

**Interreg  
Europe**



Co-funded by  
the European Union

**Green4HEAT**



# Report

## Activity A 3.1

Interregional workshop on low temperature heat networks

March 2025

## Contents

Executive summary .....	3
<b>1. Workshop on Low-Temperature Heat Networks results .....</b>	<b>4</b>
1.1. Good practice examples of low-temperature heating networks proposed by participants ..	4
1.2. Good practice examples of the integration of Low-Quality Energy and Heat Sources in LTDH proposed by participants .....	7
1.3. Urban Planning Solutions for Implementing LTDH in Green4HEAT Areas .....	8
1.4. Participant survey results .....	9
1.5. Low-Temperature Heat Networks .....	11
<b>2. Low-temperature heating development .....</b>	<b>17</b>
2.1. Overview of related planning documents .....	17
2.2. Strategic energy planning .....	20
2.2.1. Analysis of Preconditions .....	22
2.2.2. Stakeholder Analysis .....	23
2.2.3. Institutional and Organizational Framework .....	24
2.2.4. Analysis of Strategy Pathways for Transformation .....	24
2.2.5. Initial District Identification .....	26
2.2.6. Data Collection and Scenario Evaluation .....	27
2.2.7. SWOT Analysis (Strengths, Weaknesses, Opportunities, and Threats) .....	28
2.2.8. Evaluation of Implementation Conditions and Synergies .....	28
2.3. Application of Simulation Tools in Strategic Planning .....	29
<b>3. Recommendations for Policymakers .....</b>	<b>30</b>
3.1. Strengthening the Legal and Regulatory Framework .....	30
3.2. Financial Incentives and Investment Support .....	30
3.3. Stakeholder Engagement and Local Government Support .....	31
3.4. Integration of Renewable Energy and Waste Heat .....	31
3.5. Standardized Monitoring and Evaluation Mechanisms .....	31
<b>4. Funding attraction .....</b>	<b>32</b>

## Executive summary

This report aims to depict the design and installation process of Low-temperature district heat (LTDH) systems within the Green4HEAT project, including survey results, strategic planning recommendations, policy suggestions, and funding sources.

The stakeholder survey reveals that municipal authorities and technical experts are the principal drivers of the discussion on LTDH. Meanwhile, the engagement of urban planners and private energy companies is rather low. Most respondents agreed that the development of LTDH in their regions is still in its infancy and requires policy support and investment. Everyone agrees that the key to successful integration is to include the energy component and improve the building envelope. However, the drive among district heating companies to move is still rather divided.

LTDH is a game changer that improves energy efficiency and cuts greenhouse emissions by operating at relatively low temperatures on the network. To succeed, it must incorporate renewable energy sources, maximise waste heat recovery, and align with EU policies like the Green Deal and Fit for 55. Municipalities are central to strategic energy planning, and this role involves the involvement of policymakers, industry representatives and financial institutions to accelerate uptake.

The transition to LTDH needs proper policy implementation, financial assurance, and technological development. At the national level, legislation, investment assistance, and new business strategies are vital to the process. The EU funding mechanisms, the European Investment Bank loans, and other private funding sources are how to break the financial barriers. The use of LTDH has great potential to contribute to mitigating urban emissions, but its implementation needs collective action. Therefore, the Green4HEAT project can be a reference for best practices for extending LTDH networks through promoting municipal cooperation, the involvement of all the interested parties and sustainable funding mechanisms.

The deliverable presents the results from the Green4HEAT workshop on February 5, 2025, in Valmiera, Latvia. The event gathered representatives from municipalities, academic professionals and representatives from the energy sector. The gathering allowed participants to exchange practical tools and good practices about Low-Temperature District Heating (LTDH) systems. The workshop drew from the previously created Input Paper for the International Working Group on LTDH in Green4HEAT Territories to establish planning principles for LTDH systems throughout project regions. The workshop included interactive simulations using a platform specifically designed for digital energy modelling. The participants were divided into groups to analyse different energy planning scenarios, which included renewable energy integration, building renovation and storage options, and production system optimisation. The simulation results helped participants develop strategies for LTDH transformation during stakeholder engagement sessions.

The report combines theoretical frameworks with workshop-based practical knowledge to support future LTDH development in Green4HEAT regions.

# 1. Workshop on Low-Temperature Heat Networks results

The Low-Temperature Heat Networks workshop was held 05/03/2025 for project partners and an invited target audience. The workshop was held by Green4HEAT project partners and an invited target audience, including representatives from municipalities, research institutions, industry stakeholders and energy professionals. It served as a platform for sharing knowledge and partnerships for sustainable energy solutions for LTDH networks. The meeting aimed to define the best practices and the main principles of planning for implementing LTDH networks in the Green4HEAT project regions. In the workshop, pilot applications of LTDH networks were shared, waste heat integration strategies were discussed, solutions for integrating urban planning for LTDH deployment were explored, funding opportunities for sustainable energy projects were identified, and the collaboration between municipalities, industry stakeholders, and researchers was strengthened.

## 1.1. Good practice examples of low-temperature heating networks proposed by participants

The Green4HEAT project gathered multiple case studies showcasing the successful implementation of LTDH networks across different European regions. The key takeaways from these examples include innovative system designs, integration of renewable energy sources, and sustainable urban heating solutions. The examples discussed differ in scale (large, medium, local), DH elements included in the modernization or transformation (heat production, heat distribution (grid) and heat consumers), and the integration of renewable energy resources:

**Latvia – Gulbene Municipality:** Implementing an LTDH system in Gulbene focused on modernising an existing district heating network. Modernisation include all DH elements. Introducing smart metering and energy-efficient distribution has significantly reduced energy losses and improved heating quality for public buildings and residential areas.

**Lithuania – Vilnius LTDH System:** This modernisation project focused on heat distribution part and involves replacing old pipelines with pre-insulated ones, integrating renewable energy sources such as biomass, and improving efficiency by reducing heat loss. The development of LTDH aims to provide affordable and sustainable heating to urban residents.

**Poland – West Pomerania:** A passive building development integrating geothermal heat pumps for heating and cooling, significantly reducing operational energy demand and promoting sustainable heating.

**Terma, Gdansk Suburb:** A project utilising waste heat from soldering furnaces for space heating, ventilation, and domestic hot water preparation. The initiative effectively reduces reliance on fossil fuels while maximising industrial heat recovery.

**Geotermia Podhalańska:** A geothermal-based district heating system that provides sustainable heating by utilising Poland's natural geothermal resources. This approach significantly reduces carbon emissions and supports Poland's transition to green energy sources.

**Hungary – Hódmezővásárhely Geothermal District Heating:** One of Hungary's oldest geothermal heating networks supplies heat to homes and public buildings. This project has demonstrated the potential of geothermal resources in providing stable, low-carbon heating and reducing reliance on fossil fuels.

**Belgium – Kortrijk Passive House Community:** Kortrijk has developed a passive house community where low-temperature district heating is used efficiently. The buildings are designed with high insulation standards, allowing LTDH to operate optimally.

**Belgium – Schoten Aquathermal Energy:** This project explores the potential of aquathermal energy by studying heat recovery from nearby water sources for sustainable district heating. While still in the research phase, the initiative aims to reduce dependency on fossil fuels and ensure reliable heating services in the future.

**Slovenia – Ljubljana District Heating:** Ljubljana has expanded its district heating network by incorporating renewable energy sources and improving efficiency. LTDH integration in new developments ensures long-term sustainability and reduced emissions.

**Spain – Barcelona Waste Heat Recovery:** Barcelona has implemented a district heating system that captures surplus heat from industrial processes and integrates it into the urban heating network. This initiative reduces waste and enhances energy efficiency in the city.

**Greece – Kozani District Heating:** This project utilises biomass and geothermal sources to provide district heating. The system supports Greece's efforts in carbon reduction and the transition to more sustainable energy use.

**Denmark – Albertslund:** A large-scale renovation project in Albertslund has focused on integrating LTDH into residential areas. The initiative includes better insulation, smart heating management, and renewable energy integration.

**Kalundborg Waste Heat Utilization:** The city of Kalundborg has developed an extensive waste heat recovery system, transporting low-temperature surplus heat over 20 km to supply urban heating networks.

Table 1. Summary Table of Good Practice Examples

Country	Good Practice Example	Key Features	Scale of DH system	RES integration
Latvia	Gulbene Municipality	Smart metering, modernised of heat production, heat distribution and heat consumer	Small	Pellet boiler
	Salaspils District Heating (DH)	Modernisation of the DH system, integration of solar collectors, heat accumulation and waste heat utilisation.	Large	Integration of solar collectors, heat accumulation and waste heat utilisation
Lithuania	Vilnius LTDH System	Modernisation of old pipelines, integration of new energy-efficient technologies	Large	Heat storage, biomass and solar power
Poland	West Pomerania (Marshal's Office)	Passive building development with geothermal heat pumps, reducing operational energy demands	Local	Heothermal heat pumps,
	Jabłoń District Heating System	building energy efficiency increase, supply temperature decrease	Medium	Heat pumps with photovoltaic system
Hungary	Hódmezővásárhely Geothermal DH	One of the oldest geothermal DH systems, serving homes and public buildings	Large	Geothermal system, storage tanks
Belgium	Kortrijk Passive House Community	Implementation of LTDH in a high-energy efficiency residential area	Medium	Woodchip boiler with storage tank
	Hospital site in Brasschaat	New shallow geothermal energy source for a group of buildings in the healthcare industry	Medium	

Slovenia	Ljubljana DH	Expansion of district heating networks using renewable energy sources and improving efficiency	Medium	Increase of renewable energy sources share
Spain	Barcelona Waste Heat Recovery	Utilising surplus heat from industrial activities and integrating it into the heating network	Large	Utilising surplus heat
Greece	Kozani District Heating	DH uses biomass and geothermal sources, supporting carbon reduction efforts	Medium	DH uses biomass and geothermal sources
Denmark	Albertslund	Large-scale renovation, LTDH integration	Large	Biomass combustion, CHP plants and waste incineration
	Kalundborg	Large-scale waste heat utilisation over 20 km	Large	Heat pumps and waste heat integration

## 1.2. Good practice examples of the integration of Low-Quality Energy and Heat Sources in LTDH proposed by participants

During the Green4HEAT workshop and discussions with project partners, multiple case studies showcased the successful integration of low-quality or waste heat into LTDH networks. These examples demonstrate the feasibility of utilising industrial waste heat, geothermal energy, and aqua thermal sources for sustainable heating solutions:

**Germany - HafenCity, Hamburg:** The project incorporated surplus industrial heat from a copper smelting plant, proving that heat-intensive industries can play a key role in LTDH development.

**Sweden - Brunshög, Lund:** One of the most extensive LTDH systems in Europe, it utilises surplus heat from research facilities, such as the MAX IV and ESS installations, to supply a growing urban area.

**Belgium - Schoten:** A municipal project currently under study, exploring the potential of aqua thermal energy sources and how natural water bodies could provide a reliable, renewable heat source for LTDH networks.

**Poland - Geotermia Podhalańska:** A long-standing example of how geothermal energy can serve as a primary heat source for district heating networks, reducing reliance on conventional fuels.

In the workshop, participants identified multiple advantages of incorporating low quality energy into LTDH networks, including significant carbon emission reduction, improved energy efficiency, reduced costs of not relying on imported fuels, and increased reliability by using stable heat sources such as geothermal and aqua thermal energy. However, several challenges were identified that limit their widespread application. There are technical difficulties in retrofitting existing district heating infrastructure to accommodate low-quality energy sources. At the same time, regulatory barriers slow down the permitting process for waste heat recovery. Initial costs may be high and may require government grants or private equity. It is still a problem that the public is not very knowledgeable about the subject, and some communities have fears concerning the effectiveness and dependability of low-temperature heating systems, which could be addressed through focused awareness campaigns.

To overcome these barriers, future implementations should focus on improving policy support by reducing the time for permit processing and promoting the incentive for organisations that contribute waste heat into the LTDH networks. Enhancements to the infrastructure, such as improved heat exchangers and insulated pipelines, will be crucial in facilitating the integration of low-temperature heat sources. This will be important in the case of public-private partnerships to share investment costs and operational responsibilities for sustainable project development. Lastly, the continuous development of best practices through workshops, pilot projects, and research collaborations will be essential for constantly improving the technology adoption of LTDH networks. These recommendations align with the Green4HEAT project's wider ambitions to enhance the uptake of sustainable LTDH networks across Europe.

### 1.3. Urban Planning Solutions for Implementing LTDH in Green4HEAT Areas

Urban Planning have a significant role for Implementing LTDH. During discussions with project participants during workshop discussed about different solution of urban planning and the most important aspects were identified:

- Strategies for land use changes;
- Construction regulations and standards;
- Financing schemes for LTDH Implementation;
- Future LTDH development directions.

**Strategies for Land Use Changes:** During discussions with project participants, several strategies were identified to optimise land use for LTDH implementation in Green4HEAT areas. Municipalities are encouraged to introduce zoning policies prioritising district heating infrastructure in urban development plans. Heat zoning maps, such as those used in the Province of Antwerp, provide valuable guidance on suitable locations for collective LTDH projects. Redeveloping brownfield sites for district heating purposes and integrating LTDH networks into new urban expansion areas were also proposed as effective strategies.

**Construction Regulations and Standards:** It is important to align building regulations with the needs of LTDH systems to achieve efficient energy use. Participants also stressed the need to set policies to mandate low energy building standards and ensure new developments are LTDH-ready. Municipal regulations should demand that buildings connect to LTDH networks, if available. Large-scale renovations in areas like Albertslund, Denmark, have successfully incorporated LTDH systems into existing housing stock, showing that it is feasible to retrofit existing buildings for low-temperature heating.

**Financing Schemes for LTDH Implementation:** The sustainability of financing models is crucial to the successful deployment of LTDH networks. Participants suggested government subsidies, EU funding programs, and private sector investments as principal mechanisms for supporting LTDH projects. Public-private partnerships targeted in Flanders, Belgium, have helped to solve the problem of high initial investment costs and thus make the projects feasible. In Latvia and Poland, district heating investment support programs have given financial incentives for upgrading heating infrastructure. Green bonds and low-interest loans were also seen as possible means to help invest in the deployment of LTDH.

**Future Directions:** To increase the adoption rate of LTDH networks, municipalities should include district heating planning in the general urban development strategies. Policy incentives like lowering property taxes for buildings connected to LTDH can also help in increasing participation. The awareness campaign among developers and residents about the benefits of LTDH will also be an important factor in the project's long-term success. The Green4HEAT project will go on to support these efforts by helping to share knowledge between stakeholders and offering technical guidance to urban planning authorities for integrating heating networks in the development process.

More information about the above 1) identified good practice examples for Low-temperature heating networks, 2) integration of waste heat sources, and 3) urban planning solutions for implementing LTDH can be found in the previous report Introductory Document for the International Working Group "Low-temperature heat networks in Green4HEAT territories".

## 1.4. Participant survey results

A participant survey was conducted to evaluate the workshop's effectiveness and gather insights on stakeholder perspectives. The survey aimed to assess attendees' professional backgrounds, their knowledge of LTDH, and their views on key challenges and opportunities in LTDH implementation, as well as identify responders' attitudes to main LTDH elements, barriers and possibilities. The results provide valuable information about stakeholder engagement, expertise distribution, and areas for further development.

Figure 1 illustrates the professional backgrounds of the survey respondents. The largest group, representing municipal or regional authorities, accounts for 52.9% (9 respondents), indicating strong participation from local government officials likely involved in policy-making or infrastructure planning.

District heating (DH) suppliers/distributors and engineers are the second most represented groups, each making up 11.8% (2 respondents). This suggests that technical professionals and industry stakeholders are actively engaged in discussions about district heating.

Other categories, including representatives from NGOs, manufacturing, academia, and potential investors, each comprise 5.9% (1 respondent). These groups may contribute different perspectives, such as research, advocacy, production, or financial investment in the sector.

Notably, there were no responses from urban planners, architects, representatives of energy agencies, or utility companies, highlighting potential gaps in engagement from these fields. Their absence may suggest that district heating projects are currently more influenced by policymakers and engineers than urban design professionals or private energy companies.

Overall, the respondent distribution indicates that municipal authorities and technical experts largely drive the conversation around district heating, while broader stakeholder engagement could be beneficial for a more holistic approach to development.

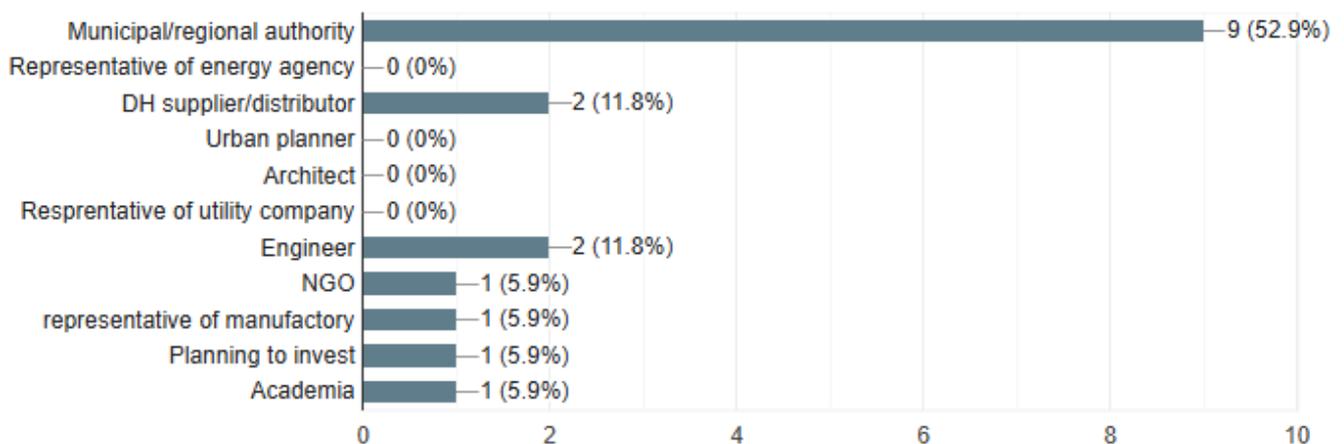


Fig. 1. Respondent field distribution

**Evaluate your existing level of knowledge and competence in low-temperature heating (1 - poor, 5 - excellent)**

Figure 2 presents respondents' self-assessments regarding their knowledge and competence in low-temperature district heating systems. The evaluation is given on a scale from 1 (poor) to 5 (excellent). The majority of participants rated their knowledge as moderate, selecting either 3 (35.3 %), suggesting that while they are somewhat familiar with the topic, there is still room for improvement. A smaller portion of respondents rated themselves as either very knowledgeable (17.6 %) or with minimal understanding (17.6 %), indicating that expertise levels are varied among participants. In general, the presentation of respondents' responses can be described as a normal distribution.

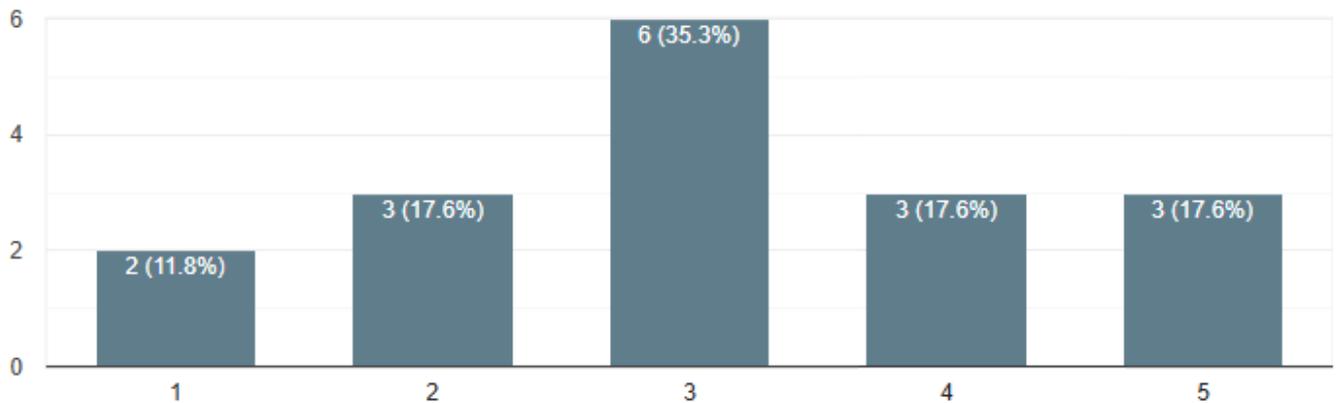


Fig. 2. Self-evaluation of LTDH knowledge

**Overall evaluation of the Workshop (1 - poor, 5 - excellent)**

Figure 3 illustrates how participants rated the overall quality and effectiveness of the workshop. The evaluation scale ranges from 1 (poor) to 5 (excellent). All attendees rated the event positively, with a significant concentration of responses at 5 (58.8 %), indicating general satisfaction. This suggests that the workshop successfully provided valuable insights, though a few participants (41.2 %) may have expected more detailed content or practical applications.

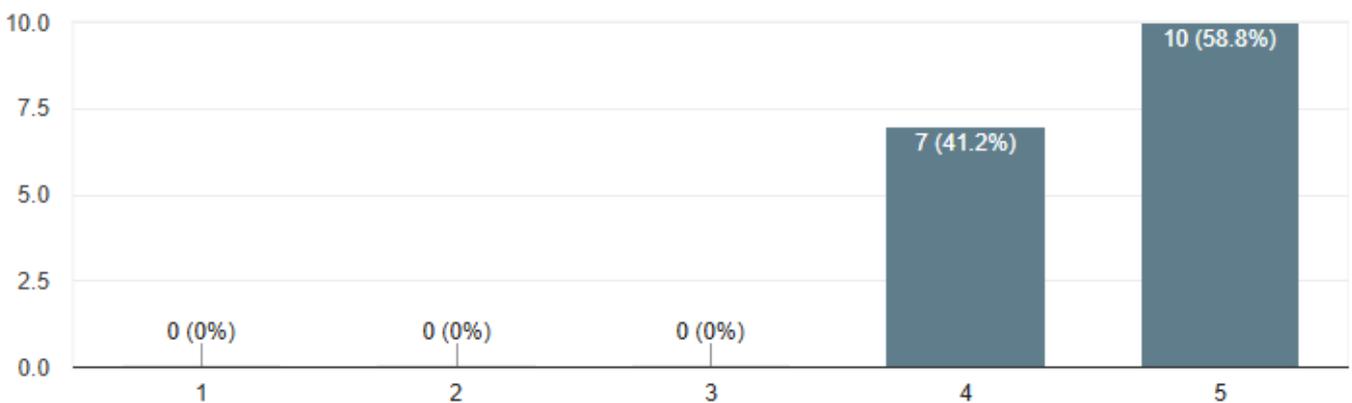


Fig. 3. Workshop overall evaluation

**1.5. Low-Temperature Heat Networks**

**Evaluate the development of Low-Temperature District Heating systems in your region/country (1 - negligible, 5 - advanced)**

Figure 4 assesses how developed LTDH systems are across different regions or countries. The scale ranges from 1 (negligible development) to 5 (highly advanced). The responses are distributed across the scale, but most responses are clustered around the mid-to-low range (58.8 % in total), meaning that LTDH is at least in the beginning stage of development in most areas. This suggests that while

some regions have made significant progress, others may still be in the early adoption phase. Unfortunately, no real region or country is reflected because the survey was anonymous.

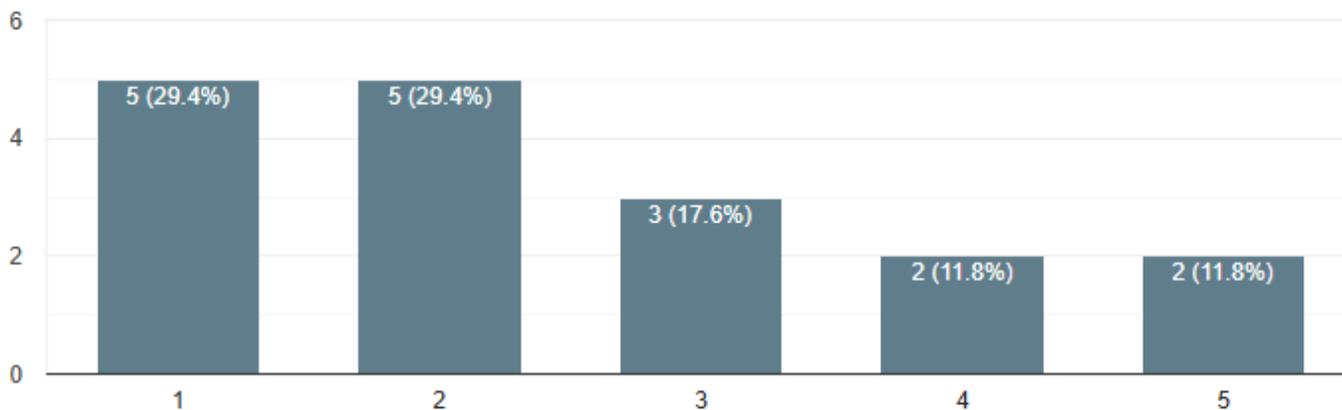


Fig. 4. LTDH development by region or country

**What is the minimum (at least) temperature level at the network temperature (supply side) to be considered Low-Temperature District Heating systems?**

Figure 5 displays the range of temperatures that respondents believe define a low-temperature district heating system. The responses indicate a consensus around a specific range, likely between 50-60°C (82.3 %), which aligns with common definitions in the industry. This highlights the need for clear technical guidelines and standardisation to ensure consistency in implementing LTDH systems.

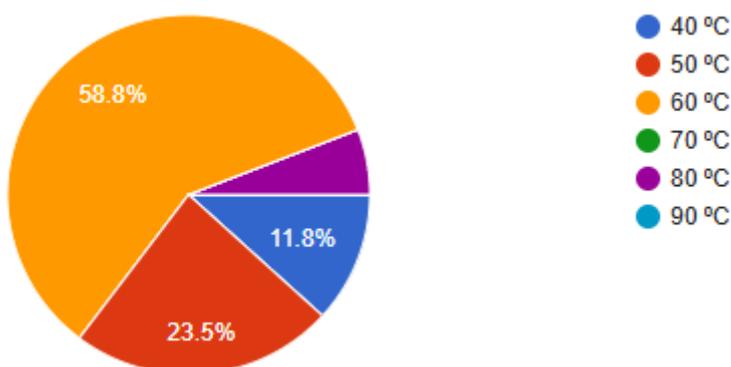


Fig. 5. Minimum supply temperature for LTDH

**Renewable energy resources are a mandatory component of Low-Temperature District Heating systems (1 - strongly disagree, 5 - strongly agree)**

Figure 6 shows that most respondents strongly agree (70.6 % in total), indicating a widespread belief that LTDH should be closely linked to renewable energy sources. This underscores the need to integrate sustainable energy solutions to maximise LTDH's environmental benefits. A minority of participants (29.4 %) have a neutral view.

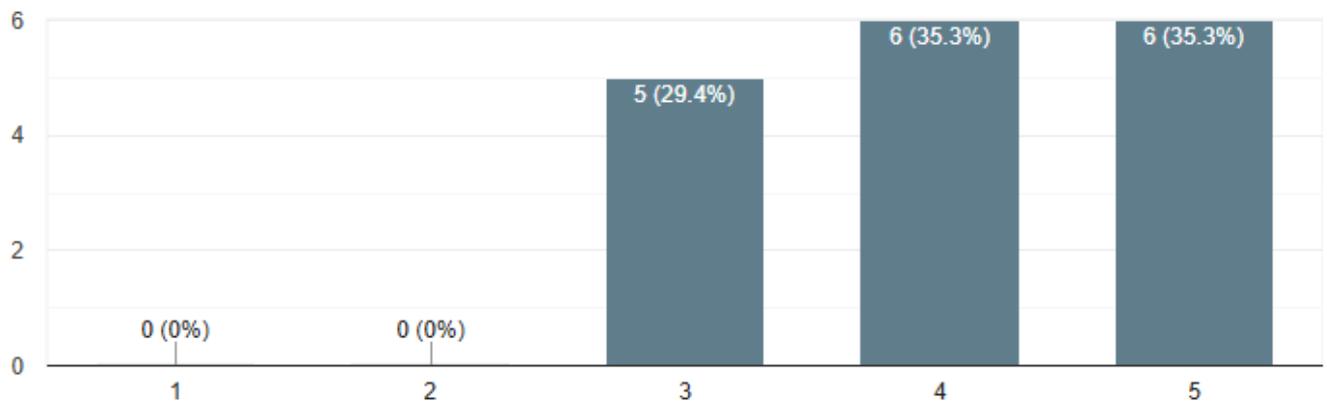


Fig. 6. Renewable energy in LTDH

**The heat pump is a mandatory component of waste heat integration at District heating (1 - strongly disagree, 5 - strongly agree)**

Figure 7 captures participants’ opinions on whether heat pumps are essential for integrating waste heat into district heating systems. Most responses fall in the “agree” category (64.7 % in total), indicating a strong perception that heat pumps play a crucial role in recovering and redistributing low-temperature waste heat. This suggests that future district heating strategies should adopt widespread heat pumps to enhance efficiency and sustainability. A minority of participants (35.3 %) have a neutral view.

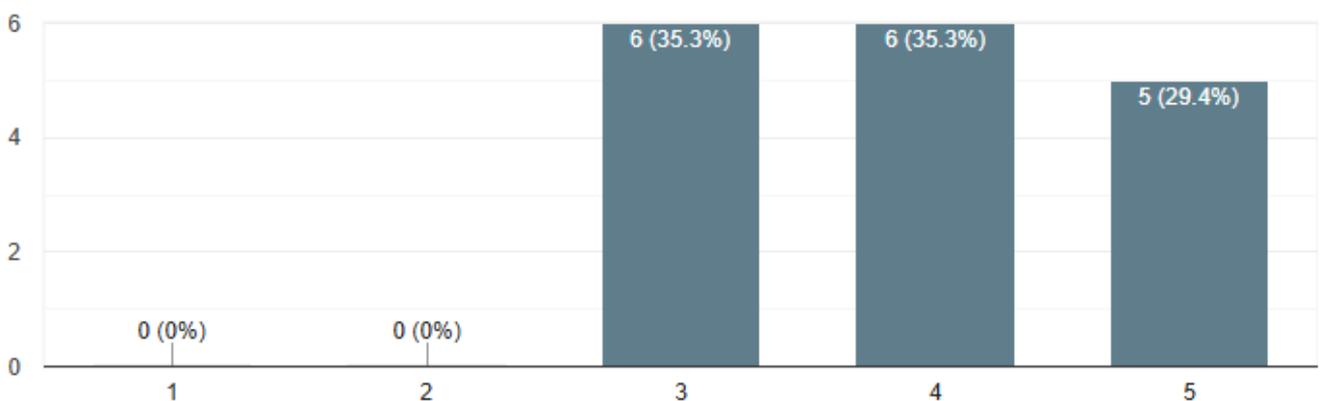


Fig. 7. Heat pumps for waste heat integration.

**The inclusion of heat energy storage technology in the District heating system is an economically sound solution and promotes Low-Temperature District Heating systems (1 - strongly disagree, 5 - strongly agree):**

Figure 8 evaluates whether incorporating heat storage technologies in LTDH is an economically viable decision. The results show that most respondents agree with this statement (70.6 % in total), reinforcing the idea that thermal energy storage can significantly enhance system efficiency by

balancing supply and demand. Proper implementation of heat storage solutions could help district heating systems operate more flexibly and reduce reliance on peak energy production. A minority of participants have a neutral view (35.3 %) or disagree with that statement (5.9 %).

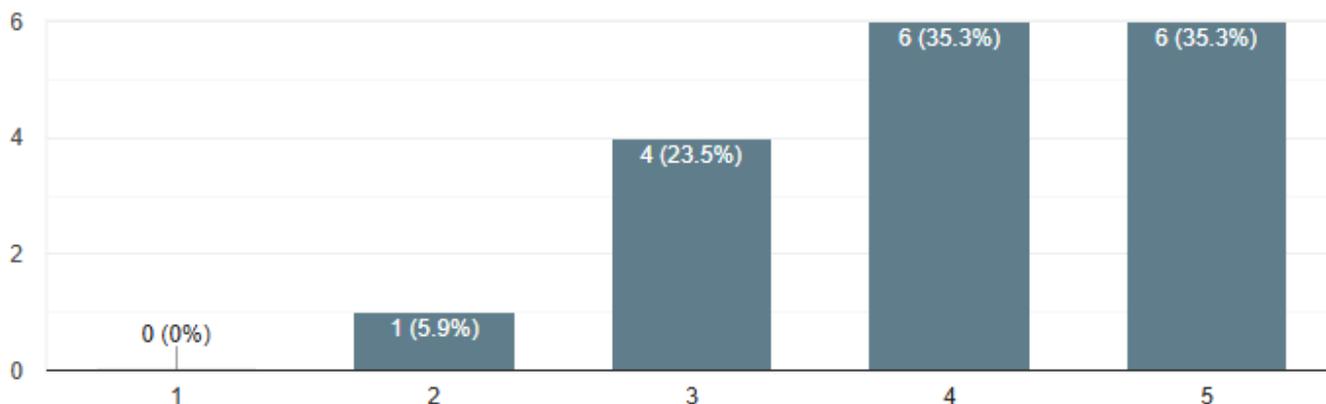


Fig. 8. Economic viability of heat storage

**Without building renovation, switching to Low-Temperature District Heating systems is not justified (1 - strongly disagree, 5 - strongly agree):**

Figure 9 presents opinions on whether transitioning to Low-Temperature District Heating is unfeasible without significant building renovations. The majority of respondents agree (76.5 % in total), suggesting that without upgrading existing building infrastructure (such as improved insulation or more efficient radiators), the benefits of LTDH may not be fully realized. This highlights a potential challenge in widespread adoption, as retrofitting buildings can be costly and time-consuming. The minority of participants have the neutral view (11.8 %) or disagree with that statement (11.8 %).

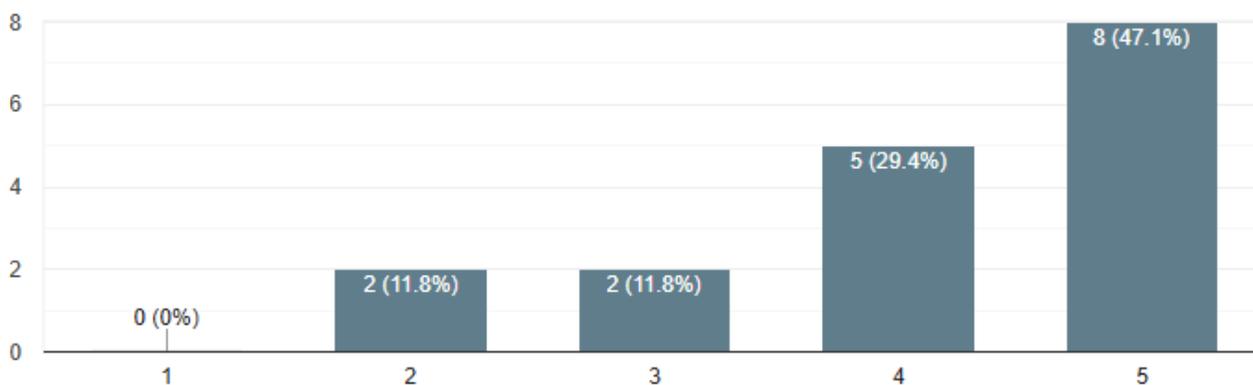


Fig. 9. Building renovation for LTDH transition

**The existing expertise of District Heating systems representatives (engineers, operators, etc) about Low-Temperature systems is appropriate (1 - strongly disagree, 5 - strongly agree):**

Figure 10 assesses the current level of expertise among district heating professionals (including engineers and operators) regarding low-temperature systems. The responses indicate a mixed view: the majority of respondents feeling that existing expertise is adequate (76.5 % in total), but minority

of respondents have a neutral view (17.6 %) and disagree (5.9 %). This suggests a potential need for further training, education programs, and knowledge-sharing initiatives to support the transition to LTDH.

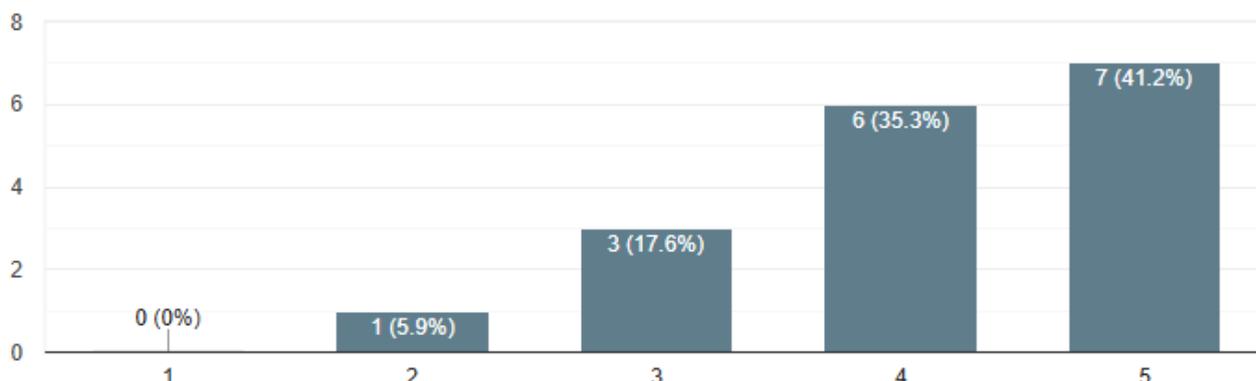


Fig. 10. Expertise of DH Professionals in LTDH

**District Heating companies and grid owners are motivated to switch to Low-Temperature District Heating systems (1 - strongly disagree, 5 - strongly agree)**

Figure 11 explores the motivation levels of district heating companies and grid owners in transitioning to Low-Temperature District Heating. A significant proportion of respondents stay neutral (47.1 %) because they may not know the motivation behind the decision-makers' actions. Some respondents believe (23.5 %) that decision makers are not motivated to provide the technical opportunity for transition. However, there are also respondents (29.4 %) who believe decision makers have motivation to act. In general, the presentation of respondents' responses can be described as a normal distribution.

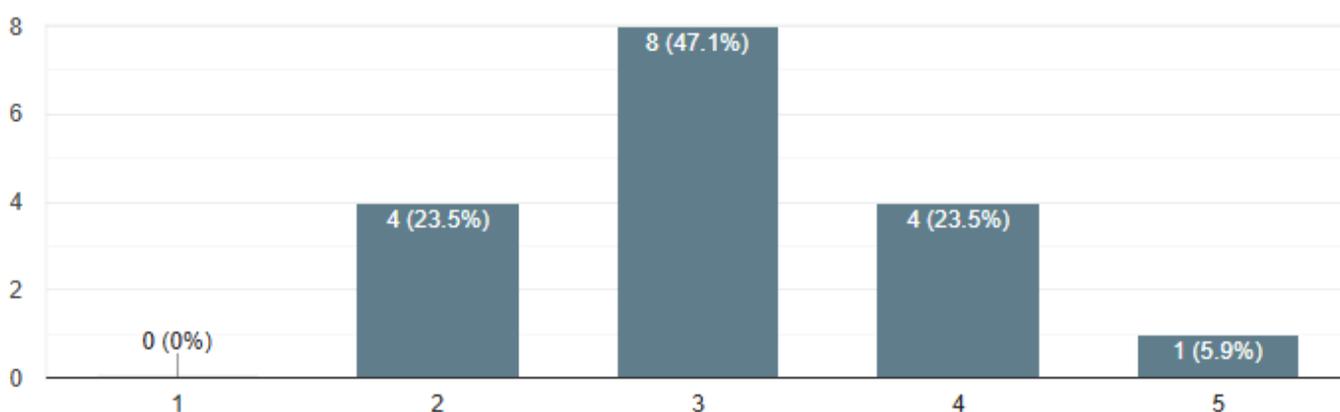


Fig. 11. Motivation of DH companies for LTDH

**The transformation of district heating to Low-Temperature District Heating systems needs to be promoted through national legislation (1 - strongly disagree, 5 - strongly agree)**

Figure 12 evaluates whether national policies and legislative measures are necessary to facilitate the adoption of Low-Temperature District Heating. The majority of respondents agree (76.5 % in total), highlighting that regulatory frameworks play a crucial role in incentivizing or even mandating the transition. This finding suggests that policy interventions, such as subsidies, tax incentives, or mandatory efficiency targets, could significantly accelerate LTDH adoption. The minority of respondents have a neutral view (11.8 %) and strongly disagree (11.8 %).

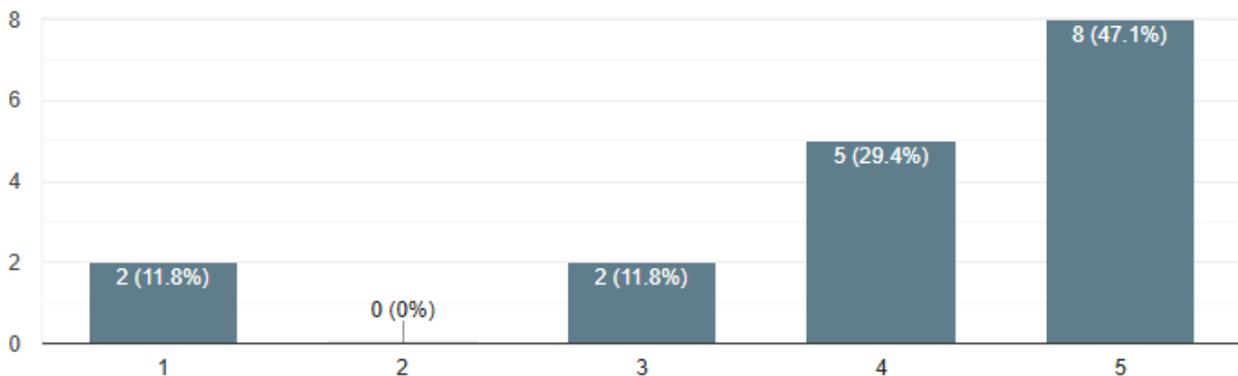


Fig.

### 12. National legislation and LTDH adoption

During the workshop, a key tool demonstrated was the energy simulation platform. Participants used this tool to see how different factors, such as building renovation rates, energy source choices, and production capacities, affect energy system performance. The platform provides an overview of the structure of the energy sector and its individual elements: heat production, electricity production, energy storage, energy users. The main goal was to show that all the above-mentioned elements of the energy sector are closely linked together. Therefore, during the LTDH implementation planning phase, it is important taking into account and evaluate the overall system of impacts of the planned activity, not only on energy transportation, but also on the energy production side and energy users. The demonstrated platform will allow simulate a variety of scenarios and understand what result will be achieved.

## 2. Low-temperature heating development

The content of Chapter 2 is closely informed by the interactive simulations and group discussions conducted during the Valmiera workshop. Participants worked with a system dynamics-based modelling platform that allowed them to test various district heating scenarios, including renovation rates, integration of renewable sources, and energy cost implications. These exercises mirrored the key components of strategic energy planning presented in this chapter—such as scenario development, stakeholder engagement, and data-driven evaluation. The methodologies described here are theoretical and practically explored by stakeholders during the workshop, making this chapter a direct continuation and deeper elaboration of those insights.

### 2.1. Overview of related planning documents

LTDH is a transformative approach aimed at improving energy efficiency and reducing greenhouse gas emissions by lowering the operating temperature of district heating networks. This transition is essential due to evolving building insulation standards, increasing adoption of renewable energy sources, and the need to optimise waste heat utilisation. LTDH allows for better integration with renewable energy sources such as geothermal, solar, and biomass while enhancing the overall sustainability of urban heating networks.

Europe's clean energy transition strongly focuses on decarbonising heating, which accounts for roughly half of the EU's energy use. District heating networks – systems distributing centrally produced heat to buildings – are a proven solution deployed in many cities, and they have evolved from old high-temperature steam systems to modern LTDH) schemes<sup>1</sup>. Lower-temperature networks (typically 50–70 °C supply) reduce heat losses and enable the use of renewable and waste heat sources that would be impractical in higher-temperature systems<sup>2</sup>.

The necessity for LTDH arises from:

- A shift toward energy-efficient buildings with reduced heat demand.
- There is a need to minimise heat losses in distribution networks.
- Opportunities to integrate surplus heat from industrial processes, data centres, and wastewater treatment facilities.
- Regulatory and environmental policies promoting carbon neutrality and decarbonisation.

Strategies based on LTDH focus on the overall planning of energy systems to be compatible with smart grids and other energy sectors. Thus, municipalities and utilities should also prepare for this transition to contribute to future sustainability goals.

---

<sup>1</sup> ManagEnergy Energy agencies leading the energy transition. [ManagEnergy - Homepage - European Commission](#)

<sup>2</sup> IEA District Heating and Cooling. [IEA District Heating and Cooling](#)

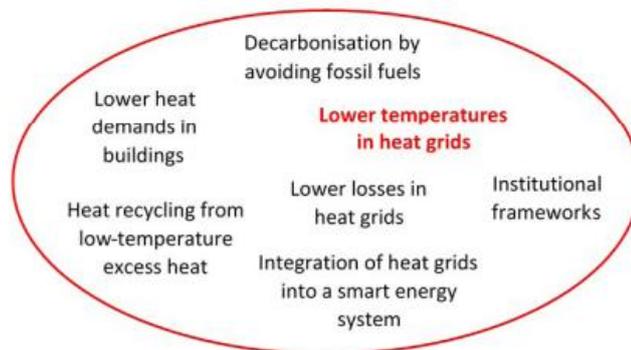


Fig.13. Abilities of LTDH within the context of future market conditions<sup>3</sup>

The Green Deal and the Fit for 55 packages are European directives and initiatives favouring the policy framework for low-carbon district heating. The main points are:

- **Renewable Energy Directive (RED)** – The RED (Fit for 55 adapted) is objectives on renewable heat are expressed in quantitative terms and are legally binding. It obliges each Member State to raise the share of renewable energy sources in heating and cooling annually (approximately 1% or more annually) up to 2030. The former has incorporated heating and cooling into the local plans, and therefore, municipalities are encouraged to incorporate renewable-based district heating in the urban infrastructure development. The directive also provided for the ability of district heating networks to be connected to third-party renewable and waste heat suppliers (or consumers to be able to disconnect from the network) if the network is not 'efficient'. Furthermore, the RED proposed an indicative target of 49% renewable energy in buildings by 2030, which requires clean heating solutions.
- **Energy Efficiency Directive (EED)** – The recast EED (Directive (EU) 2023/1791) is also applicable to district heating and cooling. It amends the 'efficient district heating and cooling' definition to specify more stringent requirements for minimum shares of renewable and waste heat at different stages to decarbonise the heat supply by 2050. To meet this, starting in 2030, no new heat generation capacity shall be deployed in a district heating or cooling system that uses fossil fuels (except high-efficiency gas cogeneration up to 2030). This is important for municipalities because the EED has been extended to require member states to promote the preparation of local heating and cooling plans in all large municipalities with a population of more than 45,000. In other words, cities are supposed to produce heat strategies that show how LTDH and other efficient solutions are going to address the future demand<sup>4</sup>.
- **Fit for 55 and Related Initiatives** – The EU's broader climate package builds on these directives. For instance, the Energy Performance of Buildings Directive (EPBD) revision will demand all new buildings to be 'zero-emission' by 2030, meaning no on-site fossil fuel use. Efficient district heating is also recognised as a zero carbon supply option for buildings in the EPBD and, therefore, will incentivise connections to networks that fulfil the EED's efficiency criteria. District heating expansion – including LTDH – to replace natural gas with renewables and to recover heat

<sup>3</sup> Averfalk H et al, Low-Temperature District Heating Implementation Guidebook. IEA DHC Report, 2021

<sup>4</sup> EU energy policy. [Energy - European Commission](https://energy.ec.europa.eu/)

is also highlighted by the EU Heating & Cooling Strategy and the RePowerEU plan. Furthermore, extending ETS carbon pricing to building fuels will enhance district heating’s competitiveness when networks are based on low-carbon sources. In brief, EU policy signals municipalities to consider low-temperature district heating to fulfil the renewable energy and efficiency objectives.

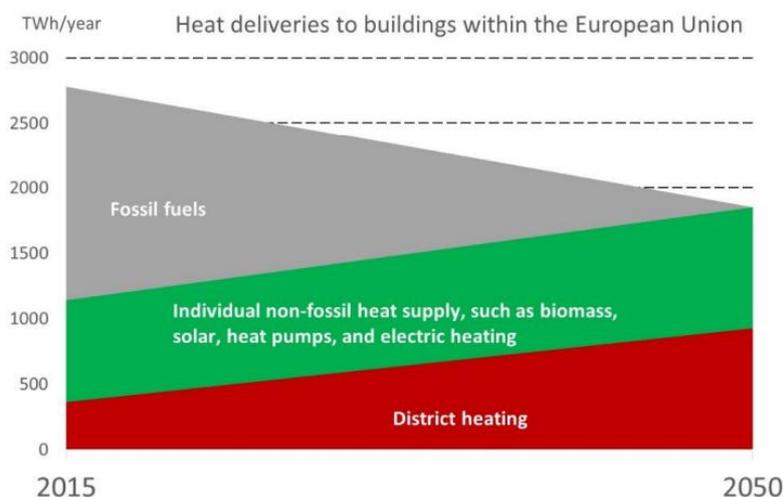


Fig. 14. Possible transition from the current heat supply to buildings within the EU being fully decarbonised by 2050<sup>5</sup>

Implementing LTDH is beneficial from different perspectives, including energy efficiency, carbon emission reduction, enhanced system flexibility, lower operational costs and overall sustainability.

Table 2. Benefits of LTDH

Benefits of Low Temperature District Heating	Energy Efficiency	Lower heat losses in distribution networks and better match with low temperature heat sources.
	Carbon Emission Reduction	Facilitates better integration of renewable energy sources, in contributing to CO <sub>2</sub> emission reduction targets.
	Improved System Flexibility	Compatible with decentralized energy sources and smart heating systems
	Lower Operational Costs	These are lower temperature requirements, reduce energy consumption and maintenance costs.
	Sustainability	Consistent with long term energy policies promoting environmental responsibility

<sup>5</sup> Averfalk H et al, Low-Temperature District Heating Implementation Guidebook. IEA DHC Report, 2021

## 2.2. Strategic energy planning

The requirement to alter the operational conditions of the DH system is attributed to the fact that the heat consumption in residential buildings has been reduced due to renovation and the adoption of energy efficiency measures/(re)construction. Therefore, new buildings are more energy efficient and have less heat demand, resulting in low heat density in newly developed areas. This situation calls for the adjustment of the operating conditions of the DH system and, therefore, to the question of how to make more consistent use of renewable energy sources to guarantee the feasibility of heat production while reducing the overall environmental impact<sup>6</sup>. One of the most recent strategies suggested for DH companies to navigate the new environment is based on lowering the supply water temperature. The LTDH system concept offers novel approaches to each of the three components of a DH system: a heat source, heating network and consumer<sup>7</sup>. There is no single answer for all DH systems to reduce the heat carrier's temperature and enhance the overall system efficiency. Hence, an informed strategy is needed to develop a new generation of DH systems. DH system development should be considered part of the municipal energy planning process. Municipalities are positioned to determine the direction of the shift and set strategic objectives for the transition to efficient and CO<sub>2</sub>-neutral heat supply<sup>8</sup>. For all these reasons, this report aims to present the steps for a detailed analysis of the existing DH system and future heat consumption forecasting to select the most suitable transformation pathways towards a more efficient heat supply by introducing the LTDH concept. In the following parts, the municipal transformation management approach is described as a cyclical process implemented in several consequential steps<sup>9</sup>. In each step, recommendations for specific actions and/or analyses to be performed are added. Nevertheless, the explained steps cannot always be separated in practice, and actions may be parallel or alternated. Management is generally the actual planning of work and processes. Nevertheless, the management of the transformation process is more than the assignment of responsibilities and steps. Instead, it is a collective searching, experimentation, and learning process. Responsibilities and the involvement of specific actors and the operative methods or tools within the steps must be reviewed during the process. The model of municipal transformation management towards LTDH is characterised by an interplay between different levels and scales of optimisation from the district (or parishes) to the entire city dimension (see Fig.15). At the city level, the focus is on the opening up of new visions of the future and the collective search for possible technical and organisational transformation approaches. For that reason, solutions must be defined to result in the transformation of the urban heat supply system rather than the use of ready-made solutions. This has to be done based on a system and stakeholder analysis. This methodology suggests the continuous reflection of particular steps to achieve the general transformation goals, including review, adaptation and concretisation of the targets.

---

<sup>6</sup> Rämä M., Sipilä K., 2017. Transition to low temperature distribution in existing systems. *Energy Procedia*, 116,:58-68.

<sup>7</sup> Schmidt D., Ballert A., Blesl M., Svendsen S., Li H., Nord N., Sipilä K., 2017. Low Temperature District Heating for Future Energy Systems. *Energy Procedia* 116; 26-38.

<sup>8</sup> Neves D., Baptista P., Simões M., Silva C.A., Figueira J.R., 2018. Designing a municipal sustainable energy strategy using multi-criteria decision analysis. *Journal of Cleaner Production*, , 176;251-60

<sup>9</sup> Riechel R., Libbe J., Koritkowski S., Koziol M., Trapp J., 2017. Kommunales Transformationsmanagement für die lokale Wärmewende. Book and Offset Printing H. Heenemann GmbH & Co. KG, Berlin, 21-86

Therefore, it can result in additional steps or skipping some of them to customise the strategy development process. Suppose it becomes apparent in the conceptual development of strategies and measures that technical or economic parameters are incorrect or there is no interest in their implementation. In that case, alternative transformation paths should be considered. In other words, the transformation process should be open and flexible.

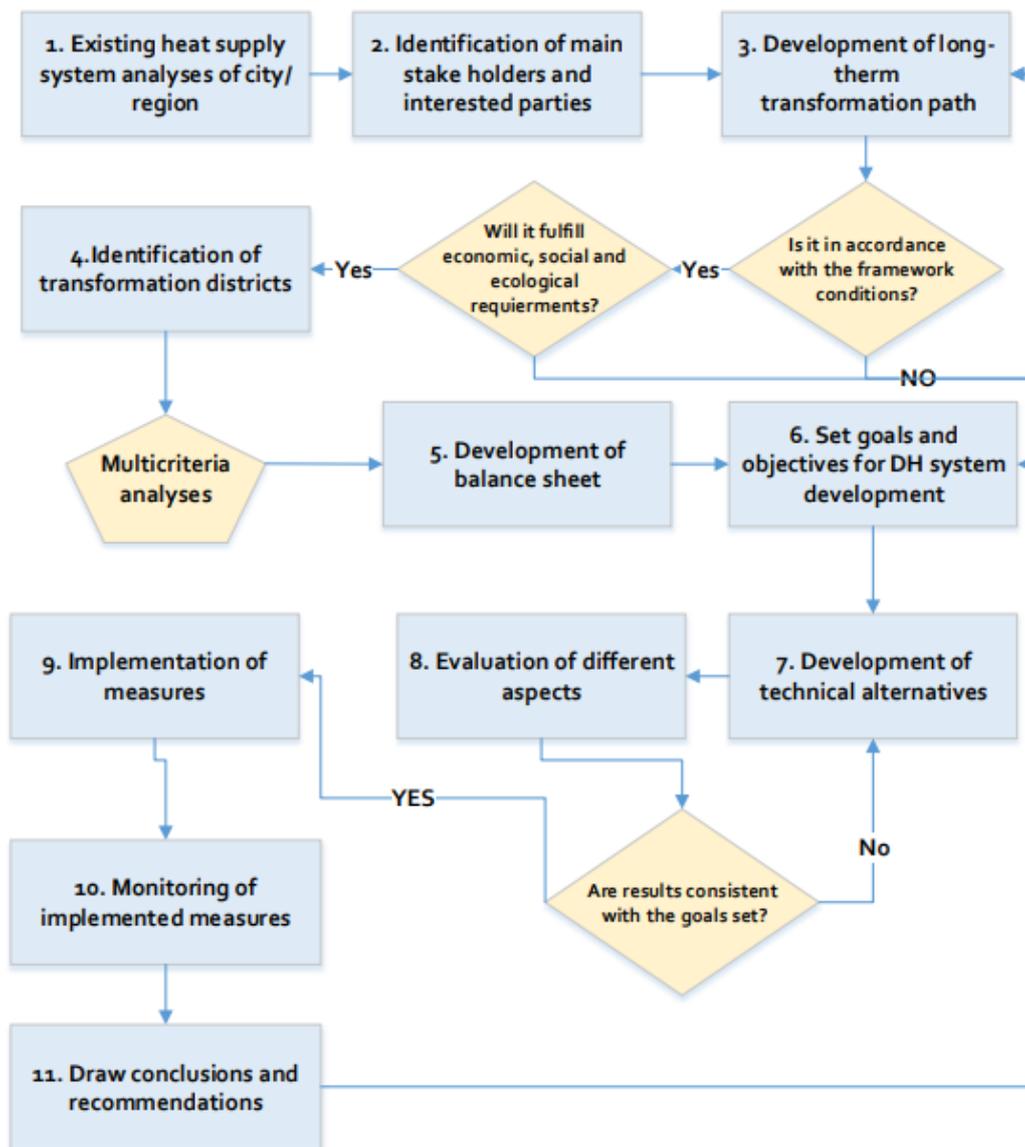
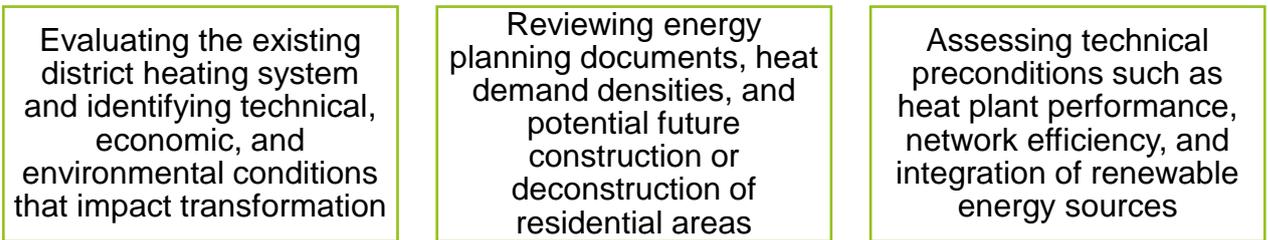


Fig.15. Transformation process dynamics<sup>10</sup>

Strategic energy planning for LTDH involves multiple stages to ensure feasibility, efficiency, and economic viability. The main steps in strategy development are: Analysis of preconditions, Stakeholder analysis, Institutional and organisational framework, strategy pathways for transformation, Initial district identification, Data collection and scenario evaluation, SWOT analysis, Evaluation of implementation conditions and synergies, Monitoring and evaluation.

<sup>10</sup> Methodology of Development of Energy Strategies. LowTEMP project training package

### 2.2.1. Analysis of Preconditions



The successful transformation of a DH system into an LTDH model requires a comprehensive analysis of various heating supply system parameters at both regional and local levels. A key aspect of this process is evaluating building interactions with supply networks, which helps optimise heat distribution and identify gaps that need attention in the transformation process.

A crucial starting point is the analysis of existing planning documents, which provide benchmarks for energy consumption and CO<sub>2</sub> emissions. These documents should align with national energy strategies and long-term sustainability goals. The effectiveness of past strategies should also be assessed, and challenges in implementation and adjusting future plans should be identified accordingly. A collaborative approach involving stakeholders at multiple levels—local, regional, and central—is essential to ensure that DH development aligns with broader sustainability objectives.

The technical preconditions of DH systems must also be examined. This includes assessing the location and efficiency of heat generation plants, such as combined heat and power (CHP) plants and heat-only boilers. Understanding factors like fuel sources, boiler capacity, and integration of heat recovery systems (e.g., flue gas condensation). Lower return temperatures in DH networks enhance efficiency, making technologies like heat pumps and waste heat recovery more viable.

Equally important is the evaluation of heat distribution networks and district transfer stations, which determine the overall performance of DH systems. The primary and secondary heating networks, heat exchangers, and connection rates across different districts influence efficiency. Additionally, wastewater treatment systems can be potential energy sources for low-temperature heat supply.

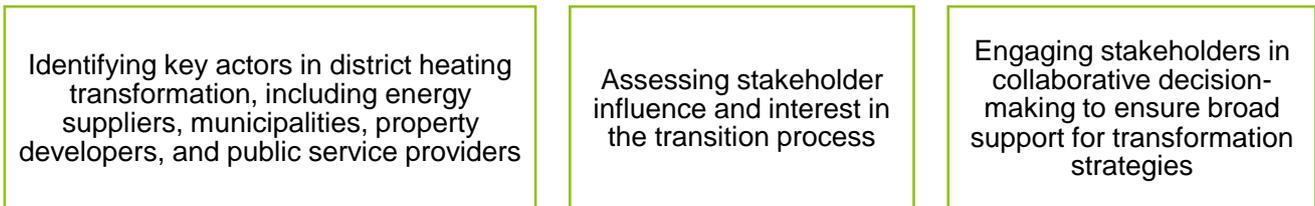
Energy system flexibility is another major consideration. The LTDH concept integrates smart energy systems, combining electricity, gas, and thermal grids to create a more adaptable and efficient heat supply. This requires an in-depth review of power grid infrastructure, gas networks, and energy transformation stations to enhance sector coupling and maximise synergies between energy carriers.

Urban planning factors must also be analysed, including regional settlement structure and heat demand densities. Different types of buildings (e.g., residential, commercial, industrial) have varying heating needs, influencing DH system operation. Mapping potential waste heat sources (e.g., data centres, sewage plants) and assessing upcoming infrastructure investments at the district level help optimise heat supply planning.

Finally, planning for future construction and redevelopment is critical. While new energy-efficient buildings are well-suited for LTDH due to their low-temperature heating systems, existing DH areas

require a longer transition period. Strategic development should focus on integrating new residential areas while addressing the challenges of deconstruction or declining heat demand in certain districts. A comprehensive, multi-level analysis is essential for successfully transforming DH systems into LTDH. By incorporating technical, urban, and planning considerations, cities can create a sustainable, flexible, and efficient heat supply that aligns with long-term energy and environmental goals.

### 2.2.2. Stakeholder Analysis



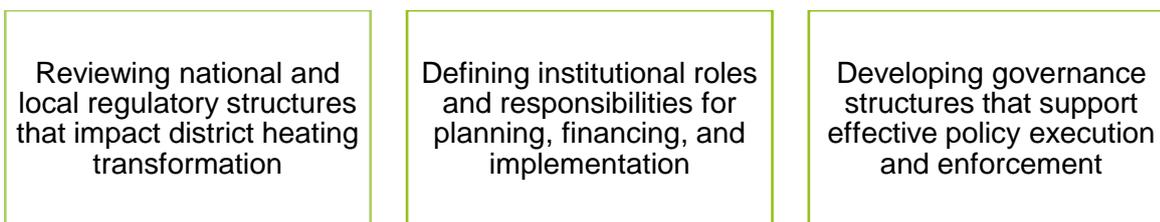
A comprehensive actor analysis is essential for identifying key stakeholders in transforming DH systems within a specific region or city. Various actors influence the transition process, including energy suppliers, housing companies, private investors, and public authorities such as sewage and waste management companies. These stakeholders play a critical role in shaping the speed and direction of the transformation through their decision-making power.

The analysis should also assess individual influence and roles, including key figures or “champions” who can drive innovation and promote change. Additionally, potential conflicts of interest, organisational challenges, and competing agendas among stakeholders must be considered to ensure a balanced and collaborative transition.

Stakeholder participation in strategy development offers multiple benefits. It integrates diverse perspectives and expertise, fostering a transparent decision-making process where all parties can understand the rationale behind strategic choices. Moreover, active engagement helps define shared goals, although reaching agreements can be challenging due to differing priorities. However, the real value of stakeholder collaboration lies not just in documenting a strategy but in discussion, negotiation, and knowledge exchange.

For successful implementation, municipalities must clearly define the benefits of participation for each stakeholder. Ensuring that all actors see value in their involvement will strengthen commitment and contribute to an efficient, inclusive, and strategically sound transformation process.

### 2.2.3. Institutional and Organizational Framework

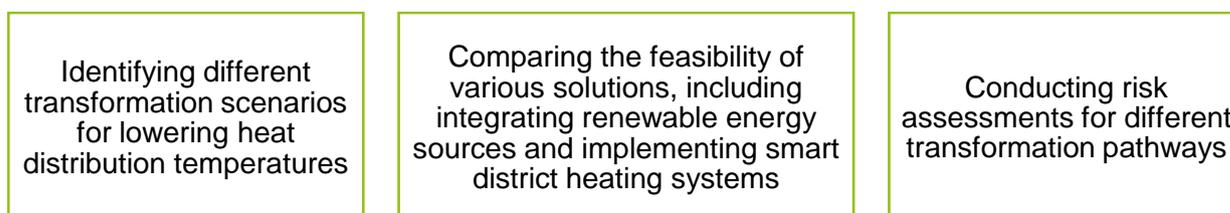


A DH system's institutional and organisational framework plays a significant role in its transformation process. Different business models, ownership structures, and regulatory policies influence the motivations driving change. DH companies may specialise in heat production, distribution, or a combination of both, affecting their approach to transformation efforts.

Ownership models vary across countries, with DH systems being managed by private stakeholders, municipalities, or government institutions. In Denmark, for example, DH system operators function as non-profit organisations, shaping their long-term development priorities differently than profit-driven entities.

It must be economically viable for DH transformation to succeed, particularly in integrating LTDH and renewable energy sources. Technological advancements should either be cost-competitive with conventional heat generation and distribution methods or supported by municipal incentives and regulatory mechanisms prioritising environmental benefits. Ensuring economic and environmental sustainability is key to successfully modernising DH systems.

### 2.2.4. Analysis of Strategy Pathways for Transformation



LTDH requires innovative solutions and a comprehensive view of the current situation. Thus, the defined development scenarios should include new heat supply solutions. A scenario can be defined as a description of a possible future situation, including the path of development leading to that situation. Scenarios are not intended to represent a full description of the future but to highlight central elements of a possible future and draw attention to the key factors that will drive future developments. When analysing the development of a building heat supply system, there are two main directions for heat production: local heat supply by individual heat solutions (called the “Thousand Flowers” scenario) or heat supplied by DH. The Thousand Flowers scenario is a bottom-up approach focusing on decentralised energy problem solutions (see Fig.16).

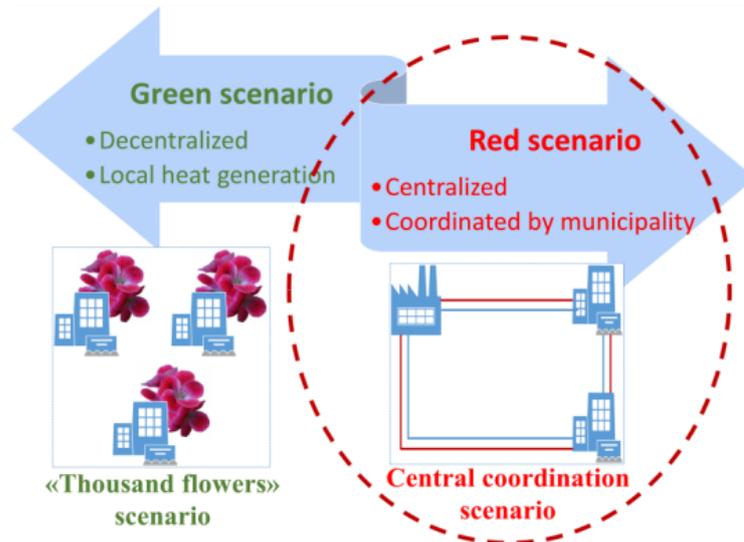


Fig.16. General development scenarios for DH system

The Thousand Flowers scenario envisions a decentralised approach where each building independently selects its preferred heat source and generation technology. This contrasts with the Red Scenario, which relies on centralised DH systems, using large-scale heat plants and heating networks to enhance efficiency and enable seamless integration of renewable energy sources. A hybrid approach between these two models is also possible, where consumers become "prosumers," feeding locally generated heat into the system and forming an interconnected energy network that includes heat, power, gas, and water systems.

Heat density within a given area is a key determinant in selecting a district heating system. When heat density is low, heat losses in the network and operational costs become prohibitively high, making individual heating solutions more competitive. The efficiency threshold for DH depends on multiple factors, including heat losses, operational costs, and alternative heat investments. The methodology for transitioning from conventional DH to LTDH focuses on minimising heat losses, even in areas with lower heat density. This transformation approach does not consider local heat generation in buildings as a primary solution for DH development.

Recent energy system developments emphasise integrating multiple energy supply networks—heat, power, and transport fuel—to achieve a CO<sub>2</sub>-neutral economy. Reducing building heat consumption is essential to enhancing energy efficiency. The transformation process prioritises converting and expanding local and district heating systems into low-temperature networks, requiring sufficient heat density to keep costs manageable. The feasibility of this transition depends on factors such as building heat demand, network temperature levels, heat sources, and generation technology.

The transition pathway varies by building type. In existing buildings with high heat demand and traditional radiator systems, lowering network temperatures is challenging but possible through temperature optimisation or heat substation adjustments. The use of renewables in such cases remains limited, with biomass and biogas serving as primary CO<sub>2</sub>-neutral energy sources for combined heat and power or heating boilers.

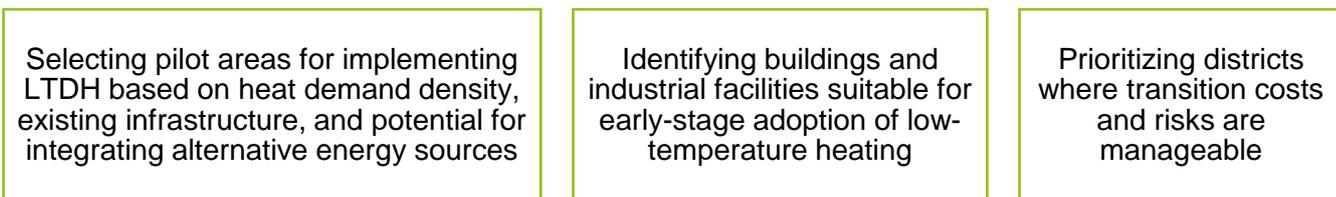
Further temperature reductions are feasible in buildings that utilise low-temperature heating systems (e.g., floor heating, wall heating, or forced air radiators), especially in mixed-building areas with renovated and non-renovated structures. In these settings, energy cascade solutions can be implemented, where return water flows serve as supply flows in energy-efficient buildings. If high-potential waste heat sources are available, they should be prioritised for integration.

The most significant reduction in district heating temperatures occurs in newly constructed or renovated low-energy building areas, where supply temperatures below 60°C allow for plastic piping and increased use of renewable energy sources. Temperatures can be further reduced in passive house developments with low heat demand. However, domestic hot water supply remains challenging, as maintaining safe water temperatures under 60°C requires additional solutions. The share of energy demand for DHW increases significantly in modern, energy-efficient buildings and passive house areas.

Existing buildings present unique challenges and opportunities. While newly constructed buildings meet strict energy efficiency regulations, the potential for upgrading older structures depends on building typology, age, and financial feasibility. Some older buildings can be renovated to passive house standards, but constraints related to historical preservation, ownership budget, and structural limitations must be considered. The adaptability of a building's internal heat distribution system is crucial for future DH transitions. For instance, lowering DH temperatures will only be effective if radiator sizes are adapted or replaced by underfloor heating.

As communities work toward a sustainable energy future, the participation of local stakeholders is critical. By involving municipal authorities, energy providers, and residents, guiding principles for heat supply transformation can be developed. These frameworks provide a strategic roadmap, ensuring technological, organisational, and institutional alignment in pursuing a low-carbon, energy-efficient heating infrastructure.

### 2.2.5. Initial District Identification



To successfully transform a DH system, it is essential to identify suitable areas where specific measures, innovative technologies, and modernisation efforts can be effectively implemented. This requires shifting from a broad municipal or regional perspective to smaller pilot cases that meet key selection criteria.

A primary criterion is **energy efficiency and renewable energy integration potential**. When evaluating different districts, factors such as building density and heat consumption must be considered to determine the feasibility of a heat supply network. Additional consumers or surplus heat

sources, such as industrial waste heat or unused renewables, should be explored to improve network viability if density is too low.

Priority should be given to **buildings and heating systems needing renovation or modernisation**, as integrating **LTDH** is more feasible when combined with planned construction or infrastructure upgrades. Additionally, **building and ownership structures** influence the complexity of implementation. Homogeneous housing developments owned by a single company require less coordination than **heterogeneous neighbourhoods** with multiple private owners, which involve more negotiations.

**Demographic trends** also play a role, as growing cities with increasing heat demand require solutions different from shrinking regions. **Social factors**, such as the ability of property owners to invest in modernisation and the affordability of utility costs, impact participation in the transformation process. Public entities often must provide incentives or financial support to drive the transition.

Multi-criteria decision analysis can be used as a structured evaluation method to select the most suitable districts for transformation, incorporating qualitative and quantitative parameters. This tool has been widely applied in **sustainable energy planning**, ensuring that the selection process considers economic, social, and environmental factors.

### 2.2.6. Data Collection and Scenario Evaluation



The transformation of DH systems into LTDH requires a detailed evaluation of different technological alternatives to identify the most economically and environmentally beneficial solution. A structured methodology is essential for assessing various development scenarios, ensuring that transformation efforts align with a district's specific needs.

The process begins with a comprehensive analysis of the existing energy supply system, including heat generation, fuel consumption, heat losses, network parameters, and temperature levels. This data is a foundation for defining shared goals and strategies while comparing transformation pathways. The assessment involves technical, economic, and environmental calculations, providing benchmarking indicators to determine the feasibility of various LTDH solutions.

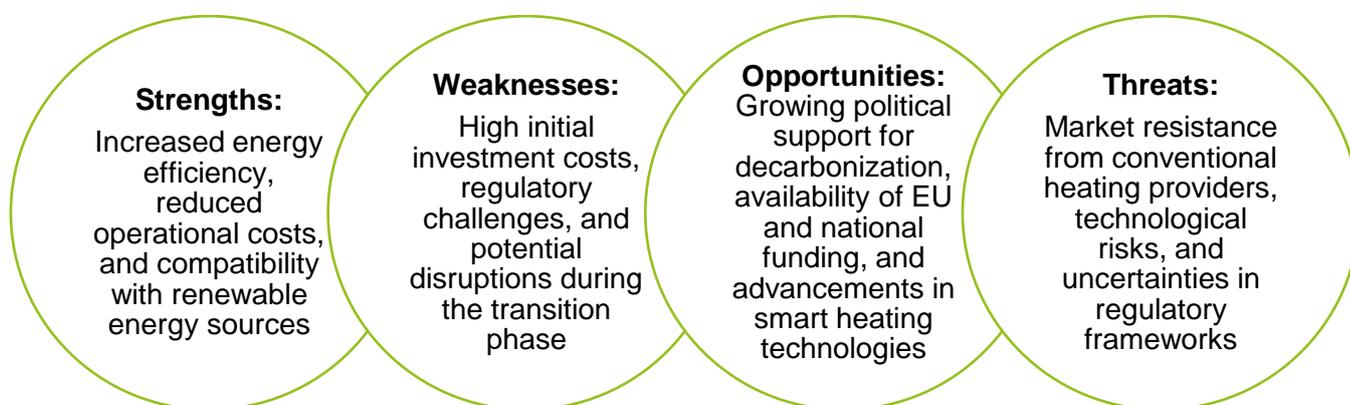
To perform a scenario evaluation, input parameters such as annual heat production, fuel efficiency, heat losses, and network infrastructure must be collected and analysed. The accuracy and quality of data sources play a crucial role in decision-making, with key stakeholders including energy providers, housing companies, building owners, and public utilities. Reliable data comes from direct consumption records, while lower-quality data may come from extrapolations, estimations, or regional statistics.

Identifying development scenarios requires a technical and structural reconfiguration of the DH system. This includes connecting new developments to the DH network, lowering temperatures in

modernised areas, and converting heating facilities to low-temperature heating systems. A strategic action plan must consider transformation technologies' efficiency and economic feasibility, such as power-to-heat, power-to-gas, and thermal storage systems.

Additionally, social and economic conditions must be factored into the planning process. The ownership structure, investment willingness, modernisation cycles, and demographic trends influence the successful implementation of LTDH solutions. Innovative heating solutions may face resistance without addressing these district-specific and stakeholder-specific factors. Therefore, a well-defined action strategy is essential to transition toward a sustainable, cost-effective, and efficient district heating system.

### 2.2.7. SWOT Analysis (Strengths, Weaknesses, Opportunities, and Threats)

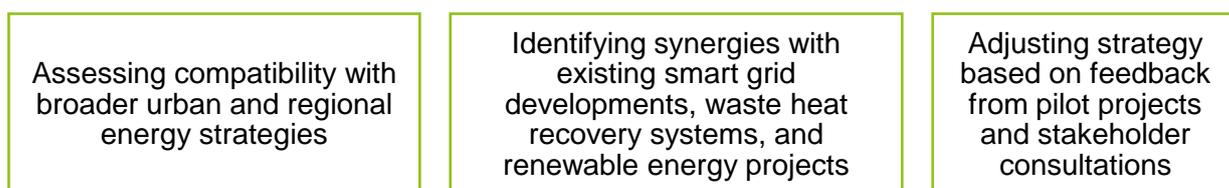


In the context of LTDH transformation, SWOT analysis is conducted after a detailed examination of technological, economic, and environmental factors. It provides a structured framework for analysing results and identifying challenges that cannot always be quantified, such as regulatory barriers, consumer motivation, and funding limitations.

The process involves gathering key data from previous evaluations and categorising them into four areas: strengths and weaknesses (internal factors), and opportunities and threats (external factors). This structured approach helps highlight gaps in the energy supply development plan, allowing for adjustments to improve strategic alignment.

A SWOT matrix is created for each technological alternative, ensuring all factors are considered in the decision-making process. Organisations can identify the most viable and effective solutions that align with their long-term energy goals by integrating SWOT analysis into strategy development.

### 2.2.8. Evaluation of Implementation Conditions and Synergies



Pilot cases are crucial in testing new technical and organisational approaches for district heating transformation. Their success depends on well-planned implementation conditions and various tools, including strategic planning, communication measures, financial incentives, and municipal regulations.

For effective implementation, strategic concepts must align with existing policies and include clear recommendations on energy efficiency, renewable energy integration, and infrastructure development priorities. Responsibilities and decision-making roles should be established early, ensuring a structured and transparent process. Action plans should remain flexible, allowing for adjustments when necessary.

Implementation can be carried out by public authorities, private companies, or individual property owners, requiring effective communication strategies to engage stakeholders. Municipalities can lead by example as property owners, setting high energy efficiency standards and adopting innovative heat supply solutions for public buildings.

### **Monitoring and evaluation**

Monitoring and evaluation are essential for ensuring the district heating transformation process stays on course. Continuous assessment helps determine whether the implemented measures align with strategic goals and whether adjustments are necessary. Insights gained from pilot cases can guide city-wide or regional scaling of successful strategies.

Tracking implementation progress increases transparency and is a steering tool for local heat supply changes. A structured monitoring plan helps regulate key indicators, such as energy consumption, efficiency of supply systems, CO<sub>2</sub> emissions, and heat supply costs. Data collection must be consistent and traceable to enable long-term comparisons, ensuring that changes are accurately attributed to local measures rather than broader national developments.

Monitoring tools, including online evaluation systems or simplified progress indicators, can provide valuable insights. Key metrics include heat demand, supply efficiency, energy mix, modernisation efforts, and infrastructure expansion. Regularly analysing these indicators ensures that the transformation process remains effective, efficient, and adaptable.

## **2.3. Application of Simulation Tools in Strategic Planning**

The participants at the Valmiera workshop utilized an interactive simulation platform to study energy equilibrium in various system configurations. The platform is accessible at: <https://exchange.iseesystems.com/public/testlearntestsagain/eq-valmiera>.

Each group received different system component pairings, such as "Buildings" and "Production" or "Inputs" and "Storage", to determine leverage points that would enhance LTDH performance. The hands-on simulations enabled stakeholders to evaluate emissions alongside renewable energy share system cost and cumulative energy demand across different assumptions.

The platform includes multiple modules:

- The Inputs module contains sociodemographic indicators, energy tariffs, emission factors, and fuel characteristics.

- The Buildings module contains renovation rates, investment parameters, and public perception factors.
- Production: The production module includes energy production technologies, operational hours, investment costs, and commissioning options.
- Storage: The platform includes electricity and heat storage options using hydrogen, compressed air, and pumped hydro systems.
- Transport: The system analyses public and private vehicle fuel use, demand patterns, and ownership expenses.
- Report: The system generates consolidated reports that display system emissions, energy costs, and renewable energy percentages.

The simulations allowed participants to perform scenario-based reasoning through real-time feedback loops, displaying the results of different planning decisions. The practical exercises enabled the practical implementation of the theoretical planning steps outlined in Chapter 2.

## 3. Recommendations for Policymakers

The transition to LTDH requires a robust policy framework at the EU level, ensuring a consistent and supportive regulatory environment across all Member States. Policymakers should focus on legislative alignment, financial support mechanisms, stakeholder engagement, and long-term strategic planning to facilitate the widespread adoption of LTDH.

### 3.1. Strengthening the Legal and Regulatory Framework

EU policymakers should ensure that energy efficiency directives and climate action policies prioritise the integration of LTDH into national energy strategies. Current legal frameworks should be revised to:

- Member States must evaluate the efficiency of existing energy producers and networks before approving new ones.
- Mandate that waste heat from industrial facilities is considered as a primary heat source for DH systems where feasible.
- Support municipal regulations that promote LTDH and zoning laws requiring connection to DH networks in high-density areas.
- Develop standardised guidelines for heat supply benchmarking and efficiency requirements to ensure fair competition between DH and individual heating solutions.

### 3.2. Financial Incentives and Investment Support

To encourage the expansion of LTDH, financial mechanisms should be strengthened and standardised across the EU:

- Capital investment aid for upgrading DH infrastructure and integrating renewables.

- State-backed loan guarantees to support private and municipal investments in LTDH projects.
- Tax incentives and reduced excise duties for renewable energy sources used in LTDH.
- Subsidies or financial support for industries transferring waste heat to DH networks.
- Carbon pricing and CO<sub>2</sub> taxation to create economic incentives for transitioning to cleaner heating solutions.
- Green bonds and EU funding programs to encourage large-scale investments in LTDH infrastructure.

### 3.3. Stakeholder Engagement and Local Government Support

Municipalities play a crucial role in implementing LTDH but often lack financial and administrative resources. Therefore, EU and national governments should:

- Provide funding and technical support for local DH planning.
- Facilitate public-private partnerships to enhance investment in LTDH infrastructure.
- Establish platforms for dialogue between policymakers, industry leaders, and local governments to align objectives and promote knowledge exchange.
- Introduce mandatory stakeholder consultations when developing DH expansion plans.
- Encourage local energy planning that integrates DH expansion with urban development strategies.

### 3.4. Integration of Renewable Energy and Waste Heat

Policymakers should create incentives for integrating waste heat and renewables into LTDH networks, ensuring efficient and cost-effective energy use:

- Mandatory waste heat integration policies where industrial waste heat is available and economically viable.
- Financial support for heat pumps, geothermal energy, and biomass-based DH technologies.
- Developing cross-sector energy networks, linking DH with electricity, gas, and industrial heat sources for greater flexibility and efficiency.
- Support for 4th DH systems to facilitate low-temperature operation and maximise the use of low-grade heat sources.
- Implement district cooling systems in densely populated urban areas to enhance energy efficiency.

### 3.5. Standardized Monitoring and Evaluation Mechanisms

To track progress and ensure continuous improvement, EU-wide monitoring frameworks should be implemented:

- Require periodic evaluation of LTDH deployment at national and regional levels.

- Develop key performance indicators (KPIs) such as GHG reductions, efficiency gains, and financial viability.
- Support digital tools for real-time energy system monitoring to improve operational efficiency and transparency.
- Implement data-sharing platforms to facilitate cooperation between municipalities, utilities, and policymakers.
- By implementing a cohesive policy framework, strengthening financial support mechanisms, and promoting stakeholder collaboration, policymakers can accelerate the adoption of LTDH across the EU. Ensuring alignment with long-term climate and energy goals will lead to greater energy efficiency, reduced carbon emissions, and a more resilient heating infrastructure for future generations.

## 4. Funding attraction

Transforming or building district heating infrastructure is capital-intensive, but municipalities in the EU can tap into a range of funding sources and innovative financing mechanisms:

- **EU Structural Funds and Recovery Programs:** The EU's Cohesion Policy funds (European Regional Development Fund and Cohesion Fund) have earmarked significant resources for the low-carbon transition, including heating network upgrades – especially in Central and Eastern Europe. Under the 2021–2027 period, many national Operational Programs allow grants for modernising district heating to reduce losses and integrate renewables. Likewise, the Just Transition Fund can support heat network projects in coal-dependent regions as part of economic diversification. The Recovery and Resilience Facility RRF, launched post-COVID as part of NextGenerationEU, is financing green recovery projects; several Member States (e.g. Czechia, Lithuania) allocated RRF grants or loans to decarbonise district heating (like replacing coal-fired heat plants with biomass or large heat pumps and connecting more customers).
- **Modernisation Fund (ETS Financing):** For 10 lower-income Member States, the EU's Modernisation Fund (financed by EU ETS revenues) is a major source of capital. It explicitly supports investments in modernising energy networks, including district heating. In its latest cycle, the Modernisation Fund disbursed €2.4 billion across projects such as rehabilitating and extending district heating networks (e.g. in Slovakia), converting coal-based systems to biomass or gas in Czechia, and improving energy efficiency in buildings which the networks supply. Municipalities in eligible countries should work with their national authorities to propose LTDH projects for this fund. It can cover a substantial share of costs for network upgrades, new boilers/heat pumps, control systems, etc., thereby lowering the burden on local budgets and consumers. The Modernisation Fund complements other EU instruments and can be blended with loans for large-scale projects.

- **Horizon Europe, LIFE, and Interreg:** These EU programs provide grants for innovative or replicable projects, capacity building, and feasibility studies. Horizon Europe (and previously H2020) fund demonstration pilots – for instance, the RELaTED and Tempo projects have advanced ultra-low temperature district heating concepts. The LIFE Clean Energy Transition program has calls focused on heating & cooling (e.g. supporting heat pump integration, skills training, and investment planning). Interreg (European Territorial Cooperation) funds regional collaborations – the LowTEMP project in the Baltic Sea region is one example of a project that produced toolkits and pilot investments for LTDH. While these programs don't typically fund full infrastructure rollout, they cover important preparatory actions: technical assistance, business model development, and knowledge transfer that municipalities can leverage before committing major capital.
- **European Investment Bank (EIB) and National Banks:** The EIB and other public banks offer low-interest loans and guarantees for energy efficiency and renewable energy infrastructure, including district heating networks. Through initiatives like ELENA (European Local Energy Assistance), the EIB also provides grants for municipalities' project development costs (feasibility studies, engineering design, tender preparation), which can be crucial to get LTDH projects shovel-ready. Many national development banks (such as KfW in Germany or BGK in Poland) have special loan programs or grants for district heating upgrades. For example, Germany launched the Bundesförderung Effiziente Wärmenetze (BEW) in 2022, a multi-billion euro scheme that co-finances new heat networks that are at least 75% renewable/waste heat, as well as the greening of existing networks – directly incentivising LTDH-compatible systems. Municipalities should survey their national funding landscape for such opportunities and consider aggregating projects to achieve economies of scale (which can attract better financing terms).
- **Private Investment and New Business Models:** Besides public funds, private investors and energy service companies are growing interested in heat infrastructure, especially when backed by stable regulatory frameworks. Models like concession agreements (where a private firm builds/operates the network under a long-term contract) or community-owned heating cooperatives can mobilise capital. Some cities have used green or climate bonds to raise money for energy projects, including district heating. Others have explored “heat as a service” models, where consumers pay a flat fee for comfort. At the same time, the provider optimises energy sources and efficiency – this can attract private actors who profit from savings achieved via low-temperature operation and advanced control. The EU's project development assistance and one-stop shops can help structure bankable projects. It's also wise to combine multiple funding sources: for instance, use EU grants for part of the project (like thermal storage or network digitalisation) and loans for the rest, supplemented by customer connection charges over time. By leveraging these mechanisms, municipalities can significantly reduce the upfront cost barriers and accelerate the implementation of LTDH networks.