WP7 / TASK 7.1 CONCEPT AND BUSINESS PLAN HEATHIGHWAY INNTAL

Projekt Heat Highway

Projektteam:
Verena Alton
Nicolas Marx
Ralf-Roman Schmidt

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1 INTRODUCTION

The project Heat Highway focuses on the utilization of waste heat from industrial processes to decarbonise the heating sector. It examines interregional heat transmission networks (HTNs) connecting different sources of industrial waste heat, sinks, heating networks, and storage facilities. These HTNs connect urban heat consumption centres with waste heat intensive industrial sites, thereby reducing economic risks and promoting innovative business models. The project encompasses two regions in Upper Austria and Styria, where focused advancements are being made. Additionally, four follower regions, Ried im Innviertel/Upper Austria, Inntal/Tyrol, St. Pölten – Krems/Lower Austria and Vienna South/Lower Austria are undergoing theoretical assessments.

In this business model plan (BMP), the Tyrolean Follower region is presented.

1.1 The Tyrolean follower region

The considered region consists of the districts of Schwaz and Kufstein in the eastern part of the Inntal, as there is already an existing HTN between Innsbruck and Wattens in the west. A small part of the Zillertal was also considered as a large wood processing industrial company, which already supplies the municipality with district heating[1], is close. Overall, there are 32 municipalities in the three districts, larger cities include Schwaz, Wörgl and Kufstein.

The usage of industrial waste heat has a long tradition in the region, with several industrial companies already supplying waste heat to the municipalities and also to the HTN between Innsbruck and Wattens. It is assumed that more than 90% of the heating demand in the municipalities could theoretically be covered by the HTN.

Several companies were contacted for necessary information such as heat demand and waste heat potential. Consequently, lists of sinks and sources were compiled. A basic routing of the HTN was derived, based on the existing HTN between Innsbruck and Wattens in the western part of the Inntal, which follows the Inntal highway. The proposed HTN will also follow the Inntal highway, supplying all 32 municipalities along the way. For this purpose, existing district heating distribution networks and municipalities without networks, where it would have to be built, were taken into consideration. The preliminary route is shown in Figure 1-1 and depicts a total of approximately 82 km of heating pipeline from Wattens to Kufstein and to Fügen in the Zillertal. Approximately 34 km pass through urban areas, while 48 km pass through rural, unpaved terrain.

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[1] https://www.ortswaerme.at/

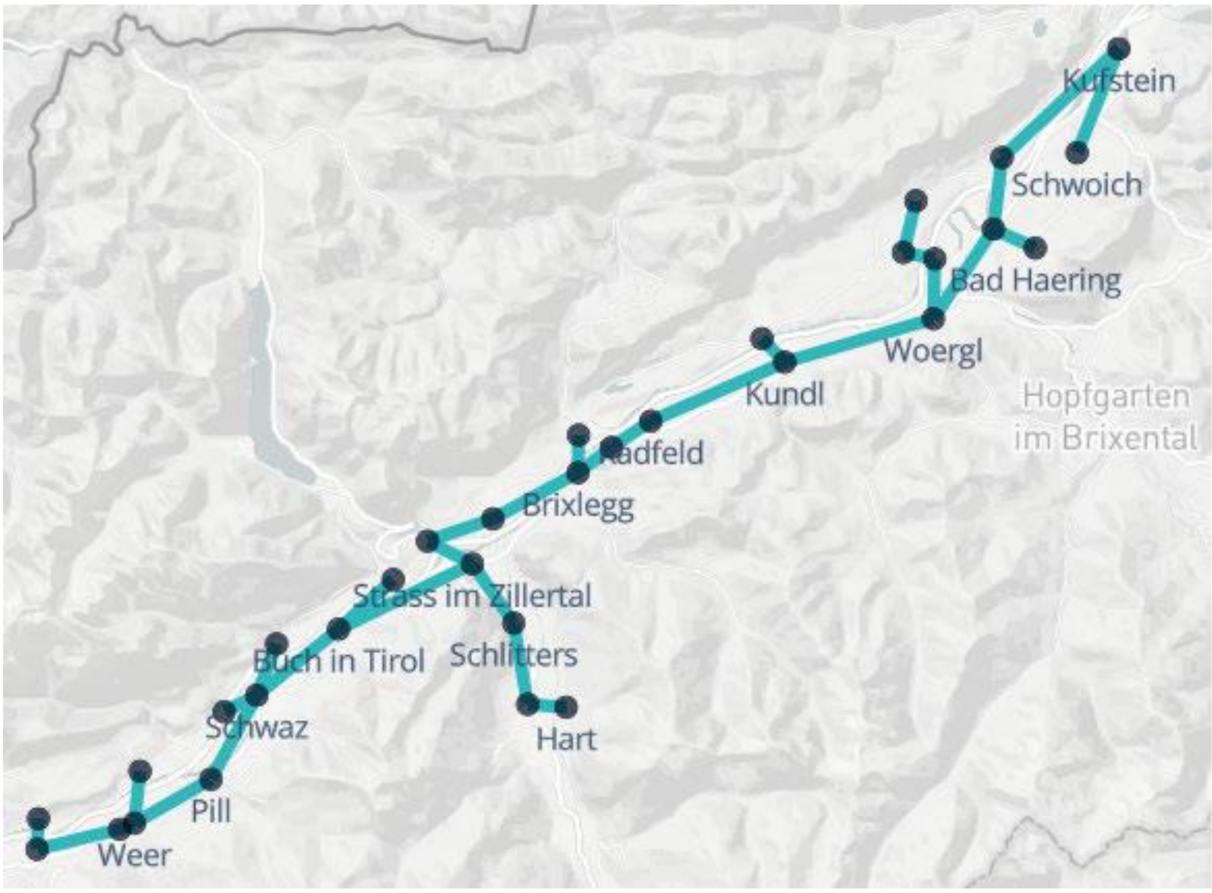

Figure 1-1: Proposed routing of the HTN in the eastern Inntal

District heating distribution networks exist in 8 (see Table 1) of the 32 municipalities.

Table 1: Existing DH Networks

Municipality	Connected Households	Network length in km
Bad Häring, Tyrol	55	5.03
Fügen, Tyrol	720	50
Kolsass, Tyrol	8	1.2
Kufstein, Tyrol	6000	37
Kundl, Tyrol	1214	24
Terfens, Tyrol	88	2.7
Wattens, Tyrol	450	24.8
Wörgl, Tyrol	613	22.8

1.2 Aim and organization of this report

The primary objective is to explore the feasibility of implementing an HTN in the Inntal region[2]. The initial phase involved a comprehensive analysis of the potential for implementing an HTN. This includes the identification of waste heat sources and potential heat sinks and therefore consumers, the utilization of both existing open data sources and first-hand information obtained from district heating operators and industrial companies. From this assessment, a preliminary pipe routing plan was developed, considering factors such as the location of industries with significant waste heat potential and the proximity to demand nodes. Subsequently, a basic techno-economic analysis was conducted to evaluate the feasibility of the proposed HTN in the follower region. This assessment encompasses especially the capital expenditures (CAPEX) and operational expenditures providing insights into the financial viability of the initiatives. Finally, based on the findings from the analyses, the results are summarized and presented in this report. The resulting

[2] Due to the similarities of the HTN concept in the HTN Innviertel and HTN Inntal several chapters are similar for both BMPs

implementation plan outlines the necessary steps and actions required to move the HTN towards implementation. The structure of the concept and BMP of the HTN Inntal is based on the recommendations of the Austrian Federal Economic Chamber (WKO).[3]

In the following chapters, the detailed content of a BMP is described, including

- the presentation of the product/service (chapter 2),
- analysis of the market (chapter 3),
- marketing strategies (chapter 4),
- financial forecasts (chapter 5) and
- plans for implementation (chapter 6).

2 PRODUCT

In this BMP, a conceptual HTN, which interconnects many industrial waste heat and other sustainable sources, district heating networks, and industrial process heat sinks, is presented for the Inntal region in Tyrol. The product range, services, the strengths and weaknesses and the basic pipe route are described in more detail below.

2.1 Products

2.1.1 Diversified Energy Sources for District Heating

The HTN Inntal offers a diversification of climate-friendly energy sources for a sustainable and secure district heating supply. By optimizing and connecting distribution networks and leveraging a diverse range of climate-friendly energy resources sourced from multiple suppliers, such as:

- industrial waste heat,
- biomass CHPs,
- heat pumps,
- biomass boilers

the region can enhance its security of supply, increase its energy independence and is able to offer price stability[4] to consumers. As a result, this approach ensures a low risk of supply disruptions and a provision of cost-effective heating solutions.

2.1.2 Serving Industrial and Residential Heat Demands

Besides providing heat to households for space heating and domestic hot water, the HTN is designed to serve distribution grids and large consumers in industrial areas. By targeting these high-demand sectors, the network ensures efficient and reliable heat supply, catering to the substantial energy needs of industrial operations while optimizing the distribution process. This focus provides significant benefits to large-scale users through consistent and dependable heat delivery. Furthermore, industrial consumers also have the possibility to feed excess heat from energy-intensive processes back into the heating network.

2.1.3 Cooling Solutions for Industrial Heat Suppliers

Customized cooling solutions for companies that emit excess heat are offered in the HTN. These solutions help to increase operational efficiency while minimizing environmental impact. Also they can reduce the CAPEX for installing cooling towers and chillers on the industry side.

2.2 SWOT Analysis

The economic risks of a HTN can be reduced by including many supply and demand nodes, especially when considering different supply units such as large scale heat pumps and CHP units. This includes, for example, increased supply flexibility and reliability of the heat supply, as a large number of sustainable energy sources can be used in the event of a supply interruption. The concept therefore enables a more robust and reliable

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[3] WKO, Inhalte des Businessplans (2023). URL: https://www.wko.at/gruendung/inhalte-businessplan

[4] https://www.sciencedirect.com/science/article/pii/S2666955223000266

heat supply for consumers. In addition, the dependency on individual and, above all, fossil fuels are greatly reduced, thus making a significant contribution to the decarbonization of the heating sector and the achievement of EU and national climate targets.

Table 2: SWOT-Analysis of the HTN concept[5]

Strengths	**Opportunities**
Optimal integration of regional industrial waste heat sources, even outside district heating areas.	Growing demand for climate-friendly district heating.
Ability to supply district and process heat to customers in rural areas.	Government financial incentives for district heating implementation.
Reduced dependence on individual producers due to multiple connected generation units.	Expanded integration of industrial waste heat and renewable sources.
Diversification of heat generation technologies.	Collaboration among various stakeholders to create local value and mutually beneficial outcomes.
Cost-optimized heat production by connecting networks and utilizing the most efficient plants.	Low-cost infrastructure development with a non-profit, cost-covering network operator, enabling the lowest heat prices.
Resilient and price-stable heat supply for communities.	Political commitment and supportive legal frameworks, such as tax reductions and subsidies, which enhance the infrastructure's economic viability.
Encouragement of cooperation between municipalities and efficient use of available resources.	Multiple stakeholders fostering the establishment of a heat market, similar to the electricity market, for cost-effective use of available heat sources.
Reduction of the specific peak load by aggregating multiple consumers and making large storage facilities available.	
Lower pipeline costs in suburban areas compared to urban centers.	
Increased flexibility, reliability, and sustainability by integrating diverse renewable sources.	
Use of abundant, unused resources like industrial waste heat, supporting climate goals and reducing energy imports.	
Provision of both heating and cooling solutions.	
Weaknesses	**Threats**
• High investment costs for building network infrastructure and related technology.	• Long-term planning risks due to changing political or economic conditions.
• Increased complexity in managing large systems, requiring detailed planning and monitoring.	• Shifts in regulatory frameworks.
• Long-term planning and securing financing are essential.	• Disagreements among stakeholders.
• Technical challenges in connecting existing networks, such as temperature, pressure, and water quality differences.	• Loss of competitiveness due to innovative or alternative heating technologies.
• Many district heating networks (DHNs) are still underdeveloped or not yet built.	• Decreasing heating demand caused by climate change, reducing the viability of large-scale networks.
• System inertia makes it difficult to adjust parameters like reducing system temperatures.	• A well-established natural gas network that may compete with HTNs.
• Reducing transmission temperatures requires significant adjustments in distribution networks and end-user systems.	• Challenges in making investment decisions for new infrastructure amid the transition from large centralized to smaller decentralized energy systems.

[5] The SWOT analysis is based in part on the outcome of Task 2.1 - Review of national/international best practice

• Peak load provision should occur at the local distribution level to limit infrastructure costs.	
• High coordination needs among various stakeholders, including heat producers, transmission, and distribution operators.	
• Connecting to a transmission network may displace production for distribution network operators with their own generation facilities.	

3 MARKET & COMPETITION

The primary market for our heat distribution system includes municipalities and distribution grids, large industrial consumers, and environmentally conscious entities, typically within the industrial sector rather than households. Acceptance by the population is crucial, as "not in my backyard" sentiments as well as the wish for an individual heat supply can impact project implementation. Government agencies and support programs provide incentives for decarbonization, adding to the appeal of our solution. Additionally, the market encompasses hardware providers, technical and planning offices, TIGAS (the operator of the heat transmission network in Innsbruck), and other operating companies.

3.1 Trends and developments

The goals of the heating transition by 2040 in Austria and by 2050 in the EU include a clear phase-out of oil and gas for heat supply. These energy sources are major contributors to greenhouse gas emissions in the heating sector and are to be replaced with sustainable alternatives. Under the framework of the European Green Deal[6] and national laws and regulations, ambitious measures are being taken to accelerate this transformation. The Austrian Renewable Heat Act (EWG)[7] and other legal provisions promote increased use of renewable energies and the transition to climate-friendly and highly efficient heating systems. Achieving this transition requires significant investments in infrastructure and technologies, as well as comprehensive adjustments in building construction and renovation to meet stricter energy efficiency standards.

Key legislative frameworks include the EU Energy Efficiency Directive[8] and the Renewable Energy Directive (RED III)[9], both integral parts of the European Green Deal. Nationally, the Bundes-Energieeffizienzgesetz[10] is a pivotal regulation supporting these efforts. Financial incentives are also essential, supported by the EU

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6 Council of the EU and the European Council, European Green Deal (2024), URL: https://www.consilium.europa.eu/en/policies/green-deal/.

7 Bundesgesetz über die erneuerbare Wärmebereitstellung in neuen Baulichkeiten (Erneuerbare-Wärme-Gesetz – EWG), StF: BGBl. I Nr. 8/2024.

8 Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast) (Energy Efficiency Directive - EED).

9 Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (Renewable Energy Directive - RED III)..

10 Bundesgesetz über die Verbesserung der Energieeffizienz bei Haushalten, Unternehmen und dem Bund sowie Energieverbrauchserfassung und Monitoring (Bundes-Energieeffizienzgesetz – EEffG), StF: BGBl. I Nr. 72/2014, idF: BGBl. I Nr. 59/2023..

General Block Exemption Regulation (GBER)[11] and the national Umweltförderungsgesetz (UFG)[12]. Additionally, the establishment of necessary infrastructure is governed by the Umweltverträglichkeitsprüfungsgesetz (UVP-G)[13], ensuring environmentally sound project developments.

Companies can integrate these initiatives into their sustainability reporting, guided by the EU Taxonomy Regulation, which sets the criteria for sustainable economic activities. Political measures such as subsidy programs for switching to climate-friendly or highly efficient heating systems, such as the "Raus aus Öl und Gas"[14] initiative, play a crucial role in achieving these ambitious goals and significantly reducing dependence on fossil fuels.

In 2020, more than a third of district heating in Austria was still covered by fossil gas and oil boilers. Just over half of district heating is provided by renewable energy sources, primarily biomass. The remaining shares are heat from thermal waste treatment and other energy sources[15] Forecasts by Kranzl et al. from 2020[16] for the heating transition show that by 2050, the proportion of biomass in the district heating supply in Austria is set to increase significantly (>70 %) and the importance of renewable energy and waste sources is set to increase as well (>20 %), while fossil resources are set to almost disappear completely from the heat supply. Furthermore, according to the heat transition scenario, district heating generation will fall by almost 30 % by 2050 compared to 2010. This is due to a combination of technological advances, improved construction and refurbishment standards as well as changes in climatic and social conditions that will affect the demand for district heating by 2050.

In a more recent study by UBA[17], district heating supply rises from 92 PJ in 2021 to 104 PJ in 2030, followed by a decrease to 83 PJ in 2050. The energy sources change significantly, as fossils and waste are phased out nearly completely, while geothermal heat accounts for about 35 PJ and biomass for about 43 PJ (with higher values in 2030 and 2040) in 2050, hydrogen plays a minor part.

3.2 Market

The market for the concept comprises various players and interest groups. Each of these groups play an important role in the implementation and acceptance of the concept and offers potential partnership and market opportunities.

3.2.2 District heating operating companies

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[11] Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty..

[12] Bundesgesetz über die Förderung von Maßnahmen in den Bereichen der Wasserwirtschaft, der Umwelt, der Altlastensanierung des Flächenrecyclings, der Biodiversität und zum Schutz der Umwelt im Ausland sowie über das österreichische JI/CDM-Programm für den Klimaschutz (Umweltförderungsgesetz – UFG), StF: BGBl. Nr. 185/1993, idF: BGBl. I Nr. 34/2023..

[13] Bundesgesetz über die Prüfung der Umweltverträglichkeit (Umweltverträglichkeitsprüfungsgesetz 2000 – UVP-G 2000), StF: BGBl. 697/1993, idF: BGBl. I Nr. 26/2023.

[14] Bundeskanzleramt Österreich, "raus aus Öl und Gas" 2023/2024 (2024). URL: https://www.oesterreich.gv.at/themen/umwelt_und_klima/energie_und_ressourcen_sparen/1/raus_aus_oel.html.

[15] BMK, Fernwärme (2024), URL: https://www.bmk.gv.at/themen/energie/energieversorgung/fernwaerme.html.

[16] Kranzl et al., Wärmezukunft 2050. Erfordernisse und Konsequenzen der Dekarbonisierung von Raumwärme und Warmwasserbereitstellung in Österreich (2020).

[17] Krutzler et al., Energie- und Treibhausgasszenarien 2023 - WEM, WAM und Transition mit Zeitreihen von 2020 bis 2050 (2023).

Local DH operators are responsible for the operation and maintenance of the distribution grids as well as the management of heat supply options and grid extensions to efficiently utilize a variety of energy sources and supply a variety of sinks. Thus, they are important partners of the HTN operator, as they have to ensure the reliable and sustainable operation of the individual DHNs connected to the HTN.
Thus, municipalities and DHN operators have to closely cooperate in order to achieve optimum conditions. In case of the HTN, several municipalities, DHN operators and the HTN operator have to cooperate, which adds high complexity.

3.2.1 Municipalities and distribution grids

Municipalities play a central role in the development and implementation of heat supply concepts, in particular through their involvement in approval processes, planning procedures and the provision of local subsidies. Municipalities with existing medium and large district heating networks (DHN) and waste heat sources, such as Wörgl, Kundl, but also Brixlegg, which does not yet have a DHN but a large waste heat potential, are considered key stakeholders in the development of the HTN.

3.2.2 Large industrial consumers

Industrial companies, with their high demand for thermal energy, are key potential consumers for the HTN. Additionally, many of these companies generate waste heat that can be integrated into the HTN, making them both heat suppliers and consumers. A total of 8 industrial companies have been identified as potential participants. Beyond industry, other sectors such as wastewater treatment plants, swimming pools, supermarkets, nurseries, clinics, automotive businesses, hotels, and manufacturing industries were also considered for their potential to contribute as heat sources or sinks. These environmentally conscious, large-scale consumers are ideal partners for HTNs due to their high energy needs, which can help drive the success and expansion of sustainable heating networks.

Table 3: List of selected industrial companies in the Inntal region

Nr.	Company	Sector	Currently feed waste heat into local DH Network
1	Company 1	Crystal glass	Yes
2	Company 2	Energy technology	Yes
3	Company 3	Raw material production	-
4	Company 4	Chemistry & pharmaceuticals	Yes
5	Company 5	Wood processing industry	-
6	Company 6	Wood processing industry	-
7	Company 7	Food industry	Yes
8	Company 8	Food industry	Yes

3.2.3 Public Acceptance

Public support is essential for the successful development and implementation of heat transfer networks (HTNs). The "Not in My Backyard" [18] phenomenon can lead to resistance against new infrastructure projects. To address this, transparent communication and public participation are critical. By clearly demonstrating the benefits of HTNs—such as emission reduction, long-term cost savings, and system resilience—public

[18] „Not in My Backyard“ – compare definition by ScienceDirect (https://www.sciencedirect.com/topics/social-sciences/not-in-my-back-yard) based on Callender (2012) (https://doi.org/10.1016/B978-0-08-047163-1.00601-9)

acceptance can be promoted, especially given the rising demand for district heating[19], which has surged due to recent geopolitical events, such as the Ukraine crisis.

3.2.4 Government Agencies and Support Programs

Government support programs and subsidies play a pivotal role in promoting HTNs by offering financial incentives for decarbonization. These include subsidies and tax benefits, which lower the financial barriers for integrating industrial waste heat and renewable energy sources. These measures make HTN projects more economically viable and attractive for investment. In Austria, for example, as of 2024, subsidies cover up to 75%[20] of the costs for switching to renewable heating systems, primarily district heating.

3.2.5 Technical Planning Offices

Technical planning offices are responsible for designing and planning the infrastructure of HTNs. Their expertise ensures the efficient integration of industrial waste heat and renewable energy sources into the network. This contributes to an optimized system design, increasing both the efficiency and sustainability of the heating networks.

3.2.6 Hardware and Software Providers

Hardware and software providers are integral to supplying the technologies needed to effectively utilize industrial waste heat and renewable sources. By offering innovative solutions and reliable equipment, these providers play a crucial role in the optimization and integration of the systems, which in turn enhances the efficiency and sustainability of the networks.

3.3 Competition

3.3.1 Natural Gas Network

Currently, the greatest competition for the establishment of a HTN is the very well developed and still enlarged[21] natural gas network in the region. Customers range from connected households to industrial companies, of which some supply their waste heat to local DH networks. With the trend towards decarbonization, finding alternative suppliers for the existing networks will be an issue.

3.3.2 Individual solutions

There is competition between a variety of sustainable energy sources, for example different heat pump systems, electric boilers, and biomass boilers. These technologies are primarily competing with district heating networks for the same customers and market share. Heat pumps and electric boilers offer flexible solutions that can be directly integrated with renewable energy sources. Geothermal energy and biomass provide local, sustainable energy sources that are often supported by government incentives, which can be utilized for individual heat supply or DHNs (i.e. also HTNs). The decision for or against one or more of these technologies depends heavily on economic, environmental and infrastructural factors as well as political framework conditions and individual considerations, such as the wish for independence or availability of cheap fuels such as biomass sourced from own sources, e.g. forests or residues.

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[19] FGW and WKO, „Gas und Fernwärme in Österreich Zahlenspiegel 2023“ (https://www.fernwaerme.at/wp-content/uploads/2023/08/zasp23_2023-08-14.pdf)

[20] "Raus aus Öl und Gas" 2023/2024 https://www.oesterreich.gv.at/themen/umwelt_und_klima/energie_und_ressourcen_sparen/1/raus_aus_oel.html

[21] Energiemonitoring Tirol 2022

4 MARKETING & SALES

4.1 Business model

The business model of an HTN must be created based on structured development and analysis of several key aspects. An essential step is to create cost transparency with regard to heat generation. Thus, at first already utilized heat sources of preexisting DHNs, followed by additionally available energy sources, such as industrial waste heat and other renewables, are recognized. In order to make the marginal costs visible, the Heat Merit Order (HMO) concept was created by Moser et al. (2020), see an example in Figure 4-1[22]. The marginal costs are a crucial benchmark, as the cumulative producer surplus of the HTN determines the profitability of the investment.

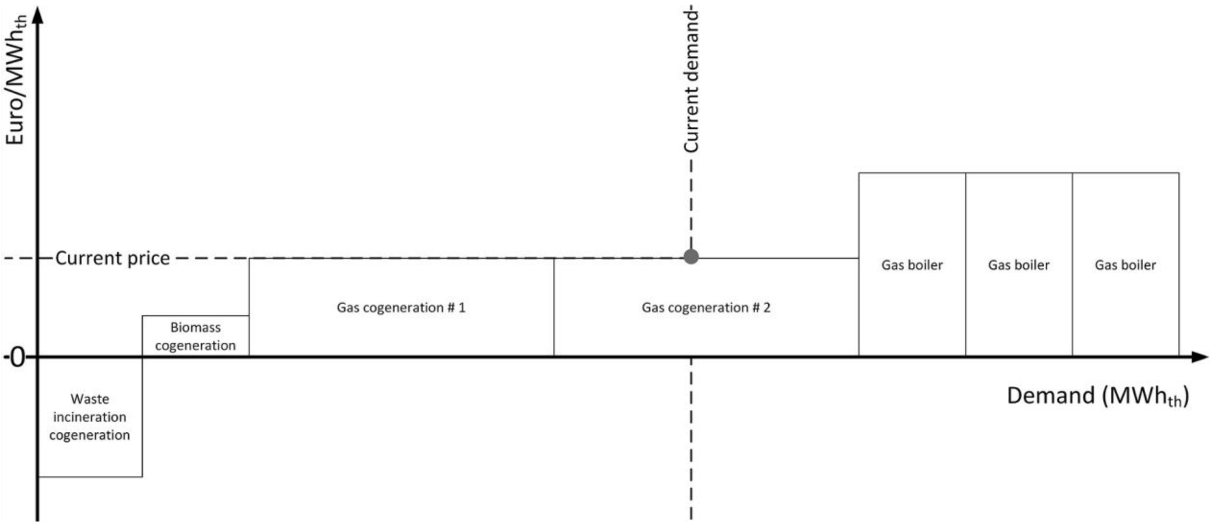

Figure 4-1: Representation of an HMO with the most common position of the gas cogeneration plants in winter. Source: Moser et al. (2020).

The HMO makes local heat generation prices transparent and, thus, allows to calculate the profitability of integrating waste heat, other heat sources and storage facilities. Beyond that, by avoiding information asymmetries, the HMO also generally supports the efficiency and operation of DHNs/HTNs. With these insights, the key components of the business model can be formulated, including the financial structure, the identification of potential investors and the definition of payment structures based on shareholders.

In the case of the Inntal, the HMO heavily depends on the energy prices and waste heat (WH) prices used. Figure 4-2 below illustrates the annual energy output in GWh from different suppliers, including network losses, for different WH prices in the HTN depending on the energy price scenario (Lambda). A low Lambda value represents a low energy price scenario, and a high Lambda value represents a high energy price scenario. The HP is mostly chosen for low energy prices (low Lambdas), but due to the high electricity prices in this consideration it is chosen less often by the HMO. As WH price increases, it is chosen more often for low Lambdas, reaching a peak at 60 €/MWh. In most cases, the CHP is chosen first, due to its ability to achieve negative fuel costs from electricity sales. There is only a small difference between low and high Lambdas, but it follows the reverse pattern of the HP. As biomass and waste heat are the largest suppliers in the HTN they mirror each other. At WH price 40 €/MWh below a Lambda of 0.6, WH is hardly used. The sharp increase from 0.6 to 0.7 is due to the fact that WH is in most cases cheaper than biomass. The dots between the solid lines reflect the discontinuation of WH supply.

[22] Moser et al., Designing the Heat Merit Order to determine the value of industrial waste heat for district heating systems (2020).

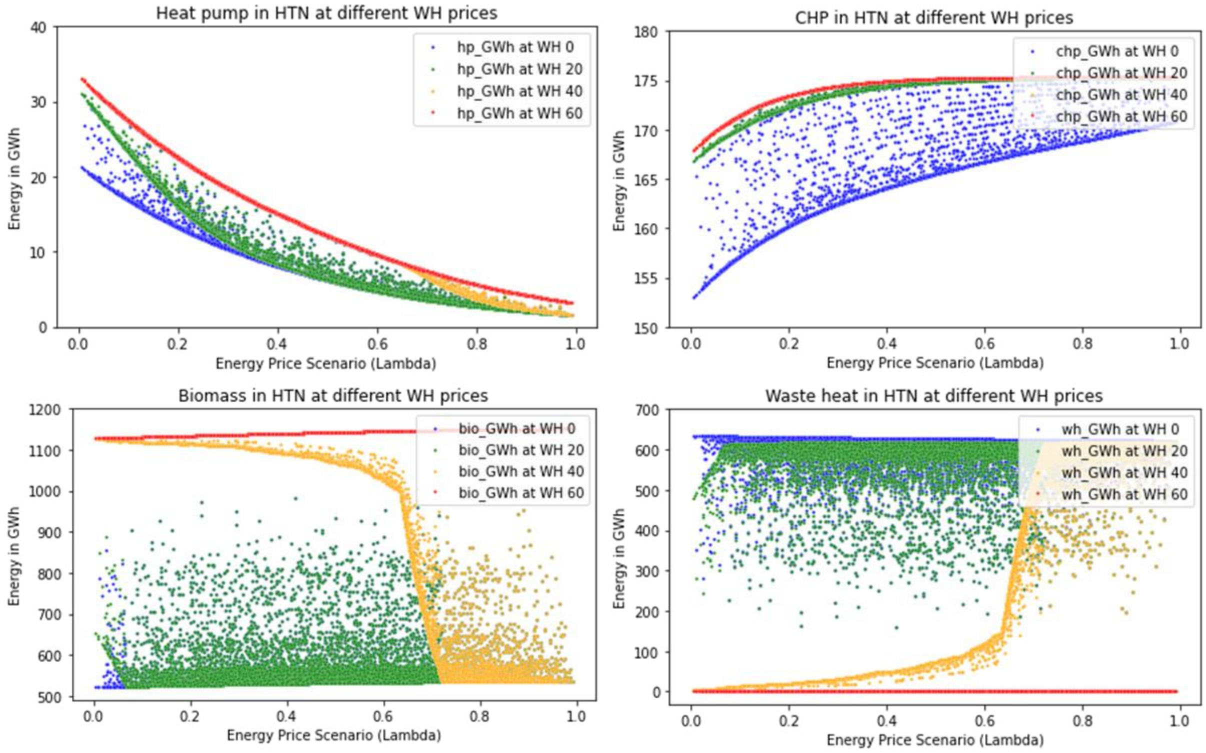

Figure 4-2: Annual energy output from different suppliers for different WH prices and energy price scenarios

4.2 Pricing and conditions

A pricing model is implemented that considers hourly pricing based on the load profiles of the distribution networks. The long-term plan includes the gradual reduction of transmission temperatures to enable the integration of low-temperature renewable energy sources and further waste heat. Distribution operators will be financially incentivized to lower the return temperature to maximize mass flow efficiency. These adjustments will be closely coordinated with the connected distribution networks to optimize system capacity.

The HTN Inntal network follows a three-phase pricing model that balances investment risks and ensures fair distribution of revenues. In the **first phase**, revenues will primarily go to industrial partner waste heat providers. This allows the industrial partners to quickly amortize their initial investments. Once these investments are paid off, the **second phase** begins, where all profits go to the transmission operator to refinance investments. In the **third phase**, revenues are shared according to the partners' investments, reflecting the risks taken.

The network's financing will be realized through a combination of equity and debt capital. By maintaining long-term, stable heat sales prices, we ensure the repayment of loans and minimize investment risks for all parties involved.

5 PERFORMANCE & FINANCIAL PLANNING

The following outlines the capital requirements (CAPEX), including investment, initial, and start-up costs, as well as the operational expenditures (OPEX) needed for an HTN. It also explores potential financing options through various funding programs. Additionally, the organizational and legal structures for operating an HTN are briefly discussed.

5.1 Company foundation

The choice of the legal form of an HTN depends in particular on the purpose of the company. Possible legal forms are:

- Limited liability company (Gesellschaft mit beschränkter Haftung, abbr. GmbH)[23]
    - Suitable for a commercial company that wants to make a profit and possibly attract external capital.
- General Partnership (Offene Gesellschaft abbr. OG)[24]
    - Suitable for smaller companies and projects where the shareholders have a high level of trust in each other and want to be directly involved in the management.
- Cooperative (Genossenschaft abbr. Gen)[25]
    - Ideal for a jointly operated project in which various stakeholders (e.g. industrial companies, DH operators, municipalities) are involved on an equal footing.
- Registered Association (Verein abbr. e.V.)[26]
    - Suitable for projects with a non-profit character or if the focus is on promotion and networking rather than making a profit.
- Public Limited Company (Aktiengesellschaft abbr. AG)[27]
    - Suitable for larger projects with high capital requirements and expansion plans.

5.2 Capital requirements

The capital requirements for the project involve significant initial investments that must be carefully planned and calculated. Key capital expenditures (CAPEX) include investments in the district heating network, construction of heat generation and storage facilities, and land acquisition, which together form the bulk of the upfront costs[28]. Additionally, legal, administrative, and regulatory expenses related to company setup and compliance with legal requirements must be factored in. Detailed planning is essential to ensure all financial aspects are covered and risks are minimized. Chapter 5.2.1 outlines the basic investment costs for the HTN Inntal project.

5.2.1 Investment cost

A basic investment cost estimate was conducted as part of the HTN Inntal study. In the maximum configuration, where all municipalities are connected, approximately 82 km of new heating pipeline would need to be built. For a DN 400 pipeline[29], the estimated cost is around 2,500 €/m in urban areas and approximately 1,700 €/m in rural, unpaved areas. This results in a total CAPEX of 222 Mio. € for the HTN. However, shorter HTNs might be economic feasible as well, depending on the connection rate of the end users to the HTN.

Table 4: Network length and cost of pipeline for the HTN Inntal

Heating network	Length of network (one way) [km]
Heat transmission network – paved terrain	34
Heat transmission network – unpaved terrain	48
Sum	82
Nominal pipe diameter	Cost [€/m]
DN 400 – paved terrain	2500

[23] WKO, Gesellschaft mit beschränkter Haftung (GmbH) (2024). URL: https://www.wko.at/wirtschaftsrecht/gesellschaft-mit-beschraenkter-haftung-gmbh.

[24] WKO, Offene Gesellschaft (OG) (2023). URL: https://www.wko.at/wirtschaftsrecht/offene-gesellschaft-og-.

[25] WKO, Welche Gesellschaftsformen gibt es in Österreich? (2024). URL: https://www.wko.at/wirtschaftsrecht/gesellschaftsformen-oesterreich.

[26] WKO, Verein als Unternehmer (2023). URL: https://www.wko.at/wirtschaftsrecht/der-verein-als-unternehmer.

[27] WKO, Aktiengesellschaft (AG) (2024). URL: https://www.wko.at/wirtschaftsrecht/aktiengesellschaft.

[28] Ramboll for the Danish Energy Agency (2022), Cost drivers in district heating: Comparison of CAPEX costs between the Netherlands and Denmark.

[29] A detailed analysis of the required pipe diameter for each network section has not been done, since it is assumed that the impact of different pipe diameters is small compared to the other factors considered.

DN 400 – unpaved terrain	1700

5.3 Operational expenditures

Running and personnel costs form a significant part of financial planning for the project. These include regular expenses such as rent, operational resources, maintenance, repairs, and other operating costs. Personnel costs encompass salaries and social benefits for employees, along with the entrepreneur's living expenses through an appropriate salary. These costs are carefully planned and monitored to ensure the company's financial stability and profitability.

Initial cost estimates have been conducted, considering both capital expenditures (CAPEX) and operating expenditures (OPEX). The analysis considers current operational costs, future energy price trends, and resource availability, aiming to identify potential risks such as cost overruns, price fluctuations, or supply issues. Operational costs are divided into fixed and variable expenses. Fixed OPEX includes taxes, insurance, service payments, and fees, while variable OPEX depends on the amount of heat supplied and includes maintenance, auxiliary energy, spare parts, and personnel costs.[30]

For the Inntal HTN, operational costs will arise from the maintenance and operation of large-scale heat pumps, biomass-based CHPs, waste heat costs, fuel demands, auxiliary energy, personnel and overhead costs, as well as the maintenance and expansion of the network.

5.4 Financing

The financing of the HTN project is proposed to come from a mix of capital sources, primarily debt capital from banks, supplemented by private investors and various national and European subsidies. Key funding sources include the Climate and Energy Fund (KLIEN)[31], managed by the Austrian Research Promotion Agency (FFG), the Umweltförderung[32], managed by Kommunalkredit Public Consulting (KPC), and European programs such as Horizon. As funding schemes frequently change, a detailed review of options is recommended during advanced planning stages. Current funding focuses mainly on CAPEX, with limited support for OPEX. The diverse financing strategy aims to secure sufficient capital and maintain financial stability.

5.4.1 National subsidies

To drive forward the successful implementation of a HTN, national funding opportunities have been investigated as part of Task 3.5 of the Heat Highway project. These subsidies can provide financial support to facilitate the implementation of the respective sections. More details can be found in "Heat Highway - Task 3.5 Business models and new players"[33], a report on national funding opportunities.

The report provides an overview of the current national funding landscape with regard to the construction of heat pipelines and industrial waste heat extraction in district heating networks. The research provides summarized information on funding channels, responsibilities, eligible measures, maximum funding levels, technical requirements and innovation criteria. The report is based on thorough research using publicly available information from various sources such as literature and the Internet. A comprehensive analysis of the various funding programs and measures at federal and state level is used to determine which options are available to support these specific projects.

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[30] Saipi et al. (2023), Techno-economic analysis of a 5th generation district heating system using thermo-hydraulic model: A multi-objective analysis for a case study in heating dominated climate.

[31] https://www.klimafonds.gv.at/

[32] https://www.umweltfoerderung.at/

[33] Muja et al., Heat Highway - Task 3-5 Business models and new players, Fördermöglichkeiten, Nicht-öffentliche Diskussionsgrundlage (2023).

The funding schemes handled by KPC stipulate that one actor in the project is responsible for submitting the funding application. The investigated funding opportunities are:

- Innovative local heating networks for businesses[34]
- Waste heat extraction[35]
- Expansion and decarbonization of climate-friendly district heating systems[36]
- Optimization measures in climate-friendly district heating networks[37]
- Local heating supply based on renewable energy sources[38]

The upper limit of the respective subsidies is 6 million €. Further detailed requirements for the subsidies can be found in the report.

6 IMPLEMENTATION PLAN

The preliminary implementation plan of the HTN Inntal is outlined below and should serve in particular as a guide.

6.1 Market analysis and feasibility study

The market analysis and the investigation of the competition for a HTN in the Inntal region have already been carried out and are described in detail in section 3. Sources and sinks of the Inntal region were defined and partially validated via interviews and a survey, also, pipe routing options were assessed. Implementation of the HTN east of Wattens should start in the municipalities of Wörgl and Kufstein, as both have existing supply networks, serving a large part of the population, supplied by industrial companies. Furthermore, several large, yet untapped waste heat potential are located in the vicinity. Step by step the network could be expanded to the west, reaching Brixlegg, where another yet untapped heat source is located.

However, a more detailed feasibility study needs to be done to get better information of the real demand and supply data, since this study is purely hypothetical and is not intended to serve as basis for further calculations or assumptions.

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[34] Innovative Nahwärmenetze für Betriebe, 2023. URL: https://www.umweltfoerderung.at/betriebe/innovative-nahwaermenetze/unterkategorie-waerme-aus-erneuerbaren-ressourcen.

[35] Abwärmeauskopplung und Verteilnetze, 2023. URL: https://www.umweltfoerderung.at/betriebe/abwaermeauskopplung-und-verteilnetze.

[36] Fernwärmesysteme, 2023. URL: https://www.umweltfoerderung.at/betriebe/klimafreundliche-fernwaerme.

[37] Fernwärmenetze, 2023. URL: https://www.publicconsulting.at/fileadmin/user_upload/umweltfoerderung/ahttps://www.umweltfoerderung.at/betriebe/optimierungsmassnahmen-in-klimafreundlichen-fernwaermenetzebetriebe/Klimafreundliche_Fernwaermenetze/UFI_Standardfall_Infoblatt_FOSSIL_OPT.pdf

[38] Nahwärme auf Basis erneuerbarer Energieträger, 2023. URL: https://www.umweltfoerderung.at/betriebe/nahwaermeversorgung-auf-basis-erneuerbarer-energietraeger.

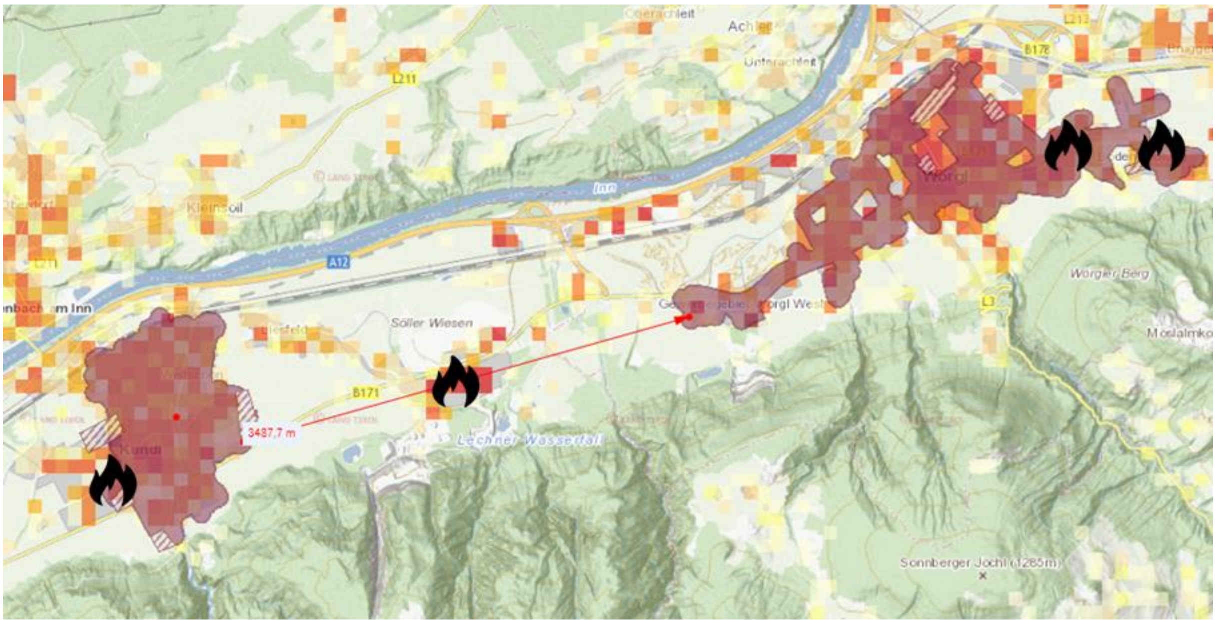

Figure 6-1: Supply networks of Kundl and Wörgl indicating existing and possible future heat sources[39]

6.2 Business model development

The advanced business model development should involve all operational stakeholders, to identify cost benchmarks and thus, financing options. Furthermore, the timeline for a stepwise implementation of the HTN, i.e. stepwise construction, should be defined. This is followed by the detailed elaboration of the business model and the financing options.

6.3 Technical planning

An initial route has already been presented in Figure 1-1. In an advanced technical planning phase, the locations should be examined on site and via a GIS analysis, and the detailed route planning is carried out in order to determine the optimum route for the HTN Inntal. Finally, detailed planning is carried out and technical specifications are drawn up to create the basis for the subsequent implementation and successful operation of the network.

The following Figure 6-2 depicts the heat density of the area, which was also used as a basis to estimate the heating demand of the 32 municipalities. Furthermore, existing heat sources, including industrial waste heat and biomass heating plants are mapped. The area covered by existing district heating plants is highlighted in dark red colour.

[39] https://maps.tirol.gv.at/synserver?user=guest&project=tmap_master&client=core

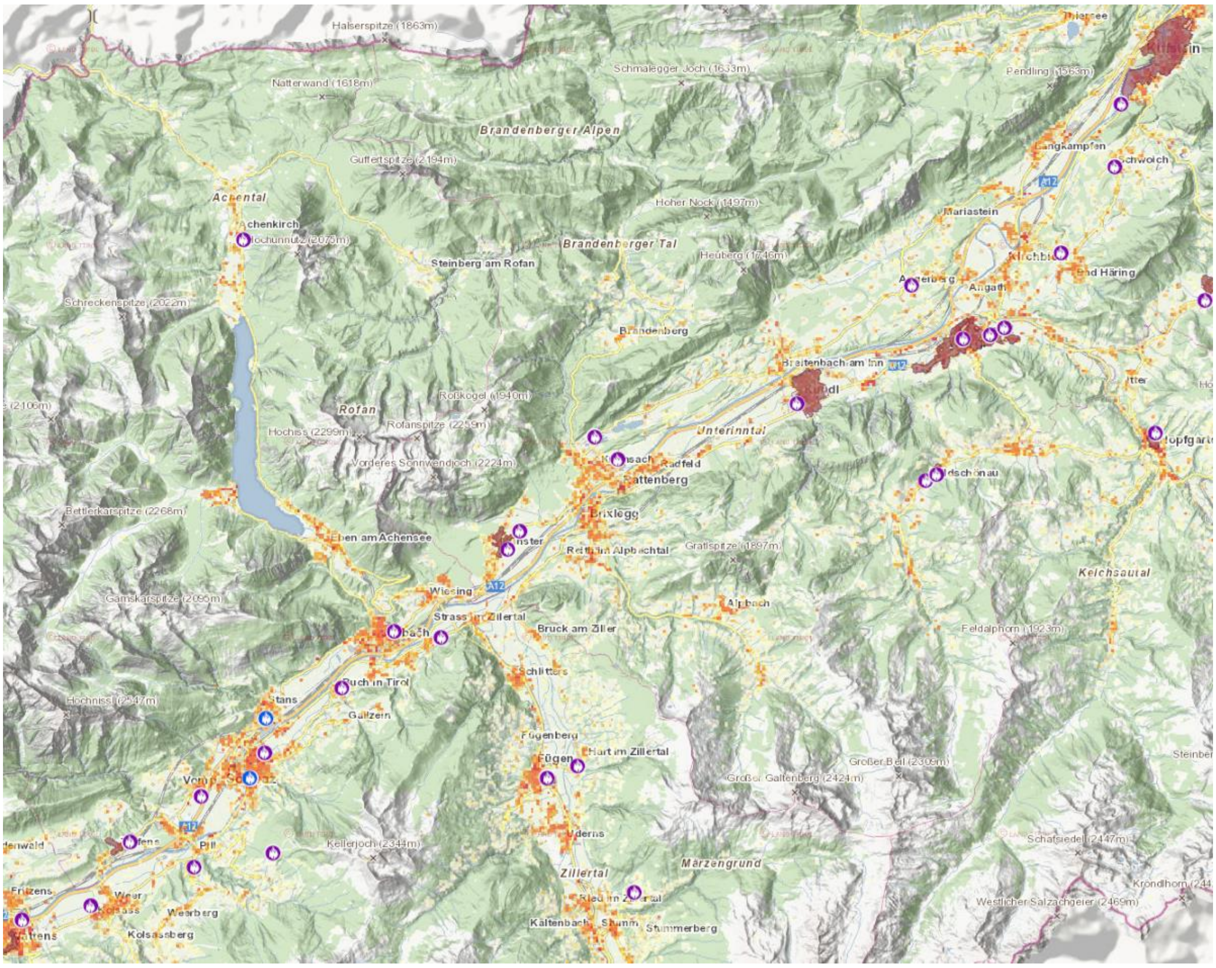

Figure 6-2: Heat density map of the area, including heating plants[40]

The information was validated and extended with results from further research (see Figure 6-3).

[40] https://maps.tirol.gv.at/synserver?user=guest&project=tmap_master&client=core

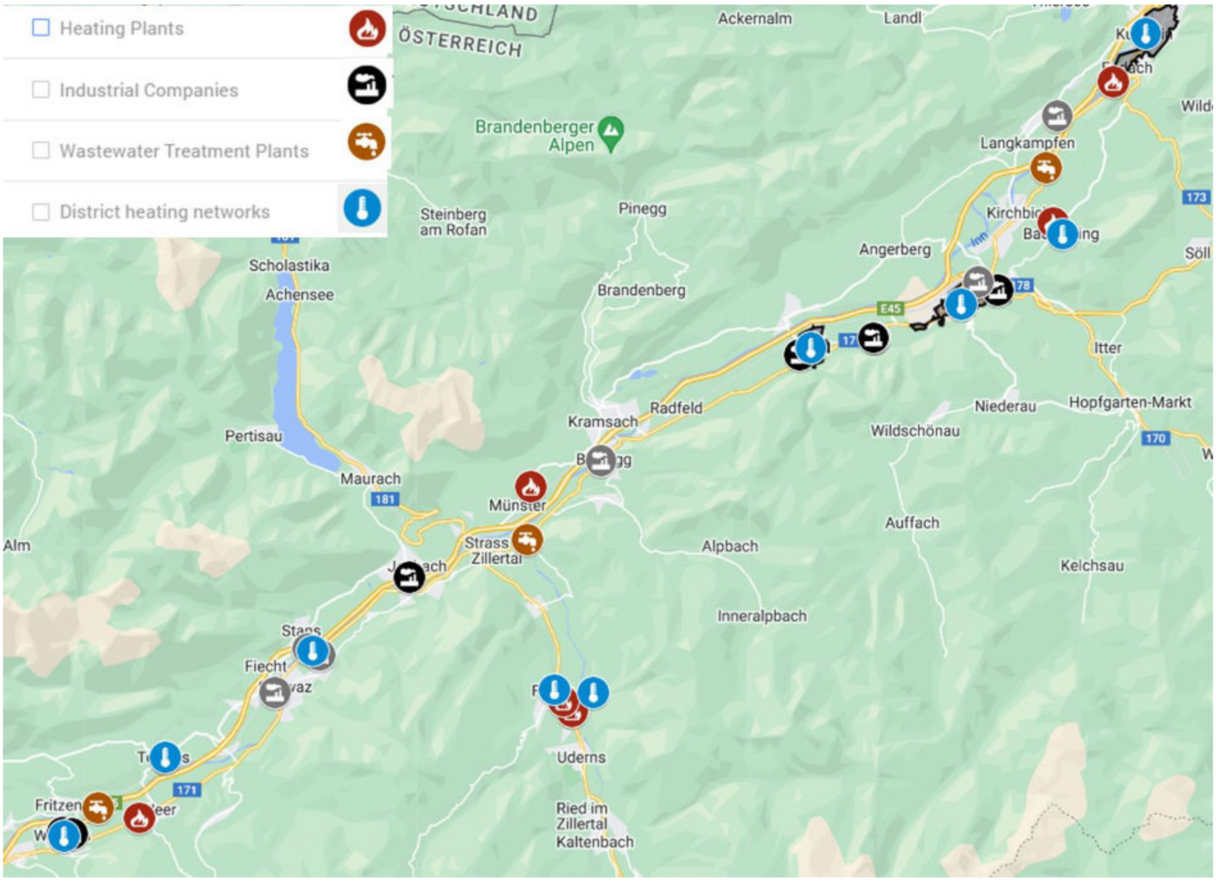

Figure 6-3: Potential heat sources and district heating networks[41]

Large-scale consumers close to the proposed route of the Inntal HTN were mapped in Figure 6-4.

[41] Google – My Maps

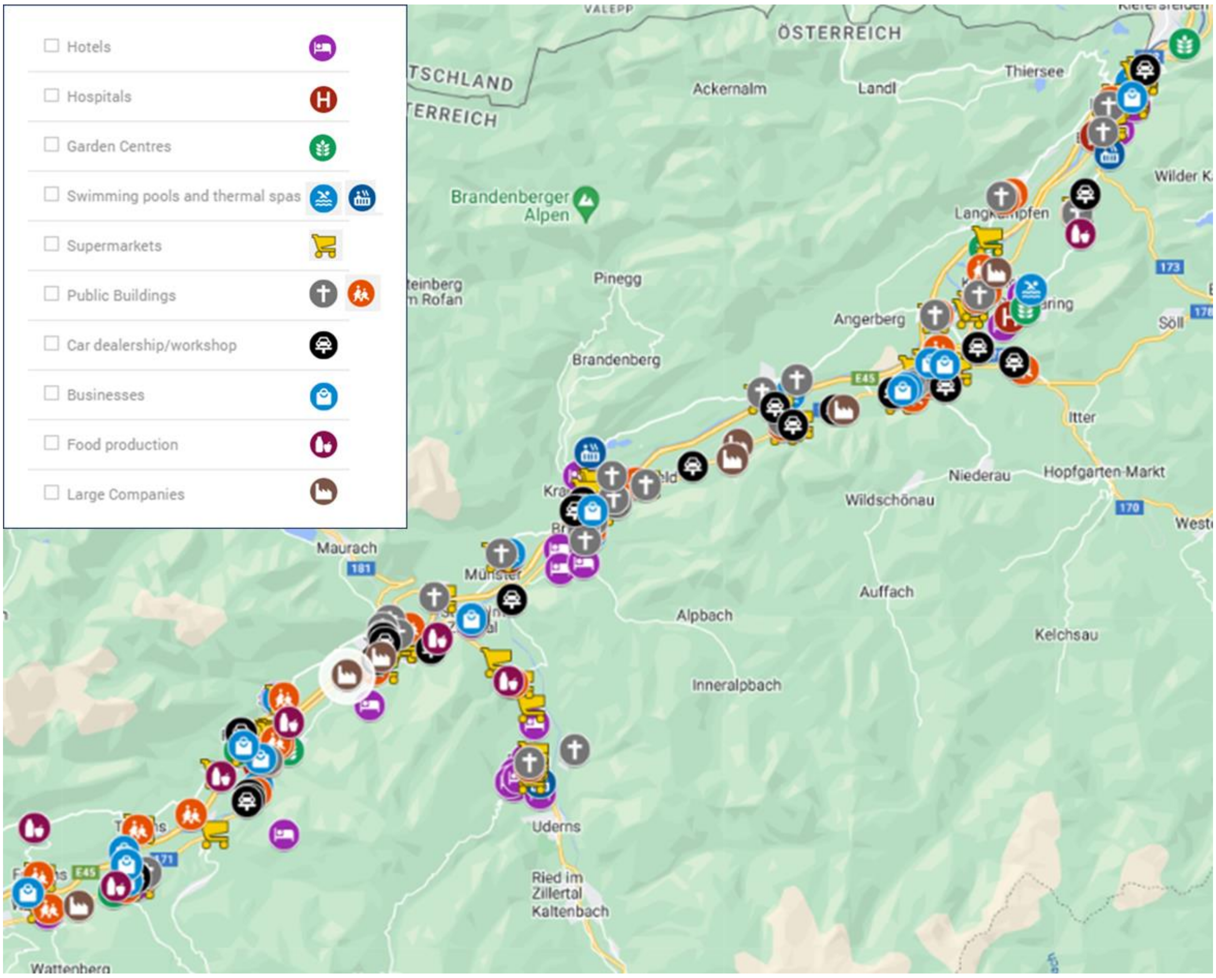

Figure 6-4: Potential heat sinks[42]

6.4 Permitting process

The permitting process for an HTN in Austria requires compliance with the Environmental Impact Assessment (EIA) Act (UVP-G), with both federal and provincial authorities involved in the permitting process. A full EIA is likely for large HTNs, assessing impacts on ecosystems, air and water quality, and noise levels, especially when crossing sensitive areas. Public participation is essential, with requirements for public hearings and stakeholder consultations to ensure transparency. To proceed, the HTN project must submit comprehensive plans covering technical, financial and environmental details for review by all relevant authorities.

6.5 Securing financing

After conceptualization and initial planning, intensive efforts will have to be made to secure financing. The initial focus is on identifying and approaching potential investors who may be interested in supporting the heat transfer network. In this sense, the establishment of collateral and payment structures to provide financial stability and transparency for both investors and project operators is of high importance. The goal is to financially secure the HTN and to develop clear and reliable framework conditions for all involved partners

6.6 Construction phase

After the detailed planning phase, the project enters the decisive construction phase. The construction process includes laying the pipes, setting up the transfer stations and installing other auxiliary components. At the end of this phase, the HTN is commissioned, with extensive testing carried out to ensure the functionality and reliability of the system.

[42] Google – My Maps

6.7 Commissioning

After the construction phase, the HTN is commissioned. This phase begins with the coordination of activities with the local DHNs to ensure seamless integration. At the same time, the system is fine-tuned to achieve optimum operating conditions. Once these preparations have been completed, the network is fully commissioned, accompanied by comprehensive inspections and tests to ensure compliance with all technical standards and operational readiness. These meticulous measures are crucial to ensure a smooth start to operations and a reliable supply of heat to the connected end users.

6.8 Start up and official opening

Following the successful commissioning of the HTN, the official start up takes place. This milestone marks the official start of operations and provides an opportunity to celebrate the achievements. Representatives of the companies involved, local authorities and other key stakeholders are in focus of the event. Finally, the operating company will officially take over control and daily operation of the network. This marks the beginning of the operational phase in which the HTN will develop its full functionality and secure the Inntal region's climate- friendly district heat supply in the long term.

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH
Giefinggasse 4, 1210, Wien

www.ait.ac.at
Fax +43 50550

Nicolas Marx
Research Engineer
Integrated Energy Systems
Center for Energy
+43 50550-6634
Nicolas.marx@ait.ac.at

Ralf-Roman Schmidt
Senior Research Engineer
Integrated Energy Systems
Center for Energy

Verena Alton
Junior Research Engineer
Integrated Energy Systems
Center for Energy