act!on heat

Empowering Municipalities for a Sustainable Future

Insights from the Act!onheat project on effective Heating & Cooling planning

Final report of the Act!onheat project

Act!onHeat has received funding from the EU Horizon 2020 programme under Grant Agreement No 101033706

Executive Summary

The planning of municipalities plays a crucial role in shaping sustainable living conditions for the future, with heating and cooling (H&C) accounting for approximately half of Europe's total energy demand. Currently, around 75% of this demand relies on fossil fuels, making the transition to climate neutrality by 2050 particularly urgent. Strategic H&C planning has emerged as a key tool for local decarbonization efforts, with Denmark serving as a pioneer in this area through the expansion of district heating since the 1973 oil crisis. This approach has since spread across Europe, driven by initiatives like the revised Energy Efficiency Directive (EU/2023/1791) (EED), which mandates H&C planning for municipalities with over 45,000 inhabitants by October 2025.

Despite its growing adoption, many European countries still face significant challenges in implementing effective H&C plans. The Act!onHeat project sought to identify success factors for strong H&C planning through a comprehensive analysis involving surveys, interviews, and meta-studies of planning documents. Key findings indicate that commitment from decision-makers, effective communication, coordination within existing municipal structures, and robust data availability are essential for successful H&C planning. Moreover, the development of a structured workflow for H&C planning was proposed, consisting of eleven steps that guide municipalities from vision development to project implementation.

Act!onHeat also provided tailored support to municipalities, including training modules and financial pre-feasibility studies. Over the project's lifetime from June 2021 to November 2024, **30 applicants** from energy agencies and municipal administrations worked intensively with us, resulting in benefits for more than 200 municipalities across **14 countries** in Europe.

The project facilitated the initiation of numerous pre-feasibility studies, allowing municipalities to explore viable solutions for their H&C needs. These initiatives highlighted the importance of adaptable support frameworks capable of addressing unique local challenges. Notable examples of successful implementation were reported from various regions, showcasing the diverse contexts and approaches adopted by municipalities across Europe.

In conclusion, while significant progress has been made in H&C planning, the successful transition to sustainable heating and cooling systems will require continued commitment, effective stakeholder engagement, and adaptive strategies tailored to local contexts. Monitoring is emphasized as a crucial component for evaluating the effective implementation of measures and determining whether plans need to be adjusted. Furthermore, it provides policymakers with valuable feedback on the effectiveness of the instruments used.

Summary of Learnings and Recommendations

Finally, the Act!onHeat project has offered insights into the challenges and opportunities municipalities encounter in the strategic planning of heating and cooling (H&C) systems, along with the following core learnings and recommendations.

Learnings

- **Resource and Expertise Limitations:** Municipalities often struggle with limited resources and expertise, hindering their ability to effectively plan and implement H&C projects. Building regional expertise through trained energy agencies is crucial for supporting municipalities.
- **Flexibility in Support:** Support structures must be adaptable to accommodate the varying progress of municipalities. Providing a flexible selection of activities and tools can enhance engagement and responsiveness to local needs.
- **Data Availability:** The procurement and availability of data represent a central challenge. Clear guidelines for data sharing and aggregation are essential to facilitate planning and reduce uncertainties.

Recommendations

- **Political Mobilization**: When developing a H&C vision, it is important to involve all relevant stakeholders, including energy agencies and municipal administrations. Effective communication about the benefits of H&C planning is vital for securing commitment.
- **Urban Planning:** Establishing an H&C working group is essential, as is comprehensive data collection. Integrating H&C strategies into existing frameworks, such as the Sustainable Energy and Climate Action Plans (**SECAP**) of the Covenant of Mayors for Climate and Energy, can provide a structured approach to local energy transitions.
- **Implementing EED:** When integrating EED requirements for heating and cooling (H&C) planning into national law, it is essential to assess how H&C can be effectively

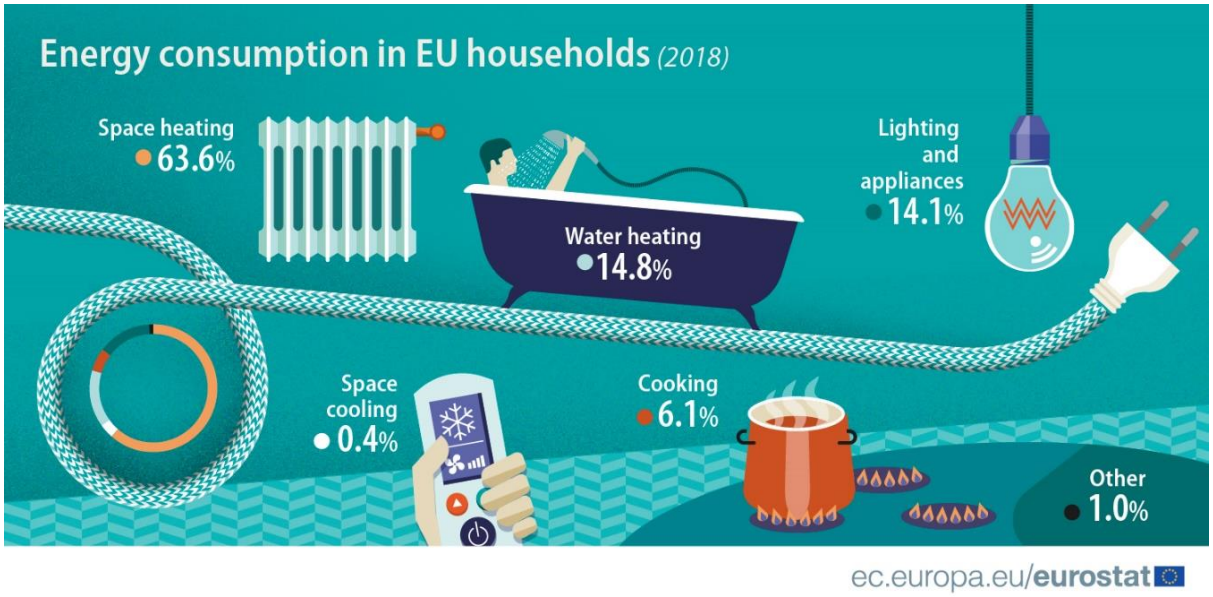
incorporated into existing policies. Simply replicating policies from pioneer states may lead to ineffective implementation and could result in unnecessary overlaps with existing policies. The focus should be on effectively aligning H&C strategies with current planning policies.

- **Financing:** Municipalities should leverage EU funding programs and consider blended financing approaches to support sustainable H&C solutions. Public-private partnerships can mitigate risks and accelerate project implementation.
- **Communication:** Targeted communication and training opportunities are crucial for engaging stakeholders and effectively disseminating the results of H&C planning efforts.

Finally, the insights gained from Act!onHeat provide a Local Replication Roadmap (Local Replication Roadmap | Act!onHeat) that integrates a wealth of knowledge to empower municipalities in developing their own strategies, rather than offering a one-size-fits-all approach.

1 Background

The planning of municipalities is of great importance, as it determines today how we can live sustainably in them in the future. Heating and cooling (H&C) is an important issue in this context, as it accounts for about half of the total energy demand in Europe, with about 75 % still dependent on fossil fuels (for 2022). Achieving climate neutrality in 2050 therefore requires a rapid and significant change in the H&C sector. In this respect, strategic H&C planning has proven to be an effective tool to develop measures at the local level and to drive decarbonisation of the H&C sector faster and more efficiently.



H&C planning: A response for resilience.

The concept was originally developed in Denmark. After the oil crisis in 1973, measures were implemented to make the Danish heat supply less oil-dependent and more efficient. For this purpose, district heating was expanded greatly. The Danish municipalities played a central role here. On the one hand, they were obliged to carry out municipal heating planning. On the other hand, they were given considerable authority to control the expansion of district heating effectively.

Today, about half of Denmark's heat is supplied by district heating. In addition, half of the heat in Denmark is produced from renewable energy sources. This is well above the European average. Strategic heating and cooling planning is seen as one element of this encouraging development. Therefore, the concept has been disseminated within the EU during the last decade through knowledge exchange and Horizon 2020 research projects.

H&C planning: on the rise in Europe

Strategic heating and cooling planning is also on the rise in other European countries. In the Netherlands, heat planning is part of regional energy planning since 2019. The goal is to convert 20% of Dutch neighbourhoods to a greenhouse gas neutral heat supply by 2030. In Austria, heat planning is part of spatial energy planning. The provinces of Salzburg, Styria and Vienna have already started to implement planning processes. In Germany, an H&C Act was enacted in 2023.

Finally, the revised Energy Efficiency Directive (EU/2023/1791) mandates H&C planning for municipalities with over 45,000 inhabitants (see Article 25). The deadline for transposition into national law is 11 October 2025.

2 H&C planning: an analysis on success factors

In most countries, strategic H&C planning is still in its infancy. Moreover, it requires extensive know-how, resources, and experience. So far, it is unclear which elements lead to strong H&C plans, i.e. plans that result in concrete actions to decarbonise H&C.

Therefore Act!onheat aimed to fill this gap to some extent. For this we conducted a meta-study of 36 planning documents (Figure 1), **interviewed 15 experts** and carried out a **survey** on the topic of H&C planning (Figure 2).

Figure 1: Map of municipalities for which documents were reviewed

Survey results reveal what local authorities find important and challenging

Key results of the survey on particularly important and challenging elements of H&C planning are shown in Figure 2. It can be seen that the points relating to a common vision of the stakeholders, availability of data and personnel are seen as particularly difficult and important. In addition, communication between stakeholders is seen as particularly important and challenging.

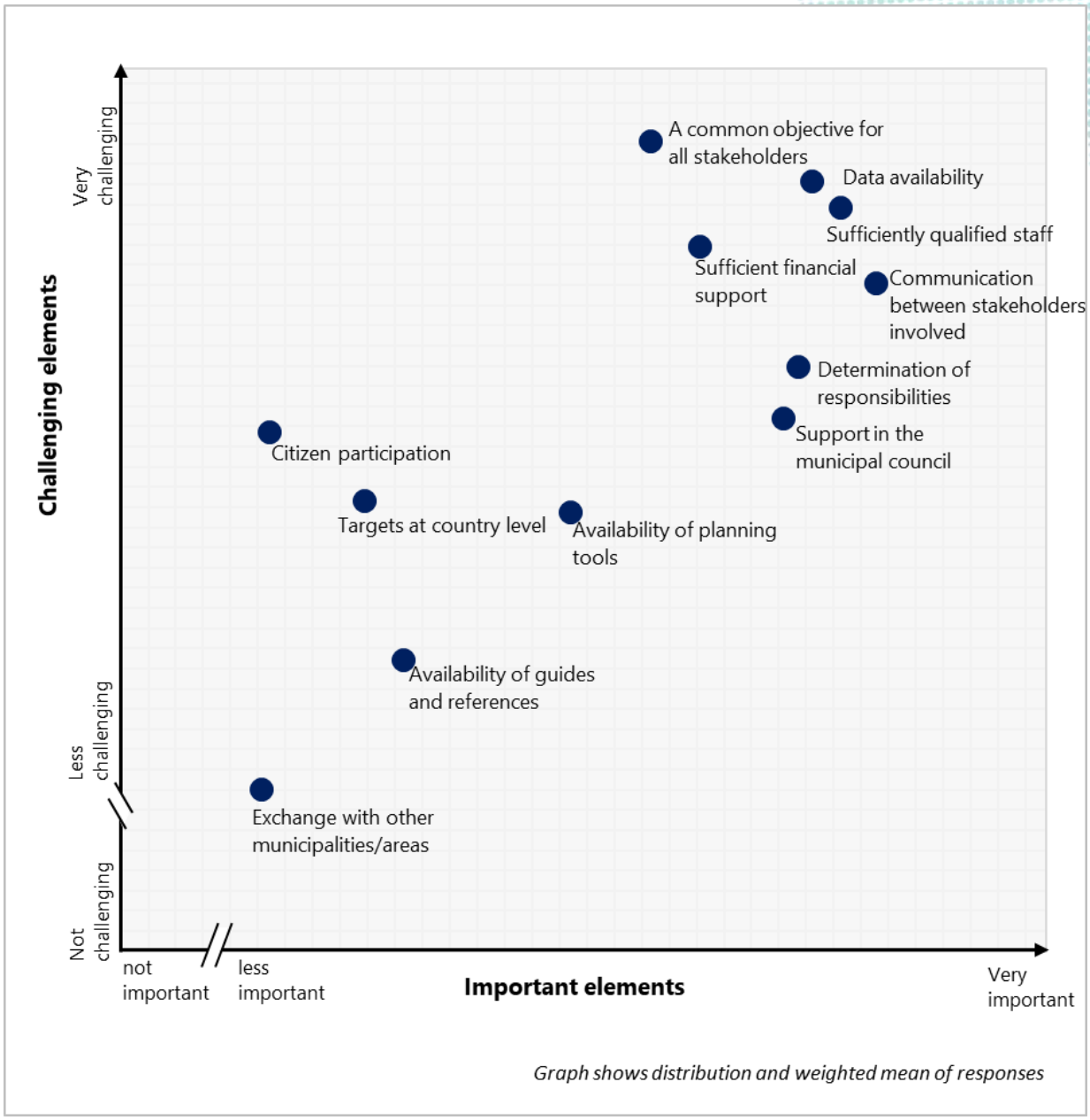


Figure 2: Key results from the survey on key success elements for H&C planning (n=349)

Interviews uncover key success factors.

Putting the results of the survey, the meta-study and the interviews in context with each other, the following key findings emerge, which provide indications on success factors for strong H&C plans.

Commitment, goals and vision

From the interviews it turned out that the commitment of decision-makers is a precondition for the emergence of strong H&C plans. In this context, it is therefore also important to define together with decision-makers and other stakeholders what the goals of H&C planning are. In the survey conducted, CO_2 neutrality is seen as the main objective of strategic H&C plans. This is followed by security of supply and the implementation of concrete measures. However, all objectives were rated quite highly, i.e. respondents considered all objectives important.

Communication: Do not underestimate its importance

It was clear from the interviews that communication of the planning process, both within municipalities and in collaboration with external stakeholders, is a challenge to be overcome for strong H&C plans. This is reflected in the survey, where good communication was rated as one of the two most important success factors. On the other hand, having a common vision was rated as particularly challenging. We therefore conclude that successful H&C planning needs (professional) moderation to develop a common vision between all stakeholders and to help with communication.

Coordination: Integrating planning into existing municipal structures

The interviews suggest that coordination and structures are important success factors for H&C planning. In the survey, sufficient staffing is also rated as particularly challenging. More staff, but also better internal structures and interlocking within existing municipal tasks, e.g. with spatial planning, could be solutions here. In addition, the provision of planning tools that reduce the workload could be helpful.

Content: Flexible, but Targeted

The meta-study revealed that the contents of the plans are quite similar. For example, there are sections on renewable potentials in all the plans. However, the way in which the content is presented differs in some cases. In addition, there are aspects that are not standard and not always included, such as the consideration of social aspects in some plans. In the survey, renewable potentials and targets, as well as measures for implementation, were rated as the most important contents. The focus of the plans is therefore more on the implementation of measures and target setting. Thus, the content does not have to be inflexible, but should be structured in a way that it supports the target set.

Data

A very central challenge emerged from the interviews seemed to be data-related aspects, which have to do with issues such as data procurement and data protection. Furthermore, the survey rated the availability and accessibility of data as an important success factor. At the same time, it seems to be a big challenge to get the data needed.

- In Austria, the Spatial Energy Planning (SEP I) project was initiated to gather modelled data at the building level for heating and cooling (H&C) plans. This data is freely accessible to municipalities in pilot regions and is well-suited for H&C planning. A follow-up project (SEP II) will enhance coordinated infrastructure planning among local authorities, energy suppliers, and network operators. In contrast, German municipalities independently obtain their data. Thus, Austria's approach may serve as a pioneering model for centralized data collection in H&C planning.
- Thus, the issue of data provision seems to be a point of controversy. In view of the fact that data availability was rated as highly challenging in the online survey, the approaches from Austria and the Netherlands and their transferability to other countries should be investigated further in.

A workflow for H&C planning

Based on the acquired knowledge, a workflow for strategic H&C planning was developed in Act!onHeat. For this, a moderated workshop was conducted with experts from the field, discussing their experiences and recommendations (do's and don'ts). Findings from the workshop were summarised, structured and transferred into a workflow.

The workflow developed consists of 11 steps addressing urban planning, implementation, and policies.

- The starting point is the development of a **vision** (**step 1**), followed by establishing a **working group** (**step 2**). The working group coordinates the process and acts as an interface with urban planning.
- **Steps 3 to 5** then comprise an inventory analysis, zoning and scenario development. These are then fed into the formulation of a **transition strategy** (**step 6**). Here, the municipality defines milestones and objectives.
- Based on the previous, strategies and/or **measures** are drafted (**step 7**). At best, implementation projects emerge directly from the process. These are then analysed for feasibility (**step 8**) and subsequently planned and implemented (**steps 9&10**).
- The working group carries out coordinating and networking tasks in these steps. The workflow is flanked by regular reviews that identify potential for improvement and thus intervene in an **iterative way** in the process (**step 11**). The following figure illustrates the process. Individual steps of the workflow are explained in detail on the website (Workflow | Act!onHeat) and in the corresponding project deliverable D2.2: Act!onHeat workflow guide.

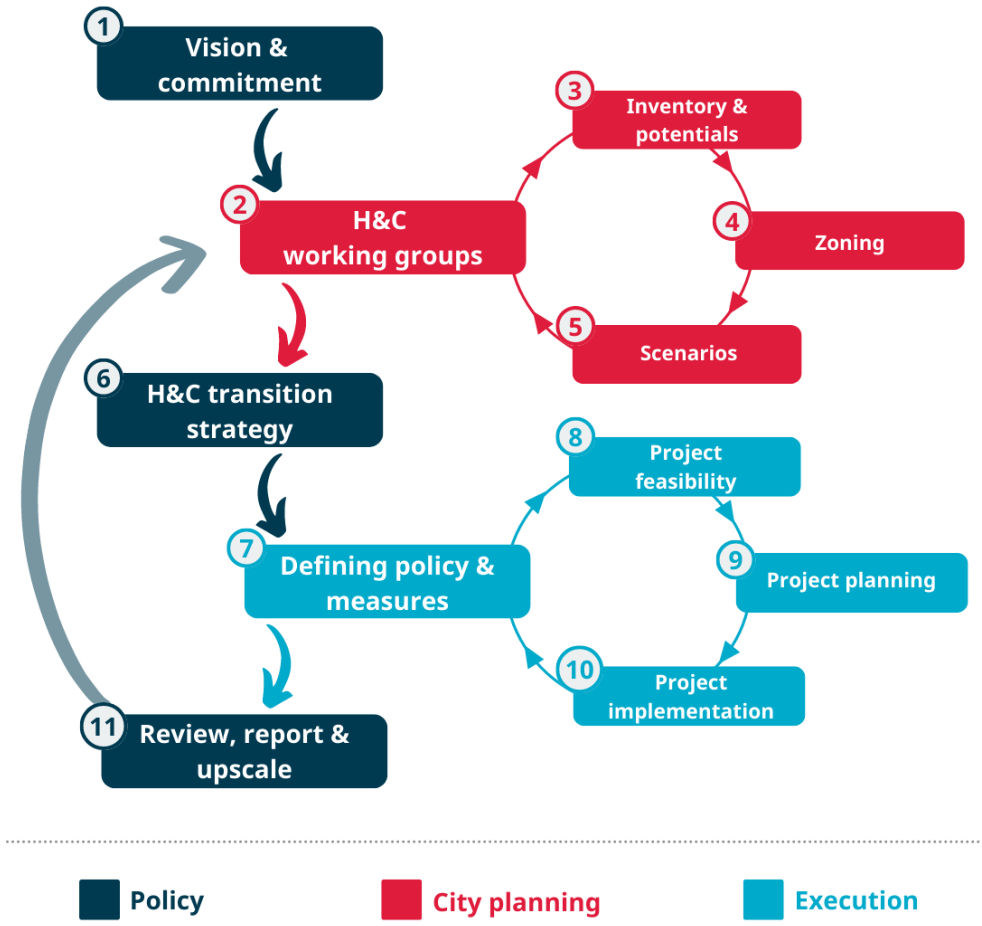


Figure 3: Workflow for strategic heating & cooling planning

Act!onHeat Support Facilities.

In summary, the analysis of success factors reveals the critical components necessary for effective strategic heating and cooling planning. **To facilitate these efforts, the Act!onHeat project has established two distinct support facilities tailored to address various stages of the planning process**.

Support Facility 1 (SF1) focuses on the initial steps, particularly from Step 2 (establishing a working group) to Step 5 (scenario development), while Support Facility 2 (SF2) emphasizes assessing the feasibility of implementation measures outlined in Step 8. These support structures are designed to empower municipalities, ensuring they have the necessary resources and guidance to translate strategic plans into actionable outcomes.

The following sections will elaborate on the specific activities and impacts of these support facilities, illustrating how they contribute to the overarching goal of achieving sustainable H&C solutions across Europe.

3 Supporting municipalities in strategic heating and cooling planning: a look back

3.1 Support Activities

Support Facility 1 (SF1) provided customised heating and cooling (H&C) planning support to municipalities through packages tailored to their specific needs. The support was organised in four structured modules (highlighted in red in Figure 4):

- Heating and Cooling Transition Strategy: Helps municipalities develop or refine their H&C strategies and building renovation plans.
- Inventory and Potentials: Focuses on compiling building inventories, assessing renewable energy potentials and mapping waste heat opportunities.
- Zoning: Helps municipalities define district heating zones and identify areas suitable for individual heating solutions.
- Scenarios: Helps to develop and evaluate future H&C scenarios, including supply systems and infrastructure needs.

The modules included activities such as data collection, scenario development, exchange of best practices and preparation of tender documents, providing municipalities with the necessary resources for effective strategic planning.

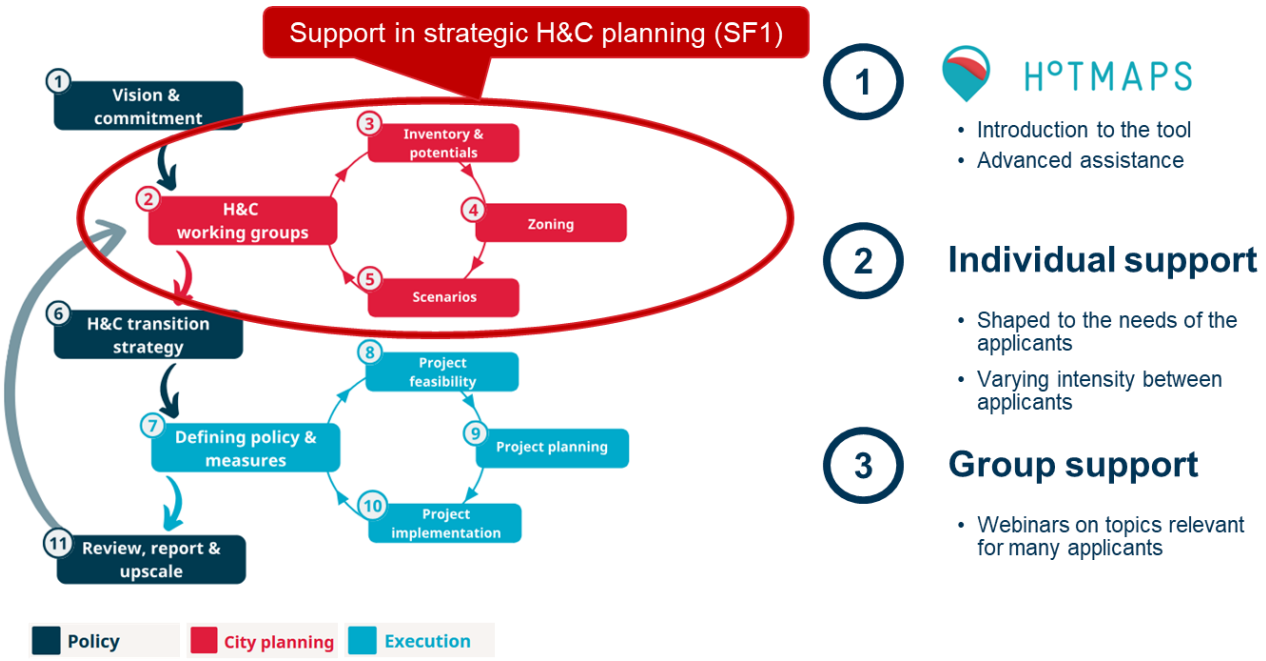
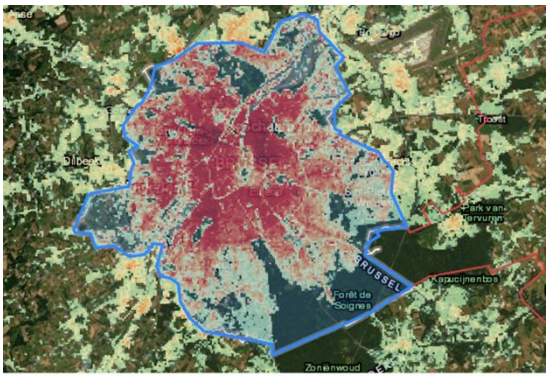


Figure 4: Structure of the support in strategic H&C planning in Act!onHeat

As shown in Figure 4, SF1 provided three types of support to city planners:

- Hotmaps: Introduction and advanced support in using the Hotmaps platform for strategic heat planning.
- Group support: Through webinars that address key issues and provide opportunities for municipalities to share experiences and knowledge.
- Individual support: Customised support tailored to specific needs, with varying levels of intensity.

Within the Hotmaps project (Hotmaps Project - The open source mapping and planning tool for heating and cooling), a toolbox has been developed and distributed to support authorities, energy agencies and other planners in the strategic planning of heating and cooling infrastructures. The focus of the application is on the urban and regional level. The toolbox allows to create plans that are in line with national and EU climate targets in the heating sector. Numerous functionalities are included in the toolbox. The toolbox allows, among other things, to model the demand for heating and cooling as well as the corresponding supply systems and the related energy system. For the evaluation of different strategies and plans for the decarbonization of the heat supply system supply and demand scenarios until 2050 can be developed for the municipal level. For this purpose, extensive data for all municipalities in the EU are stored as well as pre-selected scenarios. With the toolbox, scenario analyses are currently being carried out for 7 cities in the EU and on the basis of these analyses, strategy documents for the cities are created



INDICATORS GRAPHICS

INFORMATION	VALUE
HEAT DENSITY TOTAL	
Heat demand total	14 734.23 GWh/yr
Counted Cells	13 328 cells
Heat density min	0.03 MWh/(ha*yr)
Heat density max	9 491.29 MWh/(ha*yr)
Average heat density	1 105.51 MWh/(ha*yr)

EXPORT INDICATOR

Applicant Identification and Support

Act!onHeat identified applicants through four calls for applications, complemented by ramp-up workshops and bilateral meetings. These efforts assessed municipal needs, designed tailored support packages and motivated action towards H&C decarbonisation. Successful applicants received guidance, facilitated knowledge sharing through networks and partners, and empowered authorities with strategic plans and tailored support.

The table following summarises the participants supported through the calls for applications, which involved 54 applicants in four phases.

- A total of 33 **participants** received support: 10 received group support only, while 23 benefited from individual support, including Hotmaps training at introductory and advanced levels.
- The participants included **civil servants and/or representatives from energy agencies** who support multiple municipalities, allowing us to achieve multiplier effects through our formats.
- As part of the individual support, workshops were organized with participation from multiple municipalities. For example, a workshop for the participant Hessian Energy Agency involved eight municipalities, which were introduced to H&C planning. Another example is a workshop for the participant Macedonian Academy of Sciences and Arts, where a dataset specifically developed for North Macedonia was presented to seven municipalities.
- Taking into account the workshops mentioned above, overall, 135 municipalities gained valuable insights through their direct participation in these specialized workshops, which were prepared for the participants in the context of their individual support[1].
- Some of the individually supported participants were tasked with implementing H&C planning for many municipalities in their region, such as Le Syndicat de l'Ouest Lyonnais (SOL), which carries out planning for 46 municipalities in France, or the state of Vorarlberg, which conducts heat planning with its energy agency for 28 municipalities.
- Overall, 277 municipalities benefited from the support services provided to the 23 participants who received individual support (see Deliverable D3.1 for more details).

Call for Appli-cation	Nr. of applicants			Type of support provided				Municipalities benefiting from support	
	Total	Ramp up done	Support provided	Only group support	Individual support	Individual support + Hotmaps Intro	Individual support + Hotmaps Advanced	Supported directly	Partici-pated in a workshop
CfA-1	16	14	11	5	2	3	1	112	85
CfA-2	18	12	9	3	1	1	4	109	11
CfA-3	13	12	8	2	5	1	0	25	17
CfA-4	7	8	5	0	3	2	0	30	22
Total	**54**	**46**	**33**	**10**	**11**	**7**	**5**	**277**	**135**

Table 1: Overview of support cases in strategic H&C planning within act!onheat

[1] It is important to note that these workshops are not the topic-specific expert workshops held as part of the Group Support Activities which will be explained in the next section on the Group Support. The slides for this workshops are also online: https://actionheat.eu/local-replication-roadmap.

Act!onHeat provided tailored support to a wide range of municipalities across Europe, each facing unique challenges and pursuing specific goals in H&C planning. The following map illustrates the geographical distribution of the municipalities involved and the types of assistance delivered, alongside the number of municipalities supported.

The range of examples shows the broad engagement across different regions and regulatory contexts: from large-scale projects such as Hessen, Germany, implementing mandatory heat planning for millions of residents, to smaller municipalities like Babina Greda, Croatia, which developed heat cadastres despite limited GIS data. Urban centres such as Vilnius, Lithuania, have switched to renewable district heating, while rural areas like Steinfurt County, Germany, have adopted best practices for decentralised systems.

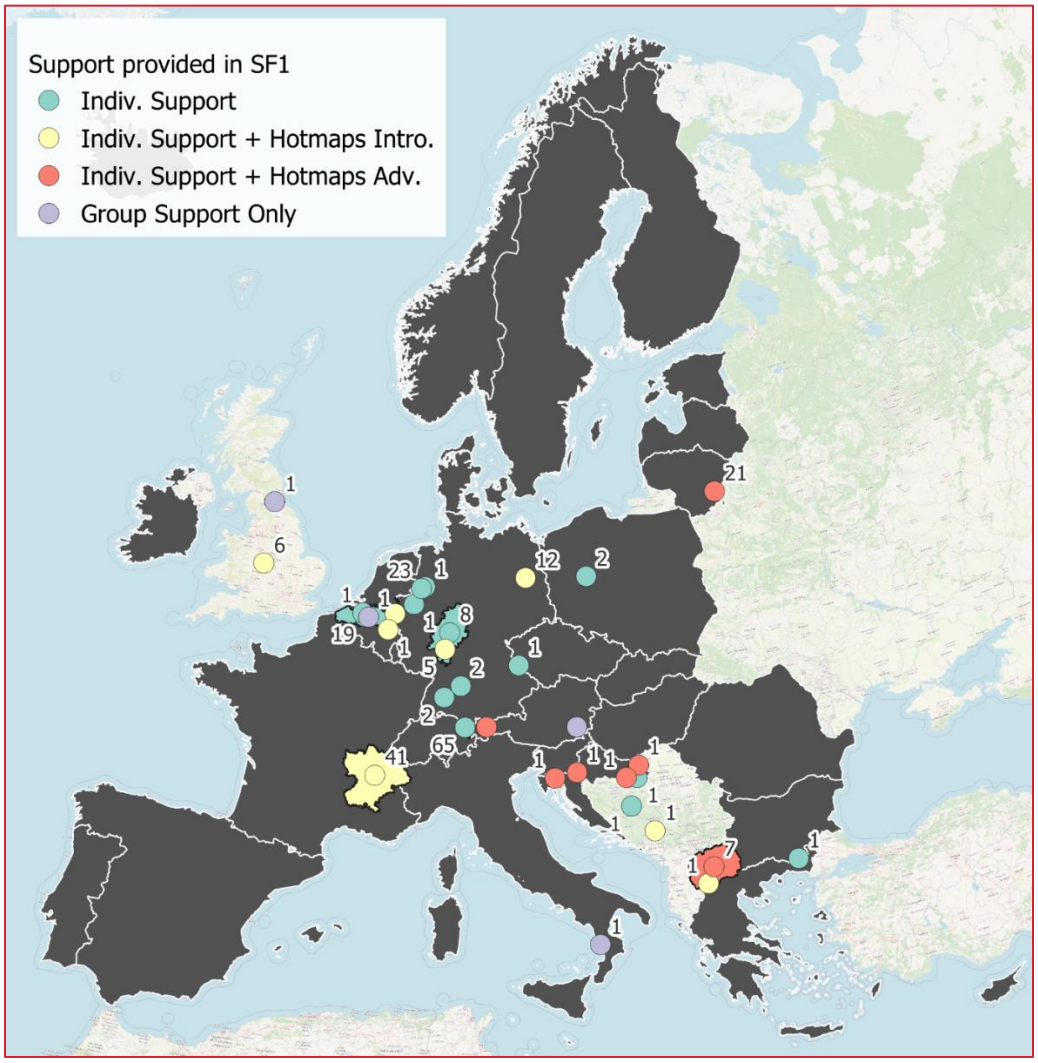


Figure 5: Geographical overview of support cases in strategic H&C planning in Act!onHeat

To illustrate the scope of support offered and its potential impact, some examples are briefly outlined:

Vilniaus Šilumos Tinklai (VST), Lithuania: Act!onHeat enabled VST, the country's largest heating provider, to explore renewable and excess heat integration using the Hotmaps toolbox and supply dispatch models. These tools improved cost analysis and encouraged diversification of renewable sources beyond biomass.

West Midlands Combined Authority (WMCA), UK: Workshops helped WMCA prepare for the National Zoning Model, incorporating insights from EU DH zoning practices and tools like Hotmaps and THERMOS (cf. section 4.1 on THERMOS). WMCA is now equipped for strategic H&C planning and potential Heat Zone Coordinator roles.

Macedonian Academy of Science and Arts (MANU), North Macedonia: Through top-down and bottom-up heat demand mapping, MANU identified district heating opportunities in selected municipalities. Workshops introduced these methods to local authorities, fostering comprehensive heat planning strategies.

Vlaams Energie- & Klimaatagentschap (VEKA), Flanders: To meet the new EED 2023 requirements for local H&C plans, Act!onHeat supported VEKA with compliance strategies and tools, enabling assistance to 19 municipalities and advancing regional sustainable H&C practices.

Kreis Steinfurt, Germany: An online survey and follow-up webinar strengthened the region's Service Centre for Climate Protection, equipping municipalities with actionable insights to overcome local heat planning challenges.

Energieinstitut Vorarlberg (EIV), Austria: Act!onHeat guided the integration of heat planning into Vorarlberg's spatial planning framework, aligning it with EED regulations on H&C planning and preparing municipalities for future needs.

A comprehensive overview of all support activities can be found in Deliverable 3.1: Supporting heat planning in Act!onHeat.

Group Support Activities

The group support activities (see Figure afterwards) were conducted in the form of nine webinars. These webinars covered diverse topics such as data management for heat planning, development of heat inventories, and using Hotmaps for strategy development.

Additional specialized sessions addressed issues like using industrial waste heat, geothermal energy, and space cooling strategies. The webinars provided practical knowledge and encouraged collaboration between municipalities and stakeholders across Europe.

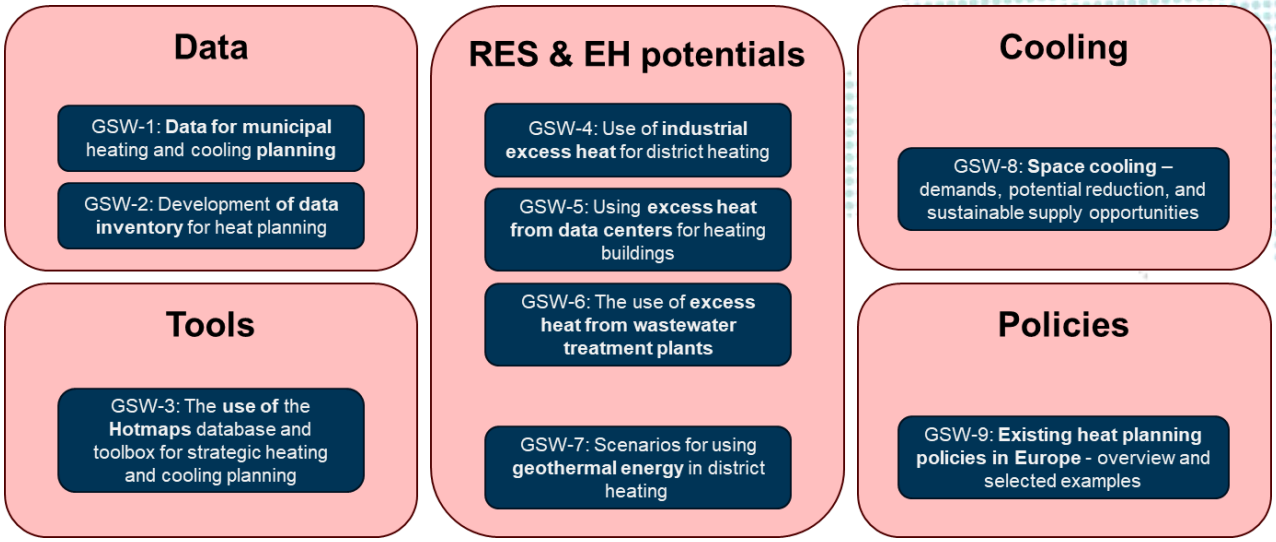


Figure 6: Overview of the 9 group support webinars (GSW) provided by Act!onHeat

The webinars highlighted the key challenges and opportunities for the decarbonisation of H&C systems in Europe. One focus was on the availability of data, which often depends on local policy support to fill gaps. Tools like geodatabases and dynamic mapping were highlighted as essential for effective planning, although regional variations in data quality pose significant hurdles. Co-operative projects such as energy atlases are promising but need to be adapted locally to be effective.

Industrial waste heat offers great potential for district heating but is often limited by internal industrial priorities. A reliable supply requires backup solutions and heat losses need to be controlled. Smaller data centres are increasingly adopting Nordic-style heat recovery strategies.

Low-temperature wastewater is a cost-effective and environmentally friendly solution for smaller communities, as examples from Northern Europe show. Its adoption relies on active cooperation among stakeholders, including local governments, wastewater treatment plants and district heating grid operators, and housing associations. Furthermore, geothermal energy offers flexibility and sustainability but requires careful planning and coordination. Here geological data and failure insurance can help to mitigate the high prospecting risk, which often hinders upfront investments.

As cooling demand increases, sustainable options such as district cooling and passive cooling are coming to the fore. Their success depends on the integration of renewable energy and efficiency improvements, while data gaps need to be closed.

The discussions emphasised the complexity of heat planning, long implementation times and changing markets. Heat pumps open up new opportunities but also bring challenges. The success of decarbonisation requires efficient, transparent solutions and community involvement. Flexible approaches with robust data and broad collaboration will be crucial to transform H&C systems.

The webinars are not accessible, but their slides with written explanations are available for download at the Local Replication Roadmap | Act!onHeat (Deliverable 5.6).

3.2 Learnings

The support measures implemented as part of Act!onHeat offer some important lessons:

Despite the success of the project, several challenges were encountered. The number of applicants was lower than expected: there were only 54 SF1 applicants, of which 33 received support. Identifying the most relevant support measures proved to be a time-consuming process, and small-scale activities often failed to engage municipalities effectively. Despite their motivation, municipalities face significant challenges, including limited resources, insufficient expertise in heat planning and a lack of clear guidance, supporting legislation and adequate funding.

Strategic heating and cooling planning should focus on building regional expertise. Provincial, regional or local energy agencies, equipped with appropriate training and capacity building tools, are better placed to provide effective support to municipalities. Financing remains a key barrier as municipalities struggle to find sufficient funds to plan and implement heat projects. Simplified mechanisms, such as provincial, regional or local one-stop-shops, are needed to facilitate access to finance.

The success of planning efforts depends on a sound regulatory framework. Municipal plans, typically developed to meet legal obligations, rely on reliable data, cost-benefit analysis (CBA) and zoning. Legislation should clearly regulate data sharing, protection and aggregation to ensure transparency and compliance. Effective implementation of zoning also requires a well-defined regulatory framework, coordinated at the national or regional level to promote consistency and effectiveness. Further information on the supported cases and the webinars can be found in deliverable D3.1: Supporting heat planning in Act!onHeat.

4 Pre-feasibility studies to get projects off the ground: our experience

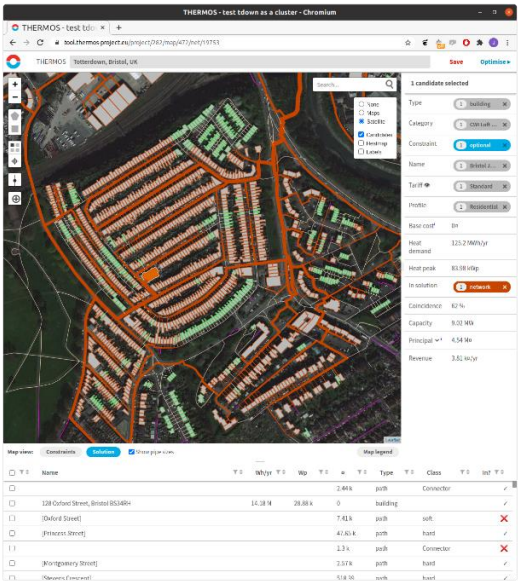
4.1 Support activities

The main objective of this task was to directly support municipalities with the development to prefeasibility stage of local area H&C projects, with follow-on assessments of financial options for selected cases. The prefeasibility support was delivered under Support Facility 2 (SF2) and was primarily based on use of the THERMOS tool.

THERMOS (Thermal Energy Resource Modelling and Optimisation System)[2] is an open-source web-based planning tool used to accelerate the development of new low-carbon heating and cooling systems.

THERMOS: Home

Using state-of-the-art modelling techniques, THERMOS will rapidly identify place-based, user-specific optimal heat network solutions for a given area, making heat network planning faster, more transparent, more efficient and more cost effective.



The tool estimates the heat demands of every building in a specified area and deploys a set of purpose-built algorithms to optimise the design and layout of local heating and cooling networks. THERMOS is designed to support heat network pre-feasibility studies, producing optimised network scenarios and enabling those with most potential to be prioritised for further investment and analysis.

Figure 7 indicates where local H&C prefeasibility support sits in the overall context of H&C workflow planning.

[2] https://www.cse.org.uk/research-consultancy/consultancy-projects/thermos/

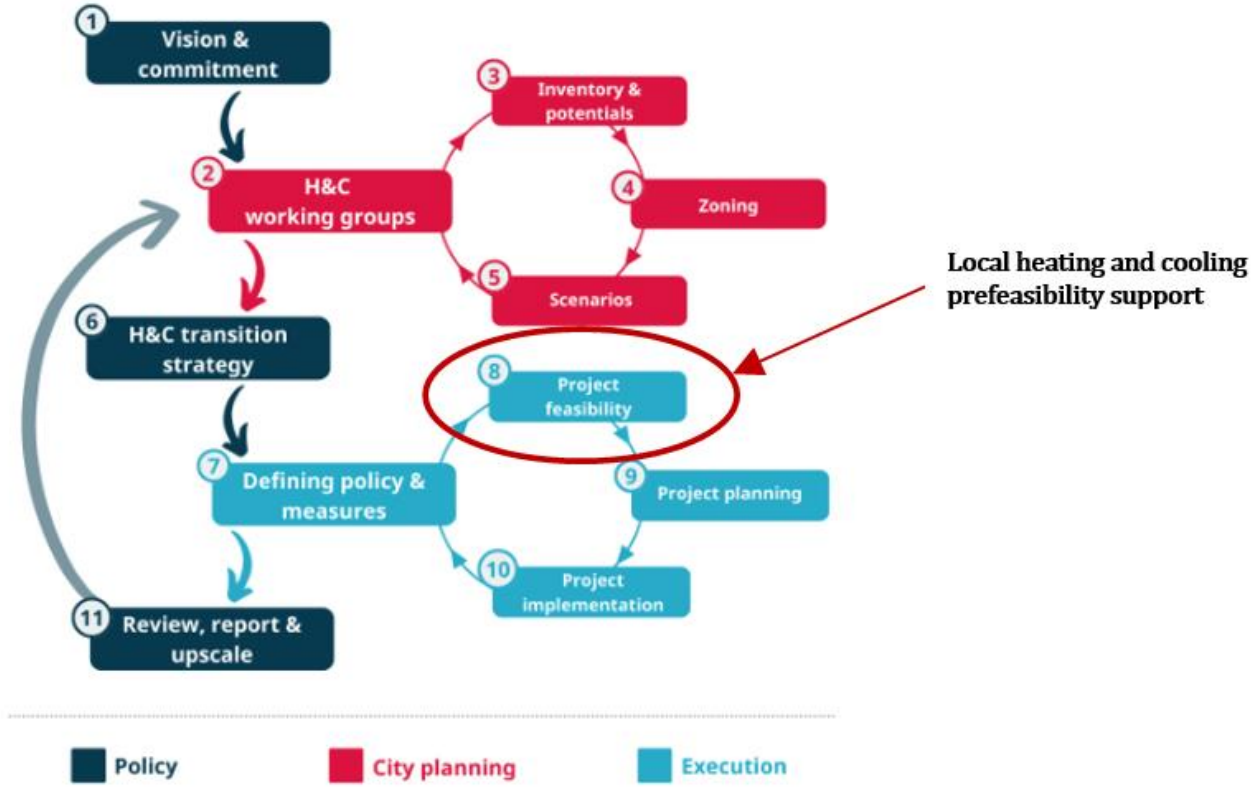


Figure 7: Local heating and cooling prefeasibility support in the context of workflow planning

Applicant Identification and Support

Following each of the four application calls, SF2 support was offered following an evaluation process, with Act!onHeat technical support partners matched to projects according to location and project technical requirements. A Collaboration Agreement was then drawn up with the participant to confirm the objectives, scope of support, resources available and timelines. In scoping the programme of work, a combination of support packages were offered to each participant – examples of these in the form of clustered activities are described in the table below for a range of typical project prefeasibility work areas.

Project prefeasibility work area	Description of possible support packages
Familiarisation with THERMOS	- Training sessions on THERMOS tailored to suit user requirements. - Run through of case studies to demonstrate the real-world applications of THERMOS.
Data preparation for heating and cooling demand estimation	- Assistance in specifying and identifying LiDAR data for a defined area to obtain building heights. - Assistance in compiling local GIS buildings and roads data to supplement or replace OpenStreetMap data (including future development). - Guidance on formatting locally-sourced energy demand data to supplement THERMOS model.
Estimation of building heating and cooling demands for a defined area using THERMOS	- Basic estimation of peak and annual demands [using OpenStreetMap polygon data]. - Advanced estimation of peak and annual demands [using OpenStreetMap polygon data and building height], possibly supplemented with locally-sourced demand data. - Heat mapping to produce visual representation of spatial heat demand density.
Development of heat network scenarios for optimisation using THERMOS	- Defining buildings and roads/pathways to be included in analysis, including incorporation of future developments. - Specification of heat supply options and their location. - Guidance on economic objectives and technical parameters and variables to be used in network optimisation model. - Development of network scenarios that incorporate a phased roll-out.
Optimisation of heat network scenarios using THERMOS	- Support with running optimisations. - Diagnostics and troubleshooting of problem scenarios. - Support on adjusting scenarios and iteration of optimisation runs.
Optimisation of energy supply plant using THERMOS	- Guidance on specifying energy demand profiles. - Guidance on specifying supply economic objectives and technologies.
Presentation and analysis of results	- Support with collation and interpretation of output data. - Comparison between optimised network solutions. - Comparison between optimised heat supply solutions. - Presentation of KPIs and sensitivity analysis.
Assessment of financial and governance options (for a limited number of selected projects only)	- Identification of financial barriers for relevant infrastructure projects. - Assessment of financing options at regional, national and EU level, including governance and regulatory aspects.

Table 2: Example support packages and clustered activities for SF2 support

SF2 support was focused on THERMOS, to which participants had unrestricted access via a dedicated server. Training was provided either to participants individually or in group sessions to ensure familiarity with the tool and to introduce a common prefeasibility study spreadsheet template, which was purposed to assist with workflow navigation, the identification and collection of data, scenario specification within THERMOS and the presentation of results.

The table below summarises applicant numbers across the four calls and the levels of support they received, ranging from attending a ramp-up meeting to concluding a prefeasibility report. Also shown is a map to indicate the geographical distribution of SF2 applicants across Europe.

Call for Application (CfA)	No. of applicants	No. of ramp-up meetings held	No. of participants receiving post ramp-up support	No. of reports issued
CfA-1	7	7	4	4
CfA-2	25	9	8	7
CfA-3	8	5	5	4
CfA-4	8	5	4	4
Total	**48**	**26**	**21**	**19**

Table 3: Summary of SF2 applications and support levels delivered

Figure 8: Map showing Act!onHeat SF2 applicant countries (Green) and approx. location of prefeasibility studies (red)

Summary of Support Outcomes

The participant teams receiving support were made up of staff from a range of organisations spanning municipalities, energy agencies, energy companies and consultants. The support provided ranged from training on THERMOS through to full prefeasibility studies where, in a few cases, much of the analysis work was undertaken by the participants themselves. Case studies included activities such as building heat demand estimation, heat mapping, exploring potential for new heat networks, modelling existing networks and the potential for extensions,

and identification of new low carbon heat sources such as industrial waste heat, heat pumps or use of sustainable biomass.

Outcomes varied in terms of technical or financial feasibility, depending on the availability and accuracy of data available. Even where data was limited however, THERMOS default values could be used and multiple scenarios could be modelled to result in optimised heat networks, matching supply capacities with heat demands to establish the potential extent of coverage. Where indicative costs of supply plant and pipe routing were available, Net Present Value (NPV) as a financial viability indicator could be compared and contrasted of modelled systems. Examples of more comprehensive studies undertaken include the cities of Zelzate[3], Poznań, Neuried, Vilnius and Frankfurt (Oder). A summary of the studies undertaken and outcomes which resulted in prefeasibility reports for the participant cities are provided in **Annex 1** to this report.

4.2 Learnings

Although Act!onHeat demonstrated that many municipalities could benefit from external support on local H&C decarbonisation studies, it also found that a number of barriers exist to achieving successful outcomes. One of the key learnings from the project was that SF2 support needed to be flexible, often requiring review according to the level of progress being made. A **more flexible approach** was therefore taken in agreeing support, allowing participants to 'cherry pick' from a list of activities.

Participants did not always have a clear idea of what they wanted to achieve and often relied on being guided through the process by the Act!onHeat support partner. **Unclear aims and objectives** were more common when there were no obvious immediate opportunities for a localised heating/cooling project e.g. local low carbon heat sources, and the study therefore became very exploratory in nature.

There were large variations in **available time and levels of expertise** that participants could allocate to the projects being supported, and plans or circumstances within council teams could often change at short notice. To help avoid this, participants were encouraged to secure senior level commitment and authorisation from the start.

The THERMOS tool was primarily developed for designing new heating or cooling networks and can draw on a range of default parameters to undertake an analysis. Results however are much improved if this is replaced or supplemented with more accurate local data e.g. using LiDAR building height data to produce more accurate heat demand estimates or use of local cost data for heat network infrastructure. Often this **data is difficult and time-consuming to obtain** but its omission can reduce the validity of results and lead to a lack of confidence in study conclusions and recommendations. To help mitigate this, a prefeasibility study data

[3] A presentation on the Zelzate case study can be found here: https://actionheat.eu/resources/presentation-9th-international-conference-smart-energy-systems

template was presented and discussed with the participant team early in the study to help plan the identification and sourcing of data.

The extent to which participants engaged directly using THERMOS was very much dependent on the interests, expertise and capacity of the individuals concerned. A **lack of engagement in using THERMOS** can often create a barrier to understanding outputs and may discourage on-going use of the tool. Participant training on THERMOS was delivered as standard, either individually or in groups with other participants to help sustain impacts when support ended.

Lastly, it was intended that SF2 support would help justify further investment by the participant in more detailed techno-economic feasibility work. From the start, participants were therefore encouraged to consider options for progressing the work once Act!onHeat support ended to help avoid **uncertainty on next steps** and plan for the decision-making process.

5 Financial studies: follow-up support and tailored advice

5.1 Core Implementation and Challenges

Act!onHeat provided tailored financial pre-feasibility studies to address a key challenge in the decarbonization of heating systems: the development of robust financial frameworks to enable the implementation of sustainable H&C solutions. The studies aimed to equip municipalities with the necessary tools and insights to navigate the financial complexities of H&C projects.

The financial studies encompassed diverse projects across Europe, ranging from district heating network expansions in Zelzate (Belgium) and Bludenz (Austria) to new system developments in Kicevo (North Macedonia) and transformative projects in Kakanj (Bosnia and Herzegovina). Each study followed a structured methodology, including regulatory analysis, funding landscape mapping, and the development of financing strategies, while utilizing tools like THERMOS for optimization. The overarching goal was to offer actionable recommendations for financing decarbonization efforts. In addition to the case studies tailored to the needs of the applicants, we also conducted two theoretical studies which go deeper into the profitability and overall financial viability of H&C development, which can be accessed online.

Each pre-feasibility study represented different stages of market development, regulatory frameworks, and technical challenges, providing valuable insights for understanding success factors in heat decarbonization projects. A key observation during implementation was the relatively lower uptake of dedicated financial pre-feasibility studies compared to initial expectations. This stemmed primarily from municipalities' resource constraints and strategic priorities, with many finding their limited time and personnel resources could be more effectively deployed in pursuing concrete project applications. However, this challenge led to an important adaptation in the project's approach: the development of readily applicable financial planning tools and frameworks that could be adapted to local contexts.

The financial studies followed a comprehensive methodology encompassing a sequential approach in which the key components were adapted to each municipality's specific context and needs. The regulatory framework analysis examined both current policies and anticipated developments at local, national, and EU levels. The funding landscape mapping identified potential financing sources across public, private, and blended finance options. Financing strategy development focused on creating robust, adaptable funding structures that could withstand market uncertainties while delivering on decarbonization objectives. A list of the main financial studies conducted in this project can be found in the Table below:

Municipality	Key Policy Focus	Identified Key Funding Sources	Challenges	Key Lessons
Zelzate	Industrial waste	EEEF, ELENA,	Maximizing	Policy alignment

Municipality	Key Policy Focus	Identified Key Funding Sources	Challenges	Key Lessons
(Belgium)	heat utilization and network optimization	EUCF, EIB loans	connection rate, ensuring supply reliability	and modular network design are critical
Bludenz (Austria) [4]	Social housing integration with district heating and renewable sources	EUCF, EEEF, Austrian federal subsidies	High initial costs, balancing affordability for low-income residents	Combining technical and financial strategies enhances viability
Neuried (Germany)	Federal support for heating networks and alignment with new Heat Planning Law	Federal funding (BEW), regional support schemes	Ensuring sufficient heat demand density and risk management	Phased development reduces demand risks
Kicevo (North Macedonia)	Post-coal transition with EU and national modernization funding	EU pre-accession funds (IPA III), Western Balkans Investment Framework (WBIF)	Developing new systems in a transitional economy	Strong alignment with EU and national policies enables funding access
Kakanj (Bosnia and Herzegovina)	Transition from coal-based district heating with industrial and renewable integration	EBRD Green Economy Financing Facility, GEF, WBIF	Balancing cost of transition and environmental goals	Integrating existing infrastructure with renewables improves feasibility
Malmö (Sweden) [5]	Innovative expanded heat pump system with strategic implications	Innovation Fund, local energy programs	Managing costs and operational risks of a large-scale project	Smart system design and future scalability are essential

[4] A theoretical financial study has been conducted and is available at the following link. https://actionheat.eu/resources/theoretical-case-studies-esg-project-upper-austria-and-expanded-heat-pump-system-project

[5] A theoretical financial study has been conducted and is available at the following link. Theoretical Case Study II_EHPS_Sweden.pdf

Municipality	Key Policy Focus	Identified Key Funding Sources	Challenges	Key Lessons
Upper Austria (Austria)	Enhanced geothermal systems in Molasse Basin	National geothermal initiatives, EU innovation grants	Integrating technology and ensuring economic feasibility	Comprehensive feasibility studies guide decision-making
Poznan (Poland)	Modernizing district heating to integrate renewable sources and improve efficiency	EU structural funds, local budgets, EIB loans	Retrofitting existing infrastructure while maintaining energy supply	Public-private partnerships and phased implementation enhance project feasibility

Table 1: List of European municipalities with conducted financial studies

To broaden stakeholder engagement and disseminate our lessons learned, Act!onHeat organized an online webinar titled "How to Finance Sustainable Solutions in District Heating." This session, held on September 17, 2024, attracted over 50 participants, and focused on financing heating and cooling projects in European cities. Speakers from the European Commission, academia, and other relevant organizations presented various financing schemes and opportunities within the sector. The discussions included different EU funding instruments, the relevance of the Covenant of Mayors, and experiences gathered during the Act!onHeat project's collaboration with cities. The webinar provided insights into the financial pathways available for sustainable H&C solutions, thereby enhancing stakeholder engagement and knowledge dissemination beyond the individual financial case studies. The recorded webinar, together with the slide decks of all the speakers can be found online.

5.2 Learnings

Through the implementation process, several significant barriers emerged that hindered municipalities' ability to fully engage with financial planning. A summary of the lessons learned can be found online.

Resource Allocation Patterns: The way municipalities allocated their limited resources proved particularly instructive. Rather than engaging in comprehensive financial pre-feasibility work, most chose to focus on immediate project development opportunities. This pattern emerged consistently across different contexts, from established markets in Western Europe to emerging systems in the Western Balkans. This prioritization reflects practical necessity rather than lack of interest. Municipalities must demonstrate concrete progress to maintain political and stakeholder support, making it difficult to justify extensive investment in preliminary planning. The studies that did proceed often became more exploratory in nature, particularly when immediate project opportunities were not evident.

Technical Support Challenges: The financial pre-feasibility studies revealed key insights about how municipalities engage with funding exploration for heat decarbonization projects. Most municipalities entered the support process seeking to understand available funding sources and mechanisms but found it challenging to engage with comprehensive financial planning processes. When exploring funding options, municipalities often needed guidance on how to systematically evaluate and combine different funding streams. While they showed interest in specific funding sources like EU grants or national support schemes, the process of matching these to project components and assessing their suitability proved complex. This was particularly evident when considering factors like eligibility criteria, timing requirements, and co-financing needs. The relationship between technical and financial feasibility also emerged as an important consideration. Technical choices about heat sources or network configurations could significantly impact funding options, requiring municipalities to consider both aspects simultaneously. While tools like THERMOS could provide initial technical parameters, translating these into financial assessments required additional expertise and resources that were not always readily available.

Regulatory Frameworks Variations: The financial pre-feasibility studies highlighted how varying regulatory frameworks across European contexts create significant uncertainty for heat decarbonization planning. In established markets like Germany and Austria, municipalities operate within well-defined national frameworks that outline specific requirements for heat planning. For instance, Germany's new Heat Planning Law[6] provides clear guidelines, while Austria integrates heat planning into spatial energy planning at the provincial level. In contrast, municipalities in Southeast European countries face a more complex regulatory landscape.

These regulatory variations directly impact how municipalities can approach financial planning. In Western European contexts, established funding mechanisms often align with regulatory requirements, creating clearer pathways for project development. However, in emerging markets, the relationship between regulatory frameworks and funding mechanisms is still evolving, making it more challenging to develop robust financial plans. The studies also revealed how regulatory uncertainty affects different aspects of financial planning. For example, requirements around data sharing, cost-benefit analysis frameworks, and project approval processes vary significantly across jurisdictions. This variation makes it particularly challenging to develop standardized approaches to financial pre-feasibility assessment, as methodologies that work in one regulatory context may not transfer effectively to another.

In response to these challenges, significant adaptations were made to the support delivery approach within Act!onHeat. A more flexible methodology was adopted, allowing participants to engage selectively with specific activities, rather than requiring full participation in all aspects of financial planning. Most applicants chose to focus on learning about funding sources rather than on preliminary estimates of financial viability, the latter of which would be required in a much more comprehensive setting where a project was to be initiated. Additionally, several local authority representatives were uncertain about whether to collect

[6] The Act (Gesetz für die Wärmeplanung und zur Dekarbonisierung der Wärmenetze) is available at the following link. https://www.gesetze-im-internet.de/wpg/index.html

sensitive local data—information not ordinarily accessible to the public—for use in this project. Their primary concern was that, even if the data-driven models demonstrated value, any future application for heat network funding would still require a separate, legally mandated pre-feasibility study. Consequently, they worried that gathering and analysing sensitive data for our purposes might lead to duplicating much of the same effort later, once the formal feasibility process was underway. Therefore, the support packages were regularly reviewed and adapted in the light of progress, with a focus on providing practical, immediately applicable tools and frameworks that could work within the resource constraints of local authorities. This adaptive approach proved essential in maintaining engagement and delivering valuable results despite the challenges identified.

6 Replicate Act!onHeat: methods and materials

The Act!onHeat Workflow Guide provides a structured 11-step approach for municipalities to develop effective heating and cooling (H&C) strategies. The steps begin with creating a vision and establishing a working group, followed by inventory analysis, zoning, and scenario development. The guide progresses through setting strategic goals, defining policy measures, and conducting feasibility studies for implementation. Project planning and execution are included, alongside monitoring and review processes to ensure iterative improvements. The guide aims to support local authorities in achieving decarbonization goals and offers tools and references to facilitate the process.

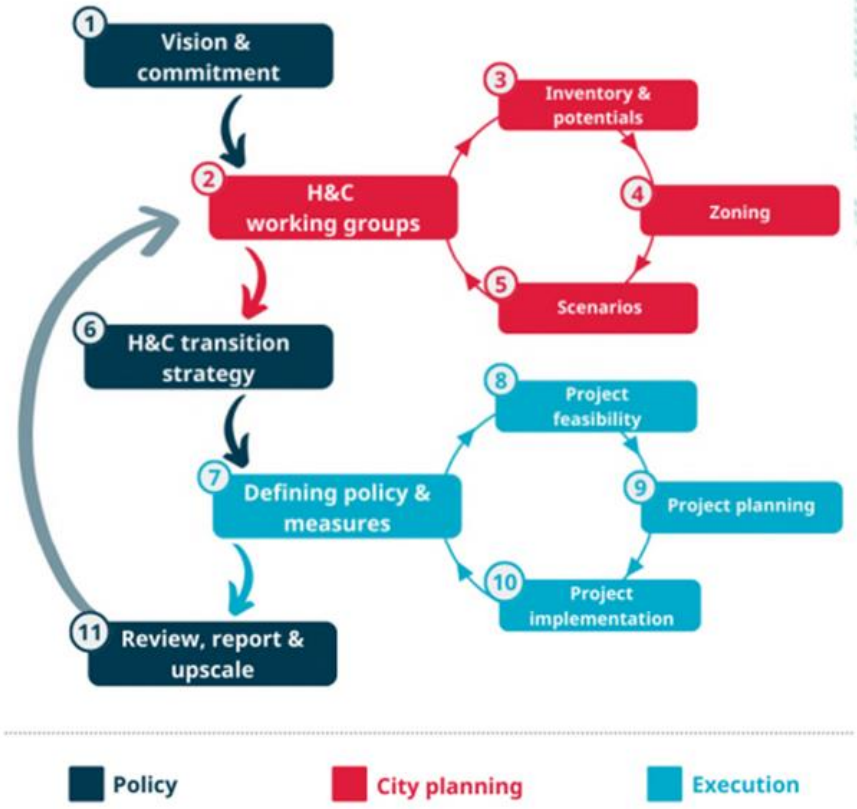


Figure 9: Local heating and cooling prefeasibility support in the context of workflow planning

6.1 Integrated Hotmaps and THERMOS User Guide

This document explains the combined use of the Hotmaps and THERMOS tools for heating and cooling (H&C) planning in municipalities, as part of the Act!onHeat project. It outlines methods for estimating heat demand, identifying areas suitable for district heating and cooling

(DHC), and conducting detailed feasibility studies for local networks. The guide uses the city of San Sebastian as a case study, describing steps like heat demand mapping, economic feasibility analysis, and tool-specific data alignment.

- Additional references include training materials and resources for both Hotmaps and THERMOS to support users in implementing DHC solutions.

6.2 Local Replication Roadmap

The Local Replication Roadmap (LRR) is a strategic guide designed to assist local governments and key stakeholders in planning and developing sustainable heating and cooling (H&C) systems. This document provides clear and practical steps to set targets, prioritize actions, and engage stakeholders at the municipal level, while facilitating the use of innovative tools such as Hotmaps and THERMOS.

The LRR focuses on key aspects, including efficient data collection and management for effective planning, implementing decarbonization projects with robust governance and financing structures, and leveraging practical insights gained through the Act!onHeat project to optimize proposed solutions.

The LRR primarily targets municipal energy planners and stakeholders involved in the decarbonization of thermal infrastructures. The benefits include:

- Strategic Guidance: Detailed guidelines to design and implement heating and cooling plans at the local level.
- Efficient Data Management: Practical examples and strategies for collecting and processing necessary information.
- Tool Integration: Optimized use of open-source tools like Hotmaps and THERMOS to streamline energy project planning.
- Governance and Financing: Guidance to advance sustainable and feasible projects with solid governance structures.

Here is the link to the LRR: *Local Replication Roadmap*[7]

[7] https://actionheat.eu/local-replication-roadmap

Figure 10: Index of the Local Replication Roadmap

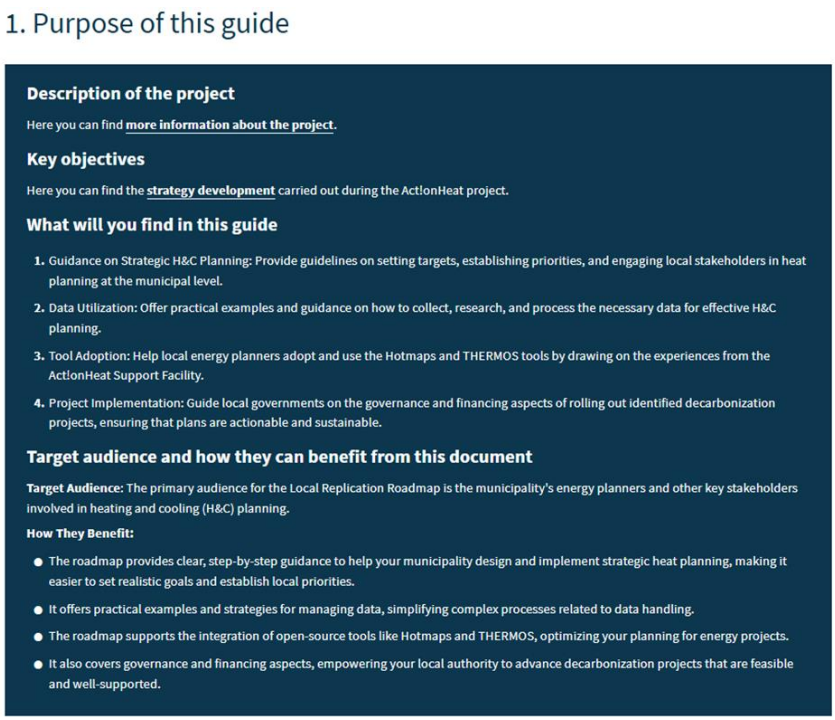


Figure 11: Purpose of the Local Replication Roadmap

Figure 12: Description of the H&C planning and financing process

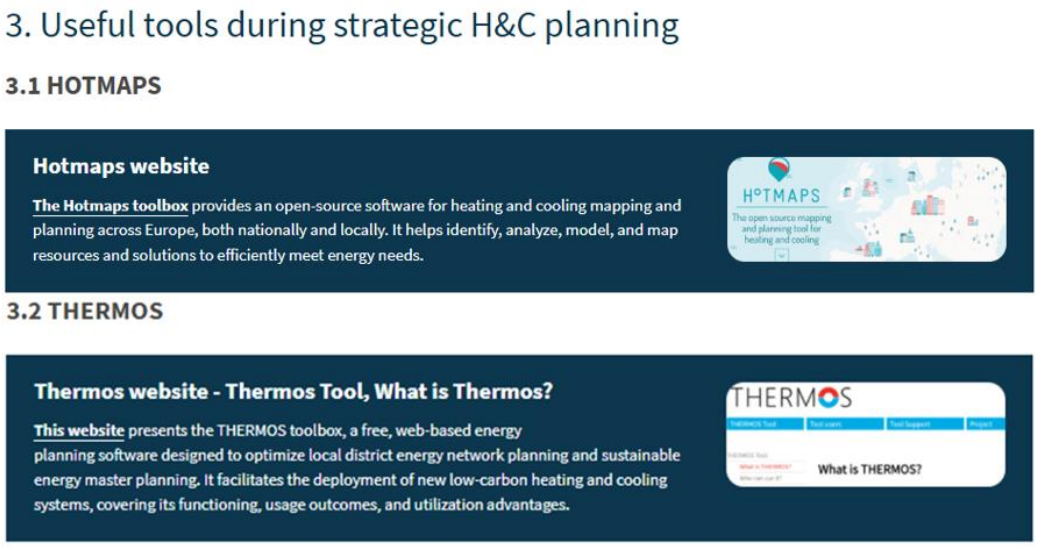


Figure 13: Useful tools during strategic H&C planning

Figure 14: Practical case studies and examples

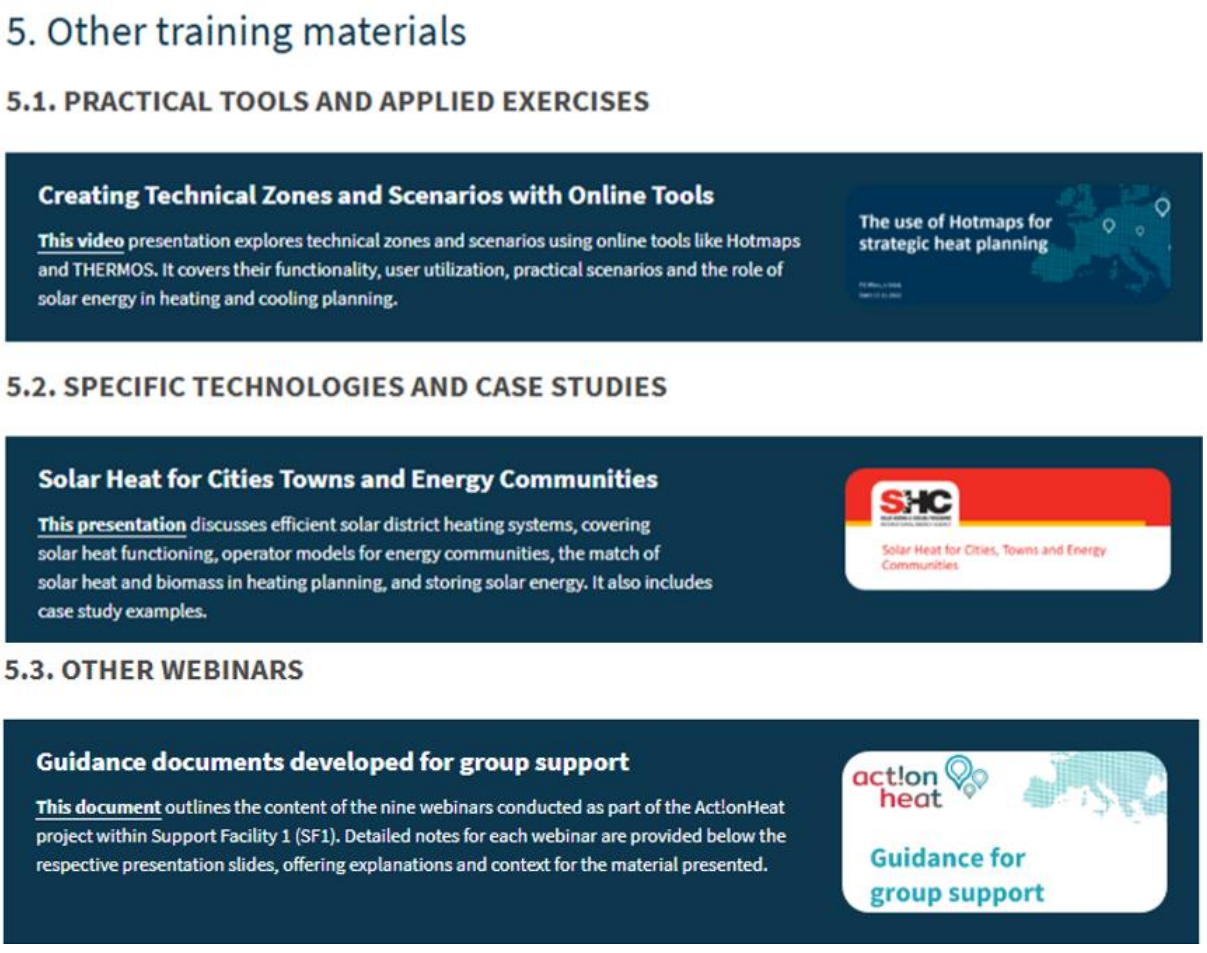


Figure 15: Other training materials

7 Recommendations to public authorities from Act!onheat cases

7.1 Policy recommendations

Strategic H&C planning starts with political and technical decision-makers developing a vision and common objectives on the matter that will ultimately lead to a H&C plan. Taking the first steps and involving the right stakeholders can be challenging. These are the policy recommendations from Act!onHeat experts based on their work during the project:

Actors to mobilise in creating a H&C vision

When starting the process of H&C planning, energy agencies, housing associations, the spatial/urban planning department, utilities, and the city council should be involved.

Having the local community onboard

This highly influences decision-makers and politicians. How deeply to involve citizens at an early stage depends on the socio-demographic structure of each local authority. In any case, it is always beneficial to involve large housing companies which own many houses.

First steps in H&C planning

Starting a H&C planning on their own might be difficult to some municipalities, particularly the smaller ones. That is why it can be a good idea to find an umbrella for the topic like other projects or plans where to include the H&C strategy. For example, the Sustainable Energy and Climate Action Plans (SECAPs) often include H&C and can integrate such a plan. The next step would be to set up a working group of motivated people within the council, which must be formally recognised and suitably resourced.

Communicate the benefits of H&C planning

Effective communication is key to securing commitment from stakeholders and decision-makers, especially with the use of objective, real data. It is important to know our audience, whether technical or non-technical, and make them feel involved by considering their feedback. Communication must focus not only on the short-term elevated costs of the plan, but also on the long-term benefits, like emissions and price reductions, and increase on quality of life.

Constant improvement of the H&C plan

Continuous improvement of the H&C plan is essential, with adaptable KPIs that become more ambitious over time and integrate more renewables. Reviews of the plan should happen at least every five years, with interim monitoring depending on data availability.

7.2 Recommendations on city planning

This section refers to the steps to be taken before having a H&C plan in place in our municipality. It includes setting up a working group, data gathering and the creation of useful

scenarios. These are the recommendations on city planning from the Act!onHeat experts:

Setting up a H&C working group

Selecting the actors to be part of a H&C working group depends on the individual structure of the municipality. There should be a representative from the spatial planning department or similar, also including the building authority (if applicable). Furthermore, other relevant departments like energy, or sustainability are recommendable to be involved. The local utility, housing associations and representatives from the city council should also be part of the working group.

Barriers in the development of a H&C strategy

The main barriers often involve technical challenges like data gaps, incomplete information on buildings, and limited technical expertise in the municipality. Planners must start analysing the state of the local thermal network, energy demand and availability of renewable sources among other aspects.

How to deal with the lack of data

When there is data scarcity to build the H&C inventory and zoning of the city, making use of online tools can be extremely beneficial. The open-source software Hotmaps gives data estimates for assessing the thermal energy demand on an area, available resources or suitability for a thermal network among others.

Inter-municipal approach

It is always a good idea for cities to team up, to act as a cluster and collaborate with the region. This helps for example in the data collection and enables the use of regional or provincial energy agencies' heat cadastres when available.

Which H&C scenarios to develop during the planning

The scenarios developed in a municipality should reflect the local objectives. Scenarios should not only project the heating or cooling supply in accordance with the development of the population, but also building retrofit, which is a big uncertainty and can highly influence the demand.

7.3 Recommendations on project implementation

Strategic H&C planning ultimately leads to the definition and implementation of projects that will help us achieve our goals. Some of the biggest challenges in this section refer to technical or financial barriers, along with the evaluation and upscaling of implemented projects. These are the main recommendations on project implementation from the Act!onHeat experts:

Potential challenges to take into account

Municipalities should be aware of the different challenges as well as possible solutions, when it comes to the implementation of projects. Lack of data is one of the most referred barriers, which can be overcome by using digital tools as estimates prioritising areas of interest for a deep dive. Moreover, there is often a lack of knowledge on the available funding and how to bring it forward.

District H&C projects bring a lot of uncertainty on costs

These projects are often planned in phases, which makes it difficult to meet the financial

targets at early stages. However, sharing the costs and risks can help overcome the uncertainty, via public-private partnerships.

Cost of connection to buildings

In district H&C projects, **the cost of connections to buildings** is often not well planned. These connections require work to be made in those buildings, bringing additional costs to the project.

How to overcome technical barriers

Digital tools like THERMOS can be extremely useful when it comes to pre-feasibility studies for expanding or developing new district H&C networks. The open source software THERMOS is a user-friendly tool that provides accurate network options analysis instantly based on modelling, with the option of real data inputs. There are a lot of training webinars and materials available on the THERMOS website for easy learning.

Upscaling of district energy projects

Before replicating a H&C project in a new area, the evaluators must decide if the solution was in fact successful and how to measure that. There are many variables to look at in the evaluation of a project, which can include economic aspects, emissions and usage of renewable energy sources, energy prices, energy flows or overall consumer experience. However, what worked in city A might not work in city B, as each local context is unique and must be looked at individually.

7.4 Recommendations on financing

When it comes to the implementation of a H&C project or plan, having the right financing model and funding is key. To assist public authorities and utilities in developing and scaling bankable sustainable H&C solutions within the EU, the following professional financing models and tools can be applied.

Use EU Funding Programmes and instruments

Municipalities can leverage grants and subsidies from EU initiatives such as the European Regional Development Fund (ERDF), and the Just Transition Mechanism as well as facilitating instruments such as the European City Facility, ELENA or JASPERS. These funds and instruments, the ones with a focus on H&C, can reduce upfront capital requirements by financing feasibility studies, research, and initial project development costs.

Blended Finance Mechanisms

These utilise the InvestEU Programme to combine public funds with private investment. This approach mitigates the risk via EU budget guarantees, enhancing the attractiveness of projects to private investors and enabling larger capital mobilisation which is crucial for H&C projects as they are commonly big in size and thus investment.

Green Bonds and Sustainable Finance Instruments

Another option is to issue municipal or corporate Green Bonds aligned with the EU Green Bond Standard to raise dedicated capital for sustainable H&C networks. This taps into the growing pool of Environmental, Social and Governance-focused investors seeking beneficial projects.

Public-Private Partnerships (PPPs)

H&C projects can establish PPPs under the frameworks provided by the European PPP Expertise Centre (EPEC). This model facilitates risk-sharing between public and private sectors, attracts private sector expertise, and can accelerate project timelines through efficient resource allocation.

Energy Service Companies (ESCOs) and Energy Performance Contracting (EPC)

Engage ESCOs to finance, design, build, and operate H&C networks under EPC models. This allows public authorities to implement projects without initial capital expenditure, repaying the investment over time through energy cost savings guaranteed by the ESCO.

Risk-Sharing Facilities and Credit Enhancement

Projects can access risk mitigation instruments offered by the European Investment Bank (EIB), such as the EIB's Project Bond Credit Enhancement and European Fund for Strategic Investments (EFSI) guarantees. These tools improve project credit profiles, making them more bankable and appealing to commercial lenders.

7.5 Recommendations on communications

To effectively reach out to and engage with local energy planners and networks, the communication work carried out within the ActionHeat project was guided by a Dissemination, Communication, and Exploitation (DCE) plan that outlined three key tactics: **Tactic 1 focused on mass communication** through digital communications campaigns via social media, e-newsletters, and the project website as well as through traditional media such as the publication of news articles and press releases. **Tactic 2 emphasised targeted dissemination** via participation in events and stakeholder engagement via dialogues and workshops, and **Tactic 3** concentrated on the creation and then **exploitation of capacity-building and training materials**. Together, these approaches aimed to raise awareness about the project and its results, specifically the Support Facilities and Training Programmes, to foster knowledge sharing on strategic heating and cooling planning in municipalities across Europe.

What to incorporate

- **Targeted dissemination** proved highly effective. Engagement through the ActionHeat Training Programme (2022, 2023, 2024) as well as the ActionHeat Roadshow, which included both in-person and online workshops, along with one-on-one stakeholder dialogues, fostered meaningful interactions and successfully promoted the project, including the Support Facilities and the related H&C digital tools Thermos and Hotmaps (now Citiwatts). This shows that dissemination activities that foster exchanges such as networking events and bilateral meetings are impactful activities for engaging with local energy planners.
- **Collaborations with established networks**, including ICLEI Members, other Horizon and LIFE projects Covenant of Mayors, NetZeroCities, BUILD UP, ManagEnergy, and past THERMOS project participants, via targeted mass mailings and promotion on their relevant communications channels further amplified outreach and credibility for the ActionHeat project as well as its Support Facilities and Trainings. This was later

emphasised by tapping into the project's newly created Ambassador Community, that then further supported in disseminating the projects offerings to their relevant H&C stakeholder groups. As such, strategically utilising established and relevant contacts and partnerships is key for acquiring an audience for such H&C related support.

- **Knowledge sharing** via capacity-building materials achieved notable success. Training Programme recordings, tutorial videos, and resources (including the integration of the ActionHeat Workflow and Local Replication Roadmap) were well-received, with over 2,400 downloads and video views showcasing significant engagement with the project's outputs and ensuring that key energy audiences were effectively reached and informed. Effective knowledge management then supports further exploitation of the project's results and outputs as well as a lasting library of materials for replication.

What to avoid (and how)

- **Dependence on mass communication:** Through careful monitoring of Dissemination, Exploitation and Communication activities throughout the project, unfortunately it was shown that mass communication activities did not lead to participant acquisition for the Support Facilities:
    - **Website traffic** fell short of expectations, with 14.540 visits compared to the target of 20.000, highlighting difficulties in acquiring an online audience for this specific audience, despite measures taken to ensure search engine optimisation on the project website.
    - **Growth on social media** platforms LinkedIn and X/Twitter was also slower than anticipated, with follower counts not meeting project goals, reflecting not only the difficulty of building a new, strong digital presence within a limited timeframe, but also disconnect of social media reaching the project's energy sector stakeholders.
- **How to overcome dependence:** While mass communications lacked the depth of impact achieved by the more targeted approaches of Tactic 2 and 3, digital promotional campaigns and media work can contribute to overall awareness of the project and its offerings such as the Support Facilities/Trainings, fostering legitimacy and brand recognition. Such awareness building, while it does not directly garner participant/user acquisition, has the potential to build a strong base for targeted dissemination and knowledge sharing to be more successful.

Going Forward

The lessons learnt from the ActionHeat project's communication tactics provide important insights for future European energy initiatives/projects. The success of targeted dissemination underscores the importance of personalised, stakeholder-focused outreach through conducting training workshops, participating in external events, and collaborations with established networks and contacts. Similarly, the strong performance of knowledge sharing highlights the value of high-quality capacity-building materials in fostering audience engagement and exploitation/replication of results. Moving forward, mass communication efforts should be used strategically to garner overall project awareness and legitimacy but not relied on for reaching and acquiring new audiences for similar energy initiatives.

8 Outlook

As part of the revised Energy Efficiency Directive, heating and cooling planning is increasingly establishing its role within municipal planning structures. Numerous studies have developed and presented case studies, instruments, and workflows that highlight best practices. A key next step at the political level is the effective implementation of the EED requirements into the national laws of member states.

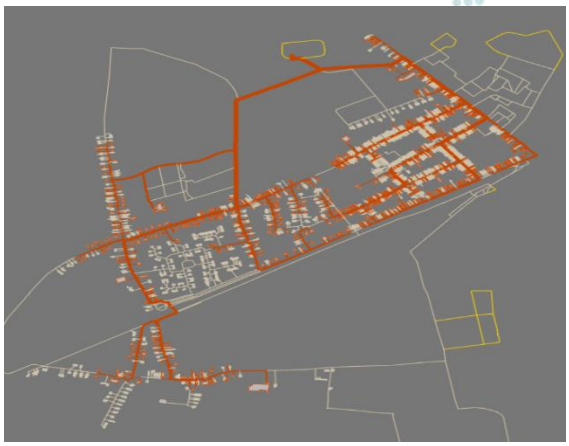
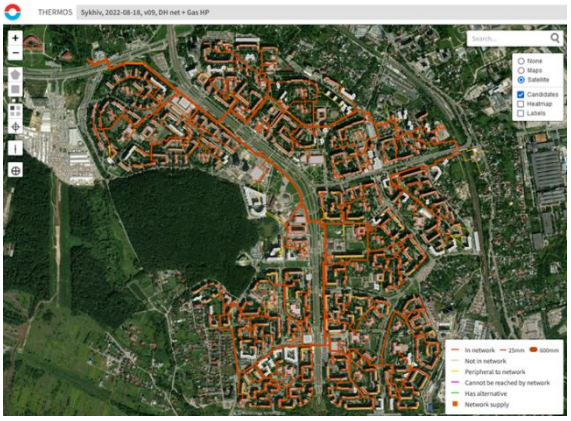
In the future, emphasis will shift towards the actual implementation of the measures outlined in the H&C plans. Ensuring adequate political framework conditions, particularly sufficient funding, will be crucial for success. This necessitates a commitment from local authorities and stakeholders to prioritize H&C planning within their agendas.

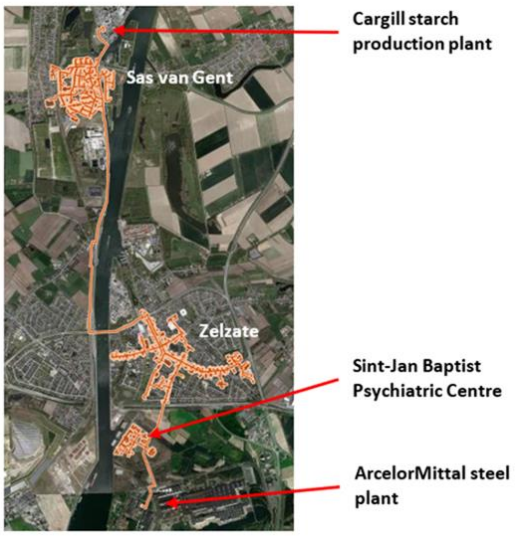
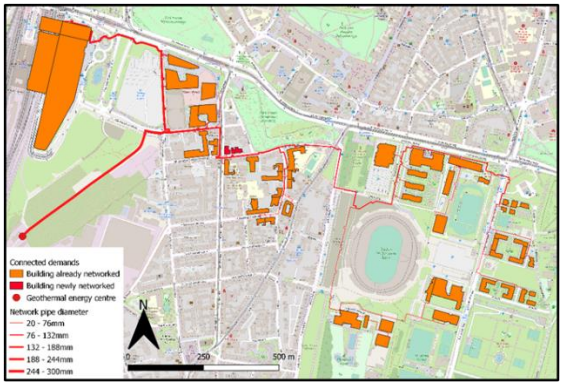
To support this, the workflow architecture presented in Act!onHeat incorporates monitoring and feedback loops designed to assess the feasibility of implementing measures and determine if plans require adjustments. This raises important questions about how monitoring information can be systematically collected and utilized at a higher political-strategic level. Continuous improvement of H&C planning practices is essential; regional, provincial or local energy agencies could play a vital role as aggregators, facilitating collaboration and knowledge sharing among municipalities.

Moreover, providing feedback to policymakers regarding the effectiveness of the regulatory framework will be critical. Key inquiries include: Do the instruments work as intended? Are there desired effects? Where do regulations fall short, where might they be redundant, and what political measures might be necessary to enhance overall effectiveness?

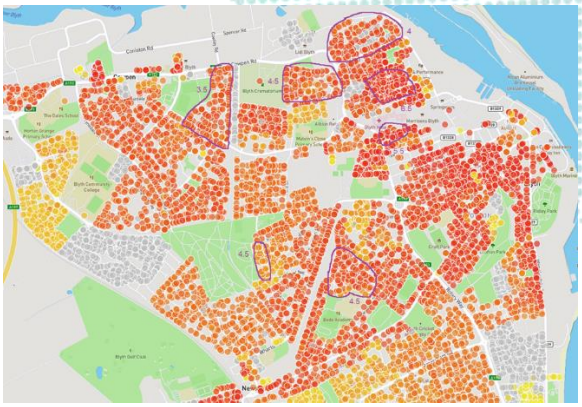
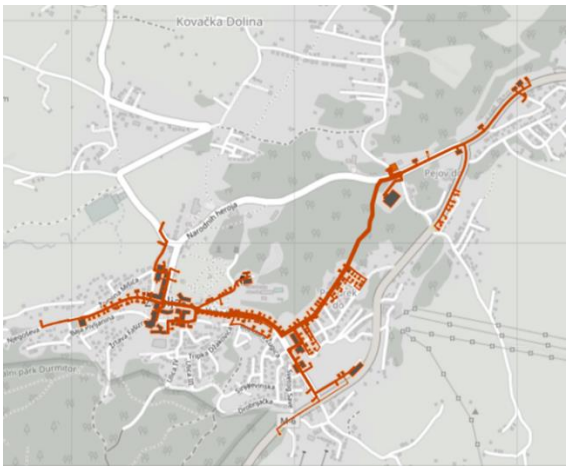
Finally, it is important to recognize that our understanding and structuring of H&C planning are significantly influenced by Denmark's successful experiences, particularly in the realm of district heating. However, it remains to be seen to what extent the approaches and tools developed can be effectively adapted and transferred to other EU member states with diverse conditions, needs, and regulatory frameworks. By focusing on these elements, we can ensure that H&C planning evolves into a robust mechanism for driving sustainable energy transitions across Europe.

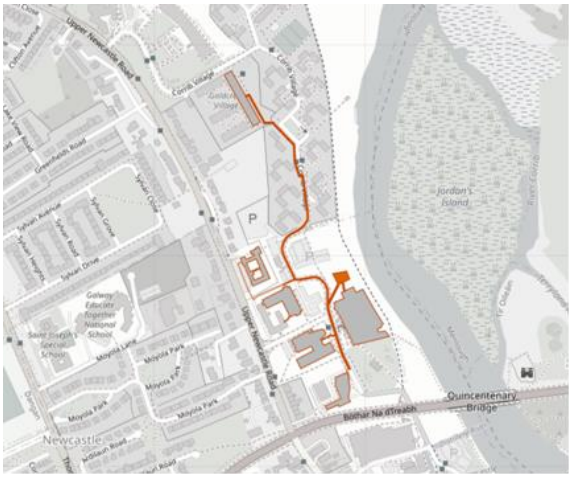
9 Annex 1: Summary of SF2 prefeasibility studies

Sint Niklaas: support provided on a study looking at options for heat networks in the town Sint Niklaas, Belgium. Council staff and third parties were trained on THERMOS and various scenarios were modelled. There were found to be uncertainties on the availability of heat sources and the province intended to explore this in more detail within other districts to develop a heat district policy paper. Opposite: modelled network scenario example, sourcing heat from a water treatment plant.	
Bludenz: support provided to the Vorarlberg Energy Agency on a study looking into the feasibility of establishing a heat network in a social housing development in the town of Bludenz within the region of Vorarlberg, Austria. Participant staff were trained on THERMOS who then modelled various scenarios exploring heat networks in comparison to individual building retrofit measures. The participant intended to use the outcomes to model similar studies throughout the region. Opposite: modelled network scenario example, providing networked heat to social housing	
Lviv: support provided to AEE - Institute for Sustainable Technologies on a study to familiarise participant staff with the workflow and capabilities of the THERMOS tool and determine its applicability for modernising the heat network in the city of Lviv, Ukraine. Modelling of options resulted in identified potential for large scale heat pumps to integrate with the existing heat network. Opposite: modelled network scenario example, sourcing heat from large scale water source heat pump	

Zelzate: support provided on a study looking at extending the existing heat network proposals in the town of Zelzate, Belgium, involving use of heat from a steelworks to include a link to Zelzate Centre and potentially to Sas van Gent in the Netherlands. Council staff were trained on THERMOS and intended to consider the study findings and share with stakeholders, to build a case for further detailed analysis. Opposite: modelled network scenario example, sourcing heat from steel plant and starch production plant	
Poznań: support provided on a study on identifying options for extending and decarbonising the existing heat network in the city of Poznań, Poland using existing and new innovative energy sources. Renewable energy technologies were found to have potential to support both existing and new networks and council staff intended to undertake further analysis with their subcontractor Veolia to develop a strategy going forwards. Opposite: modelled network scenario example, network in south of city using geothermal energy to supply existing network	
Vilnius: support provided to AB Vilniaus Silumos Tinklai to explore options to extend an existing heat network in Vilnius, Lithuania to serve additional existing and new buildings. Participants received training on THERMOS and modelling was jointly undertaken to consider new decarbonised heat sources including CHP and waste heat, and to assess the impact on heat prices of extending the network. Cooling demands were also considered for a possible cooling network. The participant intended to continue the analysis carrying out repeat modelling with more detailed energy demand data. Opposite: modelled network scenario example, cooling network for comparison to existing feasibility study	

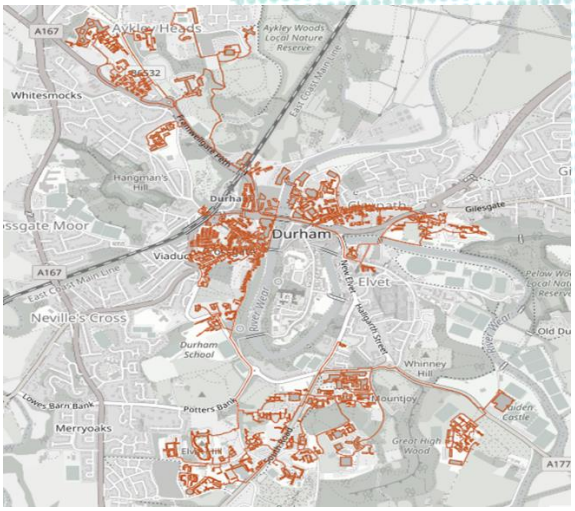
Neuried: support provided to the Municipality of Neuried, Germany on a study to familiarise participant staff with the workflow and capabilities of the THERMOS tool and to assess the investments for the installation of a district heating network in a pre-defined area. Following the study, council staff continued with an options appraisal, focusing on heat sources. The council subsequently began more detailed feasibility analysis to develop the network investigated. Opposite: modelled network scenario example, exploratory network serving 34 buildings with technology-neutral heat source	
Frankfurt (Oder): support provided to Stadtwerke Frankfurt (Oder) GmbH to familiarise the representatives of the local utilities company with the workflow and capabilities of the THERMOS tool and to assess the investments for the installation of a district heating network in a pre-defined area, including the modelling of existing pipework infrastructure. Following an exploration of several scenarios, the participant intended to further investigate possible heat sources, including large scale heat pumps. Opposite: modelled network scenario example, exploratory network serving 46 buildings with technology-neutral heat source	
Skopje: support provided to the Macedonian Academy of Arts and Sciences (MANU) to explore options to evaluate renewable energy as a heat source for the current heat network in the Municipality of Gjorce Petrov in the city of Skopje and to remodel the network to improve efficiency and possible expansion of the system. The participant intended to review the modelled options to assess their potential integration into future strategic plans for the city. Opposite: modelled network scenario example, exploratory network serving 180 buildings with large scale heat pumps	

Blyth and Cramlington: support provided to Carbon Alternatives to assist with THERMOS familiarisation, data acquisition and scenario development for studies in the towns of Blyth and Cramlington, UK. A potential heat source was identified from a nearby coal mine water treatment plant and complex network supply scenarios were modelled by sampling multiple areas of similar housing types to understand which housing areas present the most economic heat opportunities for heat networks. Next steps were uncertain as study was not finalised during the period of Act!onHeat support. Opposite: map showing areas sampled with THERMOS to assess maximum heat sales price (p/kWh) to enable economically viable heat network	
North-West Croatia: support provided to North-West Croatia Regional Energy Agency (REGEA) to gain familiarity with the THERMOS tool for possible future uses within areas identified as having potential for heat networks. An example case study was developed using the city of Zagreb and the participant subsequently intended to identify a suitable location to implement full THERMOS analysis. Opposite: map showing location of case study area in Zagreb	
Žabljak: support provided to the Municipality of Žabljak, Montenegro to carry out a comparison of the results provided by the THERMOS tool with a prefeasibility study done by EBRD. This included an evaluation of renewable energy potential for the current heating network and options to remodel to improve efficiency and potential expansion. The participant intended to review the modelled options to assess their potential integration into future strategic plans for the town. Opposite: modelled network scenario example, assuming heat sources from biomass boiler and large-scale air source heat pump	

Kakanj: support provided to the Municipality of Kakanj, Bosnia and Herzegovina in modelling geothermal heat sources to supply the existing network. This involved modelling the Kakanj network to supply a residential area using THERMOS and undertaking economic calculations in relation to tariffs. Subsequent outcomes suggested the geothermal reservoir has the potential to support the heat network and so the participant intended to present the findings to the mayor, stakeholders, team members and decision-makers within the municipality. Opposite: modelled network scenario example, re-modelling of existing network, serving 242 buildings with known geothermal heat source	
Sečovce: support provided to MH Teplárenský holding a.s., a state-owned heat supplier, to provide familiarity with the THERMOS tool and to explore the potential for decarbonisation of heat supplies to existing networks in the town of Sečovce, Slovakia. The study involved modelling the existing network to test new heat supply refit options (including biomass boiler and cogeneration/CHP), and network extension options. The participant intended to continue experimenting with THERMOS and present a case study at a future heat network conference in Slovakia. Opposite: modelled network scenario example, re-modelling of existing network to compare THERMOS outputs with real-world network	
Galway University Campus: support provided to the University of Galway, Ireland to provide familiarity with the THERMOS tool in identifying options for extending and decarbonising the campus heat network using existing and new innovative energy sources, and factoring in building retrofit measures. Further analysis using THERMOS will be used to support national funding applications for a detailed feasibility stage. Opposite: modelled network scenario example, optimised network and supply, assuming mix of air source heat pump, biomass boiler and gas boiler heat sources	

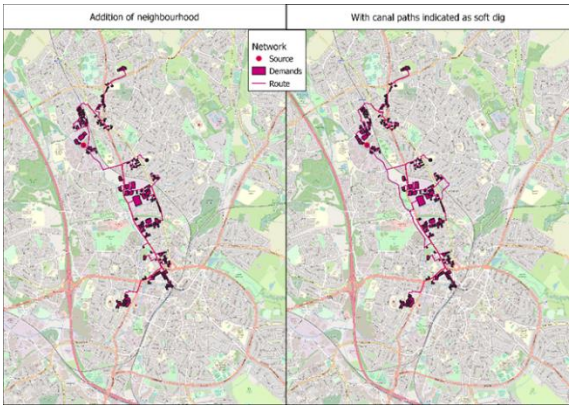
Durham: support provided to Durham County Council, UK to provide familiarity with the THERMOS tool and to undertake a heat network potential study on Durham City Centre, including an assessment of gas and electric heating counterfactuals at a high level. The Council expect to use THERMOS to support wider heat network planning when heat network zoning is introduced nationally in 2025.

Opposite: modelled network scenario example, optimised city centre network



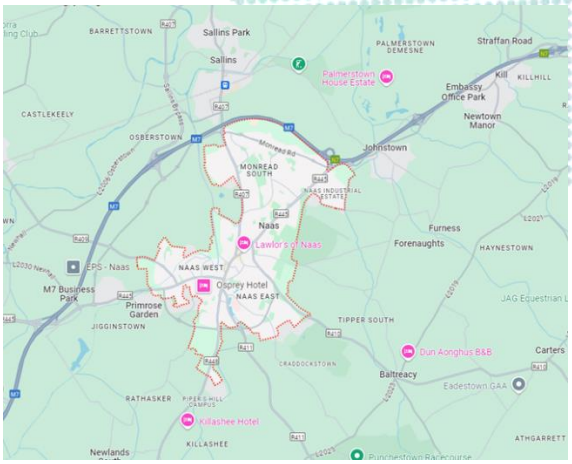
West Midlands Combined Authority: support provided to the West Midland Combined Authority, UK to provide familiarity with the THERMOS tool and to compare results to an existing study on the proposed Walsall-Bloxwich network, exploring additional scenarios for connections and/or heat sources as appropriate. Further work involved using a case study to consider how heat network plans and planning data can be integrated into local whole systems energy planning tools. The Authority is likely to continue to work with THERMOS to understand better how they may take on responsibilities as a Heat Network Zone coordinator, once heat network zoning is introduced nationally in 2025.

Opposite: modelled network scenario example, comparison of previous network study findings with THERMOS including additional modelled neighbourhood



Bishop's Castle: support provided to Carbon Alternatives in undertaking a heat network study on the town of Bishop's Castle on behalf of Shropshire Council in the UK. Support included improving the participant's understanding of data handling and GDPR agreements in relation to data collection and use with THERMOS. It is likely that the findings will justify a more detailed feasibility analysis to develop the network investigated.

Opposite: modelled network scenario example, exploratory network serving ~600 buildings with technology-neutral heat source

County Kildare: support provided to Codema (Dublin's Energy Agency) to provide familiarity with the THERMOS tool and to use the town of Naas in County Kildare, Ireland as a study location to illustrate a typical workflow. Codema intended to share findings across the four local authorities and other stakeholders served by the agency. Opposite: map showing location of study area	

Project acronym	**Act!onHeat**
Ga no	101033706
Full title	Empowering Municipalities for a Sustainable Future Insights from the Act!onHeat Project on Effective H&C Planning Final report (D1.6) of the act!on heat project
WP, Deliverable #	1.6
Version	1
Dissemination level	Public
Deliverable lead	Fraunhofer ISI
Authors	Ali Aydemir, Markus Fritz, Anna Billerbeck (Fraunhofer ISI) Marcus Hummel, Andrea-Frank Stocker (e-think), Aadit Malla (TU Wien) Martin Holley (CSE) Luis Díez García-Valdecasas (Creara) Boris Valach, Vlad Surdea-Hernea (eclareon) Julen Imana Sobrino and Jennifer Cote (ICLEI)
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About Act!onHeat

Heating and cooling (H&C) accounts for about half of Europe's total energy needs with 75% still dependent on fossil fuels. Thus, rapid and significant change is needed to reach the EU 2050 goals.

Due to the local nature of H&C systems, action has to be taken at local level involving a variety of stakeholders. This has been recognised in recent years and activities have been started like developing best practice policies and open source analysis tools. However, (efficient) H&C planning and project development are still not commonplace in most European municipalities.

Act!onHeat enabled and accelerated local Heating & Cooling transitions by:

- identifying success factors of effective energy plans, turning them into practical workflows;
- developing individual and group support activities to guide municipalities, local planners and stakeholder in applying these workflows;
- facilitating finance and the design of effective heat & cooling projects and policy frameworks

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