Improving the performance of District Heating Systems in Central and Eastern Europe

Outline of a Sustainable Adoption Roadmap

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Imprint

This paper is based on the full technical report (D6.7 Sustainable Adoption Roadmap), found under the Policy Recommendations section of KeepWarm's Learning Centre.

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1. The purpose of this Roadmap

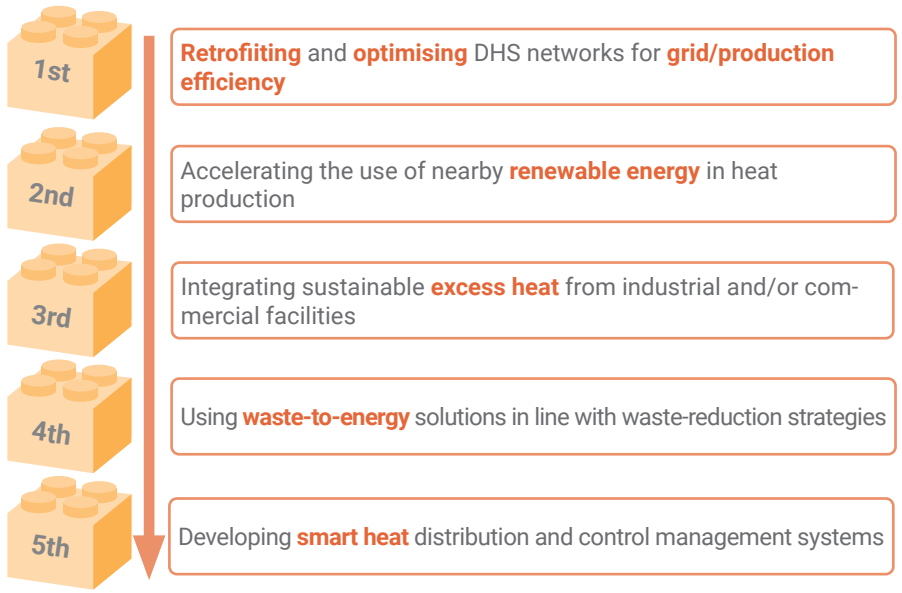
Comparing the various forms of delivered energy, there is none as substantial as heating in terms of energy consumption, not to mention its market-ready potential for both decarbonisation and efficiency. Today, **heating accounts for roughly half of the energy consumed in the European Union** (EU), while district heating (DH) alone serves 120 million customers across the EU with fundamental energy needs and comfort. Despite many key measures already being readily deployable on the ground, heat is still expected to account for the **largest share of demand in a climate-neutral Europe in 2050**.

The EU is now significantly focusing its efforts towards fulfilling its vision of a more sustainable energy system by 2050 and on the ambition to create the world's first carbon neutral continent. This is a challenge, as well as an opportunity, for the DH industry and local communities to contribute from the bottom up to national and EU goals. Though transforming the sector and maintaining its relevance within a rapidly changing energy market could prove challenging, it is also an ideal opportunity to establish more diverse partnerships for energy supply and demand. It also represents a chance to deploy new technologies to develop modern and efficient heat-providing solutions, and thereby foster sustainable energy practices across the community.

Though many existing district heating systems (DHS) play a crucial role in covering energy needs, many of them also require significant modernisation to be able to continue serving this purpose in an efficient and sustainable way during the next decades. Based on intense work with 95 DHS operators across seven countries in Central and Eastern Europe (CEE), the **KeepWarm project has identified and proven numerous benefits gained from strategic DHS modernisation**, as well as practical options for a structured approach to implement such improvements. While differences exist as to the magnitude of these factors in various national contexts, the general benefits of modernisation include the following:

- Increased security of heat supply, especially with locally-available supplies;
- Reduction of primary heat consumption and heat production costs;
- Higher energy efficiency of resources used;
- Widespread savings from the reconstruction of a heat distribution network, and even access to new and innovative revenue streams;
- Increased cost-effectiveness, business competitiveness and affordability;
- Reduction of CO_2 and other greenhouse gas (GHG) emissions;
- Balanced energy mix through the replacement of traditional fossil fuels, especially with renewable energy sources (RES);
- Enhances system-wide efficiencies by also integrating sustainably-sourced excess heat sources and/or waste-to-energy solutions;
- Replacement of obsolete equipment improves reliability of services through new DH technologies and more skilled DH employees;
- Stronger retention of existing customers and attractiveness to recruit new clients.

The modernisation of DH systems is an iterative process, which calls for the consideration of **a series of integrated technical steps and priorities**. These steps **reflect also the cost-factor of modernising DHS** and, should therefore be considered by order of importance/urgency when following the guidelines within this Roadmap. It outlines here a methodology which enables DHS operators – in partnership with stakeholders in their local and regional communities in particular – to successfully modernise their own DHS to become more efficient and sustainable following the **hierarchy listed below**.



Generally speaking, energy efficiency gains of the current network, by efficiently retrofitting and optimising heat grid and distribution systems, should be the top priority for exploitation. A higher-grade energy source is suggested after most or all (economically viable) efficiency gains have been achieved.

A phase-out of fossil fuels can best be secured from local RES options – particularly from biomass, solar-thermal and geothermal – possibly in parallel with the re-use of available heat (e.g. sustainably-sourced excess heat from a nearby industry). Waste-to-energy options, ideally when aligned with sustainably-minded waste management strategies, can be a viable choice for some DHSs, while others will find that smarter heat solutions and control management are suitable to address their own needs.

This guide is meant to inspire the owners/operators of diverse types, sizes and development-stages of DHSs to implement similar measures in their own communities. It also aims to stimulate public authorities, policy-makers, investors and other stakeholders to streamline and prioritise DH retrofits by establishing those policies, regulations, funding schemes, etc. needed to facilitate and replicate DH modernisation all across Europe, and not just with the CEE region.

The content found here is based on **KeepWarm's structured approach to DH improvement,** already applied to numerous DHS pilots (and also a set of valuable services which the consortium still offers to those wishing to exploit partners' expertise). It calls for the build-up of local capacity to assess baseline challenges and strategically engage key stakeholders.

By jointly creating a viable business plan, each DHS can successfully mobilise funding to implement concrete projects. Monitoring of on-the-ground (and in-the-air) impact offers real-world guidance on how best to upscale these results, as well as helping to shape new energy policies which enable and further replicate best practices.

KeepWarm approach to DH improvement

Training and capacity buiding
Increase the expertise of specialists working on district heating systems (DHS)

Business model development
Develop viable business plans and improve operations

Attracting funding for uptake
Mobilise funding for bankable pilot projects meeting local needs

Demonstration cases
Exhibit upgraded-DHS **demo cases** replicable all across Europe

Policy inegration
Integrate and prioritise actionable DHS-retrofits into key strategies and plans

Image: Wikimedia / CC

2. Analysis of challenges

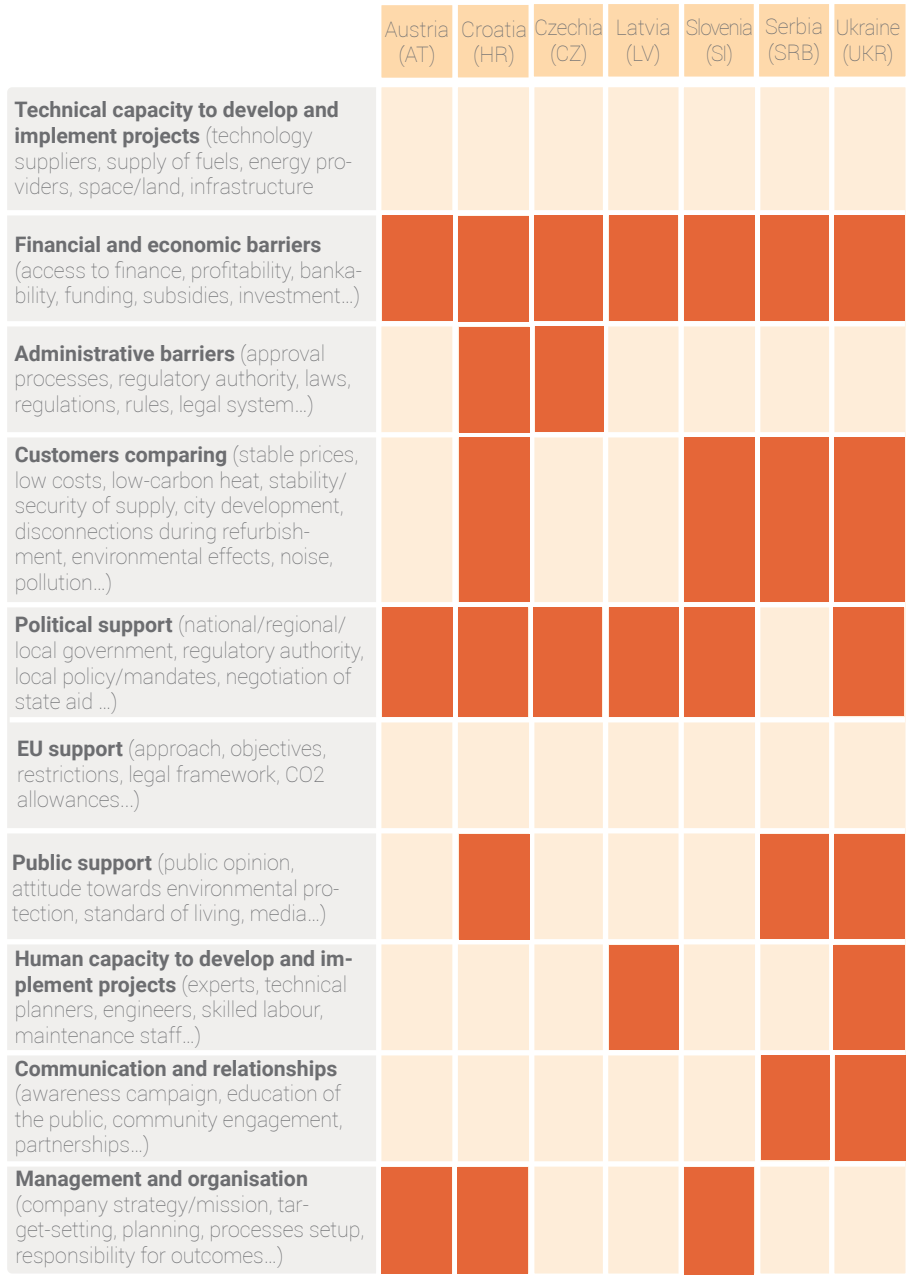
Each country and location has its own specific set of conditions and obstacles it faces, but also **unique opportunities to be exploited** and policies to be adapted. It may seem to be a daunting task to switch from a fossil fuel-based and/or inefficient DHS towards a more sustainably-sourced and efficient system with minimal losses. Moreover, alternative heating solutions (e.g. decentralised/ individual technologies) can sometimes make it difficult for DH to compete. A **tailored analysis of local challenges to DH modernisation** is therefore recommended to better understand the true needs in terms of stakeholder involvement, capacity building and business plan development.

Such an energy transition process depends on the current context of both the country and the local situation. The main challenges for the improvement and decarbonisation of DHSs across many CEE countries, as well as beyond this region, include the following:

- Decreasing DH demand and heat load due to the installation of individual heating applications and more efficient buildings (though DH is increasingly seen as a complementary solution to both of these, rather than conflicting);
- RES technologies can sometimes have higher investment costs upfront than traditional fuels (though lower operating costs);
- The lower network temperatures enabled by RESs not applicable to all older DHSs (though simultaneous retrofits of the DH can correct any mismatch);
- Lack of a national heating strategy, carbon price and legal framework for systematic DH decarbonisation (though strengthening these can accelerate DH retrofits);
- Competition among heating providers can exacerbate any profitability issues for DH (though policy efforts, e.g. obligatory connections to DH, can overcome this);
- DHS staff, as well as other stakeholders like local authorities or the financial sector, are not always aware of current best practices and innovative options (though increased training opportunities can help enhance their competence and uptake).

The following table provides an insight into **areas that significantly limit the DH modernisation process** within KeepWarm's target countries, and thus can support a national or a tailored individual capacity-building programme (such as KeepWarm already initiated and continues to offer) to overcome these challenges. As can be seen below, the surrounding enabling framework, be this financial viability/ access and/or political commitment/ mandates, have considerable impact.

Areas greatly limiting the DH-modernisation process



Likewise, challenges related to customers, public acceptance and organisational/ management can limit DH modernisation. To a lesser degree, administrative issues, capacity needs and communication/ relationships can influence these efforts in certain countries. On the other hand, neither the technical capacity to develop/ implement projects nor EU support seems to play a significant role in constraining DH modernisation efforts in any of the seven countries.

As a general rule, DH is considered most economically viable in areas with higher heat demand density, particularly in cities (one "rule of thumb" is that densities >120 TJ/km² indicate areas where DH absolutely should be used, though lower density values can also prove quite cost-effective, too). Nonetheless, there is an impression that planning support (e.g. software tools, data, methodologies, etc.) are not readily available or not applicable/practical for all countries, which may be demonstrated by an absence of pilot projects.

Another limiting factor regarding the implementation of DHS refurbishment is a combination of high investment costs for large infrastructures (e.g. system-wide improvement or extensions) and a lack of attractive financial instruments or access to funds. Furthermore, the often-low financial performance of DHS operations in some countries, sometimes requiring public intervention to ensure these key services remain, may further curtail DH ambitions.

An analysis of DHSs' regulatory framework in the seven KeepWarm countries shows that even though on a **policy level DH is generally considered as a core infrastructure for heating, many political action plans still lack clear goals. Similarly, oftentimes adopted measures and instruments are not concrete enough to enable a systematic and effective improvement of DH**. Based on the analysis of the seven KeepWarm countries, it is possible to say that:

- Local/regional energy concepts are not as effective as they should be, and that their links with plans from other sectors are insufficiently exploited;
- Local planning tools and data do not seem to really exist (except in LV);
- Tax incentives for DH retrofits are lacking (except in CZ and LV);
- Obligation schemes for energy savings are not in place (except in LV and SI);
- Shares of RES or combined heat and power (CHP) are not required to be in the thermal supply;
- Connection to DHS is not (reasonably) compulsory (except partially in AT and SI);
- A complex process of developing a DHS is often disabled by a lack of knowledge and experience within local government institutions.

To properly streamline the modernisation process **action plans should be created for the retrofitting of the DH sectors**, pointing out and prioritising areas which are insufficiently addressed in these strategies. The KeepWarm project has already developed such multi-level policy plans for several countries (and still offers similar services to those who wish them), which can serve as a valuable orientation into the legal framework for a **systematic decarbonisation of DH networks, the introduction of incentives for heat production from RESs and the increase of energy efficiency** within these systems.


Image: Pxhere / CC

2.1 Risk Mitigation for DH Modernisation

There are several additional risks which should be mitigated in anticipation of DHS modernisation in different contexts, and which the KeepWarm consortium can in fact offer its services. Below explanations of these general risks and mitigation efforts can be found, as well as a few specific to current pandemic conditions, all of which could help keep DHSs resilient to many challenges in the future:

Risk	Mitigation
Low or subsidised prices for oil and gas might currently still reduce economic interest to invest in DHS modernisation	DHS retrofitting should be presented as a **long-term investment and sustainability solution, which has proven its potential to contribute significantly to improving socio-economic and environmental goals**
Though the intense attention given to building refurbishments has justifiable reasons, such a focus might reduce priorities for DH investments.	**Proven economic gains** of investing in DHS can be rolled out on a quicker pace than deep renovation of the entire building stock. It remains important to **integrate DHS modernisation into local and regional energy plans** to ensure a level playing field between different measures contributing to the sustainability and climate goals.
Several countries have heat tariffs for consumers in place and/or publicly-owned utility plants, which often leads to low competitiveness of DH, and thus a lack of incentive for modernisation and less interest from private investors.	**Public-private partnerships** should be explored as an option, since the inefficiency of many existing DHSs means modernisation is the only logical way forward, and investments into energy efficiency can ensure that the **heat price per consumed energy is significantly reduced**.
In certain cases, it is difficult for DHS operators to secure the investments expected to be necessary for modernisation.	It is recommended to maintain **close interaction with national DHS associations, energy agencies, public funds, potential investors** (e.g. the European Investment Bank, EIB, or European Bank for Reconstruction and Development, EBRD) and other experts to ensure that local DH modernisation is supported by national planning processes.

Coping with force majeure

Under **conditions of force majeure such as COVID-19 or earthquakes**, it may prove difficult to attract larger investments, especially since some **DHS operators face problems with default payments from customers (i.e. energy poverty) and/or reduced heat sales due to the economic slowdown**.

As a stopgap measure, DHSs might choose to temporarily shift their financial resources towards the maintenance of key operational activities, though they should also be adequately supported in this (e.g. by their governments) through available support schemes.

The lower economic activity in times of **force majeure also affects banks' and financial institutions' processes**, decreases prices of (competing) fuels and reduces CO2 emissions. This can degrade the relative bankability and attractiveness of DH retrofit projects, thereby negatively affecting support through diminished investments and/or political urgency.

This is yet another valid reason why it remains crucial to establish stronger relationships and **cooperation with banks (for loans) and authorities (for subsidies, as well as co-creating joint strategies)**. Nonetheless, it would be wise to integrate concrete strategies (e.g. material investments instead of or in addition to financial ones) into project management planning which anticipate and mitigate any potential withdrawal of investments.

Pandemic restrictions on groups can also affect DH modernisation efforts by preventing many important physical meetings (e.g. internal decision-making or external consultations with customers, investors, policy-makers or others), as well as possibly constraining DH working conditions in the field and thereby delay, or perhaps even prevent, the timely implementation of maintenance and upgrades.

Familiarity with the **tools for virtual exchanges** (e.g. emails, phone, teleconferences, web-meeting software, etc.) has been proven largely adequate (though not always as satisfactory) replacements for physical meetings and negotiations, while planning for work in the field could account for slowdowns in scheduling, and of course also prioritising the health and safety of workers through suitable precaution.

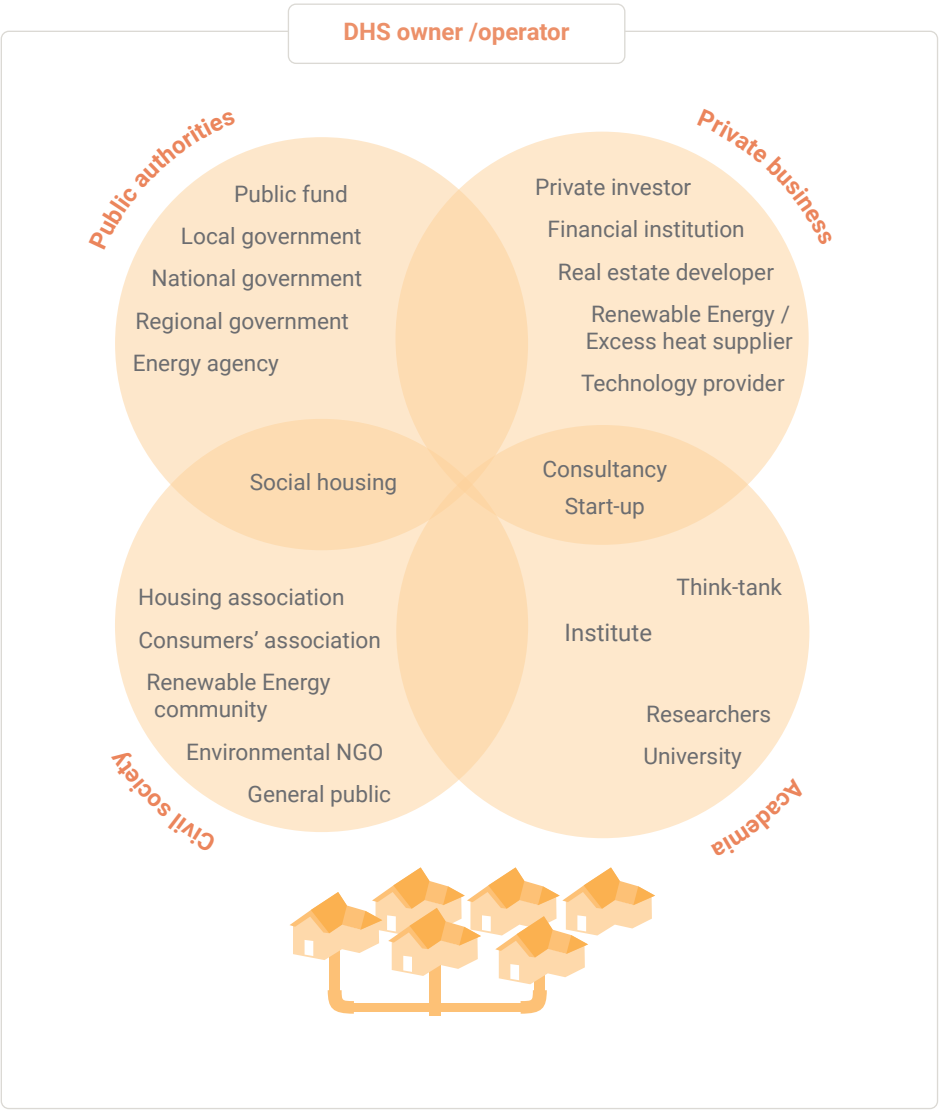
3. Getting the right people together

Although the main drivers in deciding whether to start the transition of the DHS to more sustainable forms of energy are clearly DH operators, they are not alone in this position. The engagement of different, but relevant stakeholders is essential. Actors at local, regional and national level play a significant supporting role in the transition to affordable and sustainable DHS. Ideally, they should all have a seat at the table during discussions. The general profile of the most important stakeholders that should be engaged are:

PUBLIC SECTOR

Local authorities, even if not (co-)owners of the DHS, should **streamline procurement and permit procedures** (including in cases of environmental/cultural protection) and **prioritise sustainable DH within the legal framework and all planning processes** (e.g. within their Sustainable Energy and Climate Action Plans (SECAPs), smart city strategies, circular economy plans, new zoning, business development, etc.), including with dedicated budget lines.

Regional authorities, depending on their mandate within the country, can play a similar role to their local counterparts, by **integrating sustainable DH into their Smart Specialisation Strategies** (i.e. via the approach of a Heat Synergy Region meaning urban and rural areas, which combine their renewable energy potentials and excess heat sources beyond their political boarders) and other development programmes. Additionally, they can use and **capitalise on Structural and/or Just Transition Funds in a strategic manner to finance a sustainable heating**, which is affordable to all.



National authorities should ensure that DH supplied by r**enewables and excess heat in combination with DHS-retrofits are adequately prioritised in all relevant national policies** (i.e. National Energy and Climate Plan, circular economy strategies, etc.) and the national legal framework. Special funds/grants should be set up just for green DH in order to support their contributions to national climate goals.

PRIVATE SECTOR

Banks, financial institutions and other investors should **set up special funding mechanisms/instruments and preferential conditions** (e.g. low-interest rates) and **green-prerequisites** for loan-approval to encourage DH companies' sustainability ambitions, as well as grants for technical assistance to kick-start bankable DH projects and accelerate their transition to more sustainable practices.

Companies supplying renewable energy technologies or enabling the uptake of excess heat should be **pro-active in promoting the synergetic opportunities and (mutual) benefits** they can offer as best solutions to DH companies, while also building the capacities of DHS staff, public authorities, investors and other actors to understand the value of integrating their sustainable solutions.

Real estate owners/developers and construction companies, whether working on individual buildings or whole neighbourhoods, should **integrate technologies and infrastructure** prepared to connect for DHS from the very beginning in order to support connections and expansions of thermal networks.

OTHER RELEVANT STAKEHOLDERS

Energy agencies are often **key advisors and capacity-builders**, not only for DH companies, but also for public authorities (e.g. supporting SECAP development). Therefore, they should be engaged as general expert consultants on DH transitions, as well as liaisons between DH companies and public/private actors.

Researchers, universities, think-tanks and consultancies can fill some of the same roles as energy agencies, but are particularly suited to providing i**n-depth studies with comprehensive data/analyses** (i.e. on local/regional resource availability or cost-benefits) which DHSs rely on for decision-making.

Citizens and civil society should be engaged from the very beginning and included during both the planning as well as the operation phase of the project. By doing so, citizens have the opportunity to voice any concerns regarding ongoing modernisation works and could even become financial investors of the DHS themselves e.g. via an **energy cooperative** which owns the DH infrastructure.

In order to **operationalise the overall process effectively**, it is highly recommended to engage all stakeholders who have a direct and indirect effect on the modernisation of the DHS. While the core of the decision-making process still lies within the DHS operator/owner, it is advisable to establish a working group, which includes at least representatives from the DHS operator, local government as well as possible end consumers.

This working group or **stakeholder alliance should be responsible for the communication, target-setting, prioritisation, implementation and monitoring of the DHS modernisation throughout the entire process**. In some cases, it might be worth considering working with an independent facilitator/discussion leader to ensure that all interests and needs are equally taken into account. The various stages and long-term nature of DHS project development require **strong support and firm relationship among stakeholders**, as well as a determined initiator to mediate the process. **The role of the local municipalities in this context is inevitable**, particularly considering their ambition to reduce GHG emissions and ensure sustainable energy supply of the community.

In case of public support is not yet or not sufficiently available, it is useful to organise ***Inspire Events***, in which DHS owners/operators, DH associations and agencies can reach out to public authorities and other relevant stakeholders to attract interest for thermal projects and stimulate motivation and decision-making. Participants should have the opportunity to network, discuss approaches to overcoming obstacles and share experience with the retrofit process from successful DHSs.

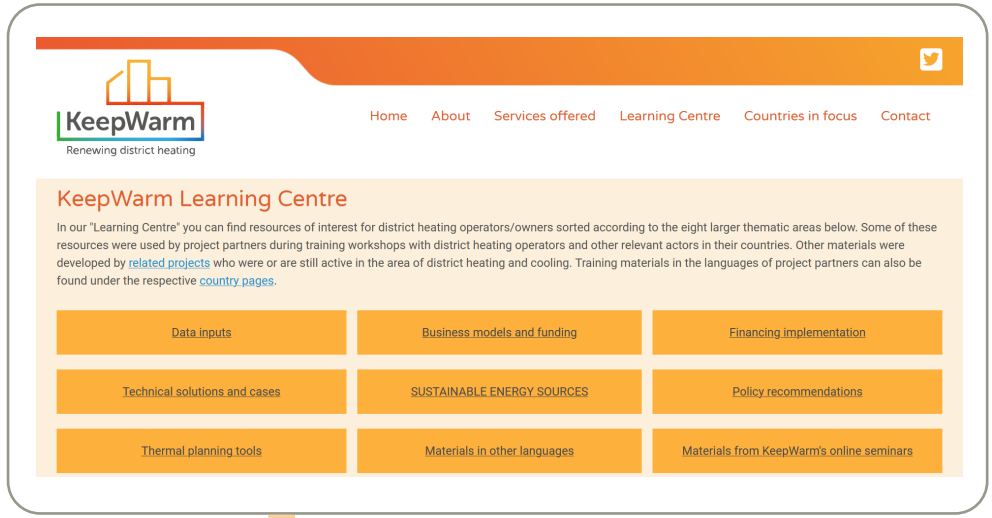
3.1 Capacity building of DHS operators and other stakeholders

Increasing the energy efficiency of the DH systems and reducing their greenhouse gas emissions by promoting a switch from fossil fuels to a feedstock based on renewables is essential for achieving modern and climate-friendly DH systems. However, a **lack of expertise and training affects the sector and hinders swift implementation of modernisation efforts**.

In fact, the EU Strategy on Heating and Cooling acknowledges that "too few professionals have the required expertise in energy efficient construction and in applying efficient and renewable energy technologies" (Brussels, 16.2.2016 COM(2016) 51 final).

This problem occurs particularly in the Eastern European context where, in the last three decades, no significant opportunities to invest in retrofitting or extending DHSs were available. This, indirectly, reduced the demand for the build-up of certain knowledge and expertise.

A very important step in implementing a modern DHS is therefore to focus on **knowledge sharing and capacity building**. Therefore, KeepWarm has analysed and structured some of the most relevant information for DHS modernisation and compiled it in a ***Learning Centre*** **available online** (https://keepwarmeurope.eu/learning-centre/).



The most effective way to share and build knowledge is through tailor-made trainings offered to pre-identified target groups such as public authorities or development and energy agencies. Such trainings should be geared towards increasing specific capacities based around the following topics:

- Capacity development on technical concerns;
- Capacity development on the utilisation of RES, waste and excess heat;
- Organisational capacity development;
- Financial concerns and;
- Managerial concerns

In order to tailor capacity building activities to stakeholders' needs, it recommended to **carry out a needs assessment** (e.g. by conveniently using the respective questionnaire developed by KeepWarm, which can be found in the Learning Centre).

The assessment should focus on the specification of training topics and determine, which are the most interesting ones for the target audience. Furthermore, it can serve to discover any preferences regarding the type, timing, organisation of said training measures and can inquire about the type of staff and their level of expertise that shall participate in the trainings. Following this, a **training plan** should be established outlining the sequence and type of capacity building events envisaged and when they will take place.


Image: ZREA

Image: LWK Steiermark

It is also very important that training experts have significant **work experience in specific areas as well as communication skills**, so that high quality and in-depth content can be brought across. The practical knowledge also allows reflecting on barriers and challenges concretely and enables learning from good practice. **Study visits** as well as hands-on working sessions can meaningfully complement the learning process. Sufficient attention should also be paid to facilitating **networking** with other DHS operators and other relevant stakeholders e.g. government representatives, energy agencies or companies in the energy sector, as this has proven to assist in the modernisation of DHSs.

The **training materials**, which were used during KeepWarm's capacity building activities, are accessible in the **Learning Centre** and can serve as inspiration and provide many examples and analyses.

4. Developing business plans and attracting investment

Having increased the overall capacity of DHS operators in the previous step, attention should now be given to developing an effective and feasible business plan that is able to attract investments/loans. An efficient DHC system should be economically viable, providing stable and resilient supplies, high-quality services with medium to long-term adaptability at low CO2-levels and affordable prices for the end-users.

It is recommended to start with a feasibility study based on the local context, within which, the following aspects are to be assessed:

- Current state of the DHS;
- Current technical state of resources and networks;
- Availability and potential for the use of renewable energy sources and excess heat;
- Economic situation;
- Investment opportunities;
- Energy market, supply and demand.

THERMOS

THERMOS features include:

- A network optimisation model to optimise supply for identifying a cost-optimal (or near-optimal) network design by allowing users to e.g. take into account energy output or cost over time through varying demand profiles and different tariffs;
- OpenStreetMap for quick and easy map creation and analysis or the possibility to upload own GIS data;
- Heat and cold map creation tool;
- Demand estimation method operating with limited data inputs in any location;
- Representation of variable pipe and dig costs (by pipe diameter), and network heat losses to the ground;
- Incorporation of capital costs for plant, pipes and connection, set against revenues from heat sales and monetised emissions;
- Interoperability with GIS formats, for model results and heat map export;
- Nearly comprehensive documentation of data requirements and model operation.

www.thermos-project.eu

Building on this information it is highly recommended to use the web-based software called THERMOS designed to optimise local district energy network planning processes and results according to user and project specific requirements such as budget, climate and energy targets. Free to use software built with and for local energy planners. THERMOS places instant address-level mapping and built-in energy demand estimations within immediate reach.

Once having obtained further information about the feasibility of the project, completing the **business model canvas** has been proven to be useful to lay out the business model for an economically-sound DHS. As can be seen below, it is a **mapping exercise**, which lays down the key partners and key activities to be carried out during the modernisation process. From the beginning, it needs to be clear what the value proposition is for both costumers and investors. This needs to be created on the background of any eco-social benefits or costs the modernisation process might have. This will make it easier to identify the right type of customers and to establish solid customer relationships. It is necessary to lay down the key resources (both financial and physical) in relation with overall costs and revenue streams.

District Heating – Sustainable Business Model Canvas

Key Partners
- Who are the owners?
- Who are the key partners?
- Who are the key suppliers of fuel and technical equipment?
- Who are partners in funding and consulting?
- Which key activities do the partners perform?

Key Activities
- Which key activities are necessary for the project?
- Which planning, construction, legal and financial activities are necesary?
- How can the activities be adjusted to ensure sustainability?

Value Propositions
- Which value to you deliver to customers?
- Which customers are served?
- Which environmental, social, etc. problems are solved?
- What are the customer, social, environmental, etc. advantages compared to individual heating systems?

Customer Relationships
- Which value to you deliver to customers?
- What types of relationship are established with each of the customers?
- Which type of contracts / agre ments are made with customers?
- How can the customers be integrated into the DH project?
- How to co-create value together with customers?

Key Activities
- Who are your customers (private households, public buildings, industries, etc.)?
- Who are the most important customers?
- Who are potential new customers?

Key Resources
- Which key resources are necessary for the project?
- Which financial resources are necessary?
- Which physical resources are necessary (e.g. new boilers)?
- Which human resources are necessary?
- Are sustainable resources used (e.g. renewables and/or excess heat)?

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Channels
- Through which channels does each customer segment want to be reached?
- How are the customers reached now?
- How are the channels integrated into the business model?

Cost Structure
- What are the most important costs inherent to the business model and DH project?
- Which key resources are most expensive?
- Which key activities are most expensive?
- What are the investment costs of the DH project?
- What are annual costs of operation?
- Are there additional costs for sustainable / renewable solutions?

Revenue Streams
- For what do customers pay (e.g. base price, metering price, heat price, connection fee, etc.)?
- Are there subsidies or other types of income with the DH project?
- Are the customers willing to pay a premium for more sustainable services / renewable heat?
- Can a unique advantage be created through sustainable / renewable elements?

Eco-Social Costs
- Which ecological or social costs is the business model causing?
- Which key resources are non-renewable?
- Which key activities use many resources?
- Which emissions are caused during operation of the DHS?
- Which emissions are caused short term during construction activities?
- How is the society affected by those emissions and activities?

Eco-Social Benefits
- Which ecological or social benefits is the business model generating?
- Who are the beneficiaries, and are they potential customers?
- Is the new business model causing primary energy savings?
- Which key resources are renewable or otherwise more sustainable?
- Which key resources are sourced locally?
- Is the business model generating added local value (e.g. new jobs, less pollution, etc.)?

Click here for a stand-alone document of higher resolution or a 100%-view version

5. Impact Monitoring and Upscaling

Once the above steps have been realised and a solid business plan established, investments mobilised and the project implemented, it is recommended to set an interval for **impact monitoring of the modernisation process**. The KeepWarm project has defined several indicators for this purpose. The following section provides an overview of these indicators as well as a short explanation and guidance on how these impacts can be assessed in order to allow an **evaluation for the upscaling of effective measures**.

Baseline for the expected improvements are contextual targets (e.g. climate change mitigation, air quality, energy poverty etc.), feasibility studies and the related business plans and financial returns of investments. KeepWarm has covered some of these indicators. Their exact calculations (incl. examples) can be found in the KeepWarm Learning Centre.

Primary energy savings
This indicator has two sub-components:

1. Improvements of the efficiency of the system and parts of the DHS;

2. Combined primary energy savings triggered by the project in its system.

In both cases, energy efficiency measures will occur in different areas: improvements to the plant or the grid, better organisational management or improved consumption by the end-consumer. The exact ratio of energy inputs versus heat consumption can only be measured by the end of the project implementation.

Increased share of renewables
Based on the feasibility studies and business plan, taking also Emission Trading Allowances into account, it is expected that the improvements/new installations will allow the DH system to switch partly or even fully to a renewable-energy-based heat generation.

Reduction of greenhouse gas emissions
GHG reduction is due to efficiency gains, switching from fossil fuels to RES, use of excess heat or due to a switch from less intense fuels. A combination may lead to at least a 15-50% reduction of GHG emissions, which can be calculated from the expected primary energy savings and RES production that replaces heat generation using fossil fuels.


Image: Flickr / CC

6. Final recommendations and outlook

Every pilot or regular DH system should be analysed according to its own specifics of efficiency and the most appropriate choice of RES. **KeepWarm suggests the adoption of a sustainable roadmap for the technical assessment and implementation**: First, energy efficiency gains of the current network shall be exploited, e.g. retrofitting of internal heat distribution systems (grid or distribution efficiency).

When most or all (economically viable) efficiency gains are obtained, an improved energy source is recommended. Heat re-use (for instance excess heat from industry) should be looked at, while considering in parallel the replacement of fossil fuels with renewable energy sources, e.g. use of local renewable (particularly biomass, geothermal and solar-thermal). Waste-to-energy options can follow as well as deploying smart heat distribution and control management systems .

Having understood the diverse opportunities for each sustainable energy component as a source for district heating, it is possible to realise their distinct advantages over traditional fossil fuels. Since any option of efficiency, RES and excess heat can offer an alternative in most cases, it then becomes a question of choosing the most feasible combination.

- **Reflect on the current and future needs of the DH company** to see which of these renewable energy and excess heat options have the technical capacity and resource supply-availability to match the local heating demand in the long-run.

- If a DHS is one of the older networks (steam), **first prioritise modernising DH boilers, insulating pipes and reducing other losses** to make the system as efficient and low carbon as possible. Even so, retrofitting DHS is the ideal moment to simultaneously implement additional measures, there might not be sufficient resources available to do so. In any case, applying the efficiency first principal will ensure that the DHS is fully prepared to integrate the highest possible share of sustainable energies thereafter.

- **Make a gradual switch to RES and/or excess heat sources. Avoid a needless swap from one fossil fuel to another such as from coal to gas. As Europe has confirmed its ambition to be climate neutral by 2050**, natural gas is likely not a “bridge technology” for DH anymore that pays off investments in time.

- **Analyse the full potential of all local and regional renewable resources** at your disposal, be it biomass fuel supplies, solar irradiance, geothermal temperature gradients, heat pump

sources or nearby industrial/ commercial excess heat facilities.

- **Build Heat Synergy Regions** meaning urban and rural areas, which combine their renewable energy potentials and excess heat sources beyond their political boarders in order to optimise and create the most sustainable and low-carbon infrastructure.

- Be aware that there is **no need to rely just on a single energy source** – most of these alternative energies work excellently in combination. Thus map out (literally and figuratively) the RES and excess heat possibilities available across the region in order to identify the most economic and synergetic combination of sustainable energy options for matching the regional DH demand.

- **Accelerate the development of new and larger networks by supporting small-scale and micro DH systems**, assisting and cooperating with diverse, local groups like energy cooperative to allow the DHC market to grow.

- **Enable new DH systems faster** by using the pre-feasibility software THERMOS to identify cost-optimal networks.

- **Establish a local coordinating working group** to support for DHS development across a range of national to local programmes and in partnership with as much stakeholders as possible.

This publication summarised the results of the analysis of the baseline conditions and stakeholders of each participating country, the barriers that district heating sector has to face, opportunities for improvement in the modernisation process, critical risks, their impacts and possible solutions to mitigate or eliminate them.

Dedicated national DHC strategies supported by improved **regulation should assign DH the leading role it deserves in supplying sustainable heat in urban areas**. Particularly, local authorities play a major role in facilitating the development of DHS by integrating them into **spatial development plans** and mediating communication between stakeholders from a broader societal perspective. Relevant skills and knowledge among decision-makers should be strengthened in order to adequately promote and raise awareness on DH (co-)benefits.

From the technical point of view DH systems have one of the distinct advantages that other heating solutions do not have - the possibility to integrate different (local) energy sources, especially RES and excess heat. Due to the large-scale and long-term investments, it is necessary to **develop targeted financial mechanisms and business models**, which will support stable development of the DHS. Public and EU funding is inevitable to accelerate renovations.

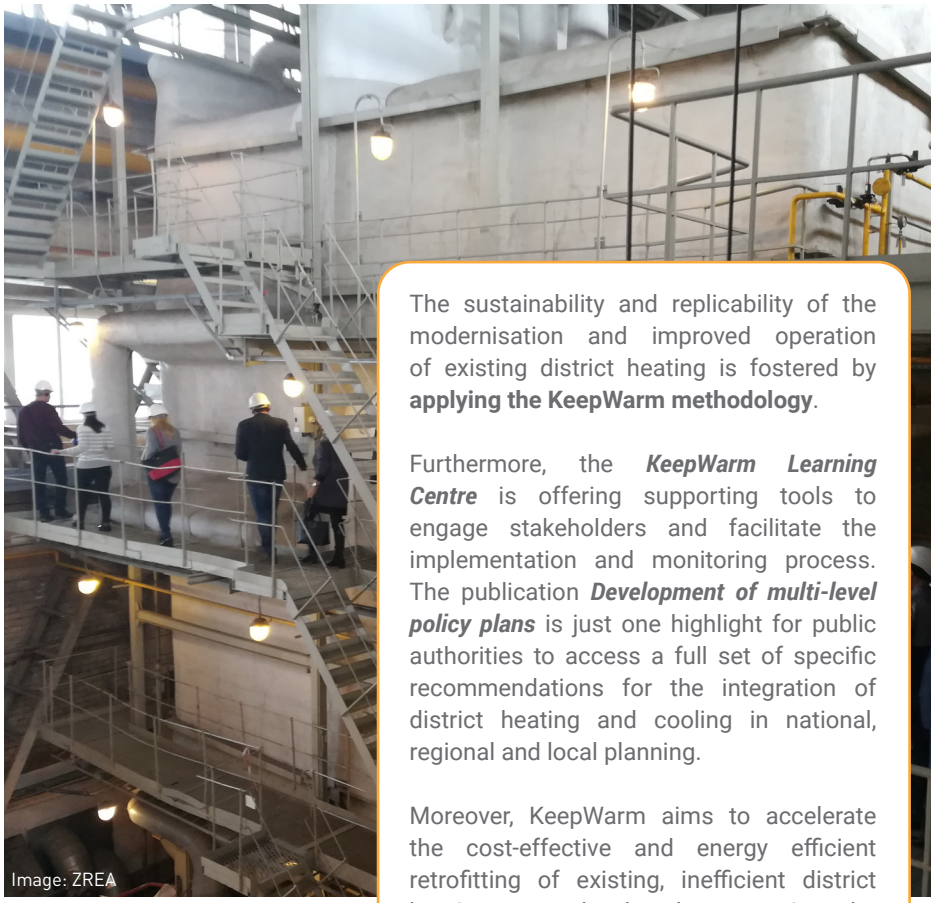


Image: ZREA

The sustainability and replicability of the modernisation and improved operation of existing district heating is fostered by **applying the KeepWarm methodology**.

Furthermore, the ***KeepWarm Learning Centre*** is offering supporting tools to engage stakeholders and facilitate the implementation and monitoring process. The publication ***Development of multi-level policy plans*** is just one highlight for public authorities to access a full set of specific recommendations for the integration of district heating and cooling in national, regional and local planning.

Moreover, KeepWarm aims to accelerate the cost-effective and energy efficient retrofitting of existing, inefficient district heating networks by demonstrating the impact and change in almost one hundred DHS across CEE in a ***virtual showroom***. Knowledge, best practises and experience from these use cases are now available for the benefit of the entire stakeholder community in the field of DHS.

Summary of the project

The project *KeepWarm - Improving the performance of district heating systems in Eastern Europe* is funded under the EU Horizon 2020 programme. Its objective is to accelerate cost-effective investments in the modernisation of District Heating Systems in Central and Eastern Europe (CEE). KeepWarm is most active in seven countries: Austria (AT), Croatia (CRO), Czech Republic (CZ), Latvia (LV), Serbia (SRB), Slovenia (SI) and Ukraine (UKR). The project focuses on this region, and these particular countries, because in most cases DHSs are frequently still inefficient and for the most part overly reliant on fossil fuels (especially gas, coal or oil).

The aim of this initiative, launched in April 2018, is to modernise DHSs around the whole region in a more sustainable manner. By improving system operations and promoting a switch to less-polluting sources, like renewable energy sources, KeepWarm contributes to reducing greenhouse gas emissions. The eleven project partners strive to ensure that best practices for environmentally-friendlier heating and cooling will be taken up across Europe, replicating KeepWarm's approach in other countries and regions, even beyond the end of the project in December 2020.

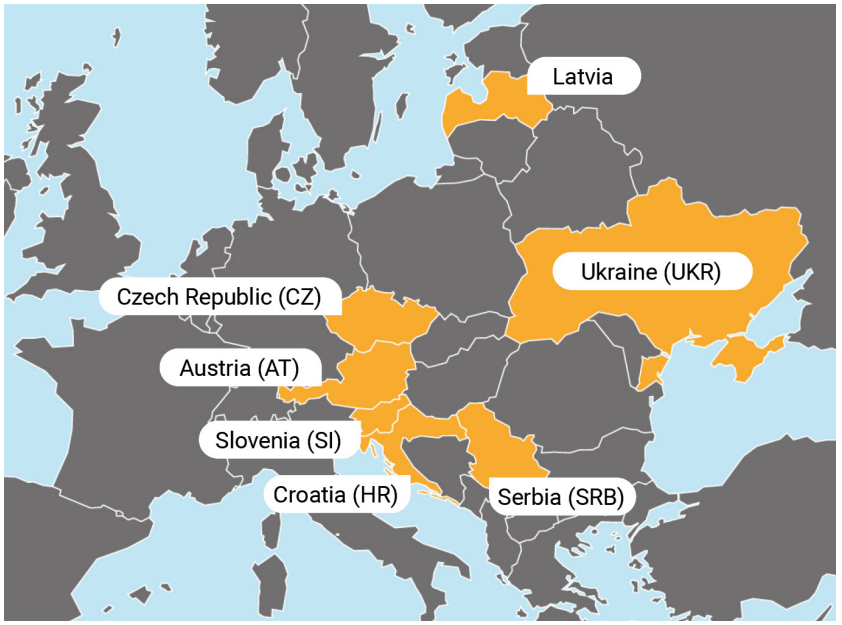
Project objectives

KeepWarm's specific objectives that were achieved:

- At least 450 relevant stakeholders with increased capacities on technical, organisational, financial and managerial aspects – includes 150 DHS operators;
- At least 95 DHS operators are able to develop business plans and to identify the most suitable financial model for modernisation of their own DHS;
- At least 23 business plans for the modernisation of DHSs have been developed and sources for investment have been identified;
- DHS network retrofitting is addressed in at least 10 local energy plans and 7 regional or national strategies or plans;
- At least 23,300 relevant stakeholders (directly) and 125,000 (indirectly) reached across Europe in order to replicate the project outputs in primary and secondary target regions and ensure the project's impact;
- Support EU policies and initiatives, such as the Covenant of Mayors

List of abbreviations

CEE	Central and Eastern Europe
CHP	Combined Heat and Power
CO2	Carbon Dioxide
DH(S)	District Heating (System)
DHC	District Heating and Cooling
EU	European Union
GHG	Greenhouse Gas
RES	Renewable Energy Source(s)
SECAP	Sustainable Energy and Climate Action Plan



KeepWarm - the seven most active countries

KeepWarm

Renewing district heating

www.KeepWarmEurope.eu

@KeepWarm_Project

Project partners

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FSB University of Zagreb Faculty of Mechanical Engineering and Naval Architecture

REGEA Regionalna energetska agencija North-West Croatia / Sjeverozapadne Hrvatske Regional Energy Agency

lk Landwirtschaftskammer Steiermark

Jožef Stefan Institute, Ljubljana, Slovenia Energy Efficiency Centre

KSSENA

TEPLÁRENSKÉ SDRUŽENÍ České republiky

KT-ENERGY

VINČA Institute of Nuclear Sciences University of Belgrade National Institute of the Republic of Serbia

ZREA Zemaklės regionalė energetikos agentūra

ICLEI Local Governments for Sustainability Europe

In support of

Covenant of Mayors for Climate & Energy

www.eumayors.eu

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DHC+ Technology Platform

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