicated municipal engagement teams and well-structured communication strategies.

10. Ensure early cost transparency to secure consumer commitments

- **Scalability: Both big and small scale**

Consumers in both large cities and small towns need clear information on district heating pricing models to encourage adoption. Cost transparency is a fundamental requirement for building trust.

- **Transferability: High**

Easily implementable, provided that clear regulatory frameworks ensure fair pricing. Effective implementation requires publicly accessible data on heating costs and potential savings for consumers.

Conclusion: Structuring a systematic framework for 5GDHC expansion and replication

By evaluating each best practice in terms of scalability and transferability, it becomes clear that some strategies are highly adaptable across different contexts, while others require structural adjustments before implementation. Additionally,

some practices are better suited for bigger scales, while others for smaller ones. Each region's unique characteristics are the ones to eventually determine which practices can be suitable for and effective in promoting and facilitating the deployment of 5GDHC systems in their territories. Based on the taxonomy presented above, however, some general remarks could be made about the scalability and transferability of the identified practices.

- **Highly scalable and transferable practices include**:
  - ✓ Binding decarbonisation targets
  - ✓ EU and national funding mechanisms, which provide flexible financing solutions.
  - ✓ Early cost transparency with respect to the DHC solutions
- **More effective in small towns:**
  - ✓ Cooperative ownership models
  - ✓ Direct outreach strategies

Best suited for large cities:

- ✓ Public-private land use agreements
- ✓ Industrial waste heat recovery
- ✓ Market-flexible public oversight

Requires strong policy frameworks:

- ✓ Permitting and regulatory certainty for large-scale system repowering
- ✓ Stable subsidies for district heating

Table 1: Assessment and valorisation of identified bet practices

Best practice	Scalability	Transferability	Key requirements for transfer & localisation
Public-private land use agreements	Big scale	Moderate	Requires municipal authority over land-use decisions and legal mechanisms to facilitate agreements. Works best in cities with high land-use competition.
Cooperative ownership models	Small scale	High	Strong community engagement, legal framework for energy cooperatives, and financial incentives for local investments are essential.
Industrial waste heat recovery	Big Scale	Moderate	Requires industrial presence, regulatory support for waste heat integration, and financial incentives to encourage industry participation.
Permitting for large-scale system repowering	Big Scale	Low	Works in cities with large district heating networks requiring modernization. Needs strong municipal coordination and long-term investment strategies.
Market-flexible public oversight	Big Scale	Moderate	Requires energy market regulation that balances private-sector flexibility with public interest oversight.
Binding decarbonisation targets	Both	High	Needs national or regional-level policy commitment, legal enforcement, and long-term investment certainty.
Stable, long-term national subsidies for DHC	Both	Moderate	Requires political commitment and financial sustainability at the national level. Must be accessible to both large and small municipalities.
EU funding for pilot projects and network expansion	Both	Moderate	Requires administrative capacity to apply for and manage EU funding. Works best when technical expertise and project development support are available.
Direct outreach strategies	Small Scale	High	Works well in small communities with close civic participation. Requires public trust-building and clear information campaigns.
Early cost transparency	Both	High	Essential for public trust. Requires clear regulatory frameworks and accessible pricing models.

Instructions on the transfer and localisation of the identified best practices

To effectively localise and adapt best practices for H&C decarbonisation and 5GDHC network planning and implementation, project partners should undertake a comprehensive assessment of their regional characteristics. This involves evaluating:

1. **Population density and municipality scale**: Understanding whether the region comprises densely populated urban centers or sparse rural municipalities is crucial. Densely populated areas may benefit from centralised district heating networks, while rural regions might find decentralised, community-led systems more effective.
2. **Energy infrastructure**: Assessing the existing energy landscape, including current district heating networks, availability of renewable energy resources, and the presence of industries capable of providing waste heat recovery opportunities, is equally important. For instance, regions with a strong industrial base can integrate waste heat into their heating systems, enhancing efficiency.
3. **Governance structures**: This aspect pertains to the degree of municipal autonomy and the influence of regional or national policies on energy planning. Regions with significant local authorities may implement tailored energy solutions more readily, whereas those under stringent national regulations might require advocacy for policy adjustments.
4. **Economic conditions and funding potential**: Partners should determine access to financial resources, including national or EU funding, and the reliance on public versus private sector investment. Understanding the economic landscape aids in selecting feasible financing models for 5GDHC projects.
5. **Public engagement culture**: Gauging the level of citizen participation in energy projects and the feasibility of cooperative models is another critical factor. Regions with active public engagement may successfully implement community-driven energy initiatives. Regions lagging in public acceptance and engagement should invest in outreach strategies.

6. **Regulatory and administrative framework**: This involves reviewing existing policies, decarbonisation mandates, permitting structures, district heating regulations, and data infrastructures, with a view to identifying regulatory and administrative barriers or facilitators. The survey conducted as part of ALPHA's current activity, which resulted in the pinpointing of gaps and challenges in the participating regions' regulatory and administrative frameworks is of particular relevance and importance to the selection and localisation of best practices.

Adapting Best Practices

Based on the comprehensive assessment, partners can adapt the following best practices to their regional contexts:

- Encouraging cooperative ownership models: In regions with dispersed populations and active public engagement, forming energy cooperatives can empower communities to collectively invest in and manage local heating systems, ensuring solutions that meet specific local needs.
- Aligning market flexibility with public oversight: Areas with publicly controlled energy companies can introduce flexible market mechanisms within existing frameworks, promoting innovation while maintaining public accountability.
- Integrating industrial waste heat recovery projects: Regions with significant industrial activity can develop policies and incentives to capture and utilise waste heat, enhancing overall energy efficiency.
- Facilitating public-private land use agreements: Urban areas with limited space can negotiate agreements to develop necessary infrastructure for heating and cooling networks, optimising land use.
- Implementing direct outreach strategies: In regions where public awareness is low, personalised engagement through community workshops and door-to-door campaigns can educate residents and secure commitment to new heating solutions.

By thoroughly evaluating regional characteristics and addressing identified challenges, project partners can effectively localise and implement best practices, fostering the decarbonisation of H&C systems and the advancement of 5GDHC networks. The last part of this section provides indicative policy recommendation

for each of the participating regions, based on their regional characteristics and the identified regulatory and administrative gaps and challenges.

Lombardy

Lombardy, Italy's most populous region and economic powerhouse, is actively pursuing sustainable energy solutions to address its environmental challenges. The region's diverse industrial base and commitment to decarbonisation present unique opportunities for implementing best practices in energy management.

Integrating and streamlining industrial waste heat recovery projects

Given Lombardy's extensive industrial activities, a significant amount of energy is lost as waste heat. Capturing and repurposing this heat can substantially enhance energy efficiency and reduce greenhouse gas emissions. The region has already initiated projects like R-ACES[3], aiming to facilitate energy cooperation and heat exchange among industries, thereby promoting industrial symbiosis.

However, as identified in the regulatory and administrative gaps' survey, challenges persist, including the need for clear policies and incentives to encourage industrial participation in waste heat recovery initiatives. Streamlining permitting processes and fostering public-private partnerships are essential steps to overcome these barriers and fully harness the potential of waste heat recovery.

Establishing binding decarbonisation targets to ensure long-term investment certainty

Lombardy has set ambitious goals through its Regional Energy, Environment, and Climate Programme (PREAC), aiming for a 43.8% reduction in greenhouse gas emissions by 2030 compared to 2005 level. However, the absence of explicit, binding

[3] https://www.energycluster.it/en/projects/completed-projects/r-aces-the-new-european-project-on-industrial-symbiosis

mandates for renewable energy use in H&C was identified as a high-impact gap, which poses a significant challenge. Implementing legally binding decarbonisation targets would provide a clear framework, encouraging investments in sustainable energy solutions and ensuring alignment with both national and European climate objectives.

Liguria

Liguria, a coastal region in northwestern Italy, is characterised by its strategic maritime location and diverse economy, with Genoa serving as a pivotal port city. Despite its strengths, the region faces significant challenges in implementing 5GDHC systems, particularly due to a lack of supportive policies for critical infrastructure, insufficient integration between spatial and energy planning, as well as limited administrative resources and public engagement.

Implementing direct outreach strategies

Public understanding and support are crucial for the successful adoption of 5GDHC systems. This is of particular importance for the region of Liguria, where the lack of resources and expertise to organise outreach programs has been identified as a high-impact barrier. To bridge the existing awareness gap, Liguria should try to access resources with a view to implementing targeted outreach strategies that resonate with its communities. Through clear communication and transparency, the region can address misconceptions and build a supportive community foundation for the successful implementation of 5GDHC systems.

South Tyrol (EURAC)

South Tyrol is a mountainous region in northern Italy renowned for its commitment to renewable energy and sustainability. Despite its advancements, the region faces

challenges in implementing 5GDHC systems, particularly due to inconsistent policies and a lack of explicit incentives for waste heat recovery. To address these issues, the following best practices are recommended:

Establishing binding decarbonisation targets to ensure long-term investment certainty

South Tyrol has demonstrated a strong commitment to sustainability through initiatives like the "South Tyrol Climate Plan 2040," aiming for climate neutrality by 2040. However, the absence of binding decarbonisation targets, especially concerning heating and cooling, creates uncertainty for potential investors. Implementing explicit, legally binding decarbonisation goals would provide a clear framework, encouraging investments in sustainable energy solutions and ensuring alignment with both national and European climate objectives. This approach would address the current policy inconsistencies and foster a more cohesive strategy for 5GDHC implementation.

Integrating and streamlining industrial waste heat recovery projects

While South Tyrol excels in renewable energy production, particularly through hydropower, the potential for industrial waste heat recovery remains underutilised. The lack of explicit policies and incentives promoting waste heat recovery has been identified as a moderate-impact challenge. To capitalise on this opportunity, the region should develop clear guidelines and incentives that encourage industries to participate in waste heat recovery initiatives. Streamlining permitting processes and fostering public-private partnerships will be crucial steps in integrating waste heat into existing and future DHC networks, thereby enhancing energy efficiency and reducing greenhouse gas emissions.

Auvergne-Rhône-Alpes

Auvergne-Rhône-Alpes region in southeastern France is notable for its diverse geography and robust economy. Despite its strengths, the region still faces some challenges in implementing decarbonised H&C systems, due to several factors, such as mismatches between resources and public authorities' responsibilities, insufficient supportive policies for critical infrastructure, and complex, fragmented regulations that hinder funding access, and limited public awareness. To address these issues, the following best practices are recommended:

Aligning market flexibility with public oversight

The region's complex regulatory environment necessitates a balance between market dynamics and public oversight to facilitate the development of 5GDHC systems. By adopting governance models that allow for market flexibility while maintaining public control, Auvergne-Rhône-Alpes can streamline decision-making processes and attract private investments. This approach would involve revising existing policies to grant local authorities more autonomy in energy planning and infrastructure development, thereby reducing bureaucratic hurdles and fostering a more conducive environment for 5GDHC projects.

Implementing direct outreach strategies to enhance public awareness and engagement

Public awareness and acceptance are crucial for the successful deployment of 5GDHC systems. The region can benefit from implementing direct outreach strategies, such as community workshops, informational campaigns, and collaborative planning sessions. These initiatives can educate residents about the benefits of 5GDHC, address potential concerns, and foster a sense of community ownership over energy projects. Engaging the public directly not only builds trust but also encourages active participation, which can lead to more successful and sustainable energy solutions.

Provence-Alpes-Côte d'Azur

The Provence-Alpes-Côte d'Azur (PACA) region, located in southeastern France, is renowned for its Mediterranean coastline, the Southern Alps, and the Rhône River delta. Major urban centers such as Marseille, Nice, Toulon, and Aix-en-Provence drive its vibrant economy, which is bolstered by tourism, high technology industries, and a commitment to sustainable development.

Despite its proactive stance on energy transition, aiming for 100% renewable energy consumption by 2050, PACA faces challenges in implementing 5GDHC systems. These challenges include insufficient integration between spatial and energy planning, inflexible models for heating system management, and complex regulations that hinder funding access.

Recommended best practice: Facilitating public-private land use agreements

To address some of these issues, PACA can benefit from facilitating public-private land use agreements. This approach involves collaboration between public authorities and private entities to optimise land use for energy infrastructure development, particularly in urban areas where space is limited.

Implementing this strategy requires the establishment of clear guidelines that encourage partnerships between municipalities and private developers, ensuring that land use planning incorporates provisions for 5GDHC infrastructure. Aligning spatial planning with energy policies is essential to identify and designate suitable areas for developing heating and cooling networks, thereby streamlining the approval process. Additionally, reviewing and amending existing regulations to reduce complexity will facilitate collaboration between public and private stakeholders on energy projects and improve access to necessary funding.

Bavaria

Bavaria, Germany's largest federal state, is actively enhancing its renewable energy infrastructure. However, the region faces challenges in 5GDHC systems, primarily due to limited expertise within local authorities in designing and implementing funding programs, as well as insufficient integration between spatial and energy planning policies and limited public awareness and engagement.

Recommended Best Practices:

Implementing direct outreach strategies to enhance public awareness and engagement

To address these challenges, Bavaria can draw inspiration from its successful energy cooperatives, which have effectively engaged communities in renewable energy projects. By organising workshops, informational sessions, and interactive demonstrations, local authorities can educate citizens about the benefits of sustainable heating and cooling solutions. This participatory approach not only builds trust but also empowers residents to take an active role in the energy transition, mirroring the collaborative spirit of Bavaria's energy cooperatives.

Leveraging EU funding for pilot projects and network expansion

To overcome financial and expertise limitations, Bavaria can tap into European Union funding programs designed to support the development of sustainable heating and cooling networks. By preparing comprehensive investment plans and aligning with EU criteria, Bavarian municipalities can secure financial support for pilot projects and the expansion of 5GDHC networks. This approach not only provides necessary funding but also facilitates knowledge transfer and capacity building through collaboration with EU partners.

Austria

Austria is committed to working toward climate neutrality, with Vienna leading the charge through its ambitious "Phasing Out Gas – Heating and Cooling Vienna 2040" initiative. This strategy aims to eliminate fossil gas from heating systems by 2040, focusing on transitioning to renewable energy sources for heating and cooling. However, the national government has not enacted binding legislation to mandate this transition, and even Vienna's plan lacks legally binding decarbonisation targets. This discrepancy between municipal and regional ambitions and national policy creates challenges in achieving cohesive and effective decarbonisation across the country. As discussed above, this issue came up during the workshop's discussion

Recommended best practice: Establishing binding decarbonisation targets to ensure long-term investment certainty

To address these challenges, it is recommended that Austria implement legally binding decarbonisation targets, particularly for the heating and cooling sector. Such targets would provide a clear and enforceable framework, offering long-term investment certainty and aligning efforts across municipal and national levels. This approach would not only facilitate the phase-out of fossil fuels but also promote the integration of renewable energy sources, thereby contributing to Austria's overarching goal of climate neutrality.

Implementing binding decarbonisation targets involves key steps such as the following:

1. Legislative action: The national government should enact laws that define specific, enforceable decarbonisation goals for the H&C sector. This legislative framework would mandate the gradual replacement of fossil fuel-based systems with renewable alternatives, ensuring a unified approach across all regions.
2. Financial support schemes: Developing robust financial incentives and support mechanisms is essential to encourage both public and private investments in renewable energy projects. This could include subsidies, tax incentives, and

grants aimed at reducing the financial barriers associated with transitioning to sustainable H&C solutions.

Municipality of Trebjne

The Municipality of Trebnje, strategically located along the Temenica River and intersected by major transportation routes connecting Ljubljana to Novo Mesto, serves as an inter-municipal administrative center with a diversified economy. Key industries include metal processing, woodworking, textiles, and construction.

Despite its economic strengths, Trebnje faces several high-impact challenges in advancing sustainable energy solutions, particularly in the implementation of 5GDHC systems. These challenges encompass inconsistent and conflicting policies, insufficient integration between spatial and energy planning, inadequate financial support, and a lack of explicit policies promoting waste heat recovery.

Recommended Best Practices:

Leveraging EU funding for pilot projects and network expansion

To address the challenge of inadequate financial support, Trebnje can actively pursue European Union funding opportunities aimed at promoting sustainable energy initiatives. This could provide essential financial backing for projects focused on enhancing energy infrastructure. For instance, Slovenia has previously secured EIB loans to upgrade its electricity distribution network. By preparing comprehensive project proposals that align with EU sustainability objectives, Trebnje can attract similar investments to develop and expand 5GDHC networks, thereby improving energy efficiency and reducing environmental impact.

Integrating industrial waste heat via public-private partnerships

Trebnje's diverse industrial sector presents a valuable opportunity to harness waste heat generated from manufacturing processes. By establishing public-private

partnerships, the municipality can facilitate the recovery and utilisation of this excess heat for district heating purposes. Collaborative efforts between local authorities and industries can lead to the development of infrastructure that captures waste heat and redistributes it for communal heating needs. This approach not only enhances energy efficiency but also aligns with Slovenia's Energy Act, which mandates that at least 50% of heat in district heating systems must originate from renewable sources or waste heat.