Interreg Danube Region

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REHEATEAST

Scoping pilot locations / stakeholders / technologies

Deliverable 2.2.1

The document includes input from partners

Pannon European Grouping Of Territorial Cooperation

NFFKÜ International Fund Development and Coordination Agency

Energy Institute Hrvoje Požar

Technical University of Cluj-Napoca

Local Energy Agency Pomurje

European Grouping of Territorial Cooperation Via Carpatia

Standing Conference of Towns and Municipalities

Jožef Stefan Institute

Resource Aarhus Center in Bosnia and Herzegovina

Center for Energy Efficiency Eneffect

ABE Balkan for Innovation in Europe Ltd.

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Project partners in project REHEATEAST

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PP2: NFFKÜ International Fund Development and Coordination Agency (HU)

PP3: Energy Institute Hrvoje Požar (HR)

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Content

Executive summary

The REHEATEAST project aims to mitigate fossil energy consumption in district heating and cooling systems while promoting the integration of renewable energy and waste heat. By fostering multi-stakeholder collaboration and cross-sectoral partnerships, the project seeks to develop, test, and disseminate feasible solutions for large-scale building and system rehabilitation programs and climate adaptation measures in the Eastern Danube Region.

With the Scoping pilot locations/stakeholders/technologies, we wanted to present selected and, therefore, most suitable approaches to optimization of district heating and cooling systems in one place. Optimizing district heating and cooling (DHC) systems involves improving efficiency, sustainability, and cost-effectiveness. By adopting different strategies and approaches and leveraging modern technologies, district heating and cooling systems can be made more efficient, sustainable, and adaptable to future energy needs.

In general, approaches can be classified into different sets of measures, as shown below:

A. Advanced Control Systems
- Dynamic Control: Use predictive and adaptive control algorithms that respond to real-time data, weather forecasts, and demand fluctuations.
- IoT and Smart Sensors: Deploy IoT-enabled sensors to monitor temperature, pressure, and flow rates in real-time.
- Demand Response: Implement systems that can adjust supply based on demand, reducing energy wastage during low-demand periods.

B. Energy Source Optimization
- Renewable Integration: Incorporate renewable energy sources like geothermal, biomass, solar thermal, and waste heat recovery.
- Combined Heat and Power (CHP): Use CHP systems to generate electricity and simultaneously utilize waste heat for heating.
- Seasonal Energy Storage: Use technologies such as thermal energy storage (TES) to manage seasonal variations in demand.

C. Network Design and Retrofitting
- Hydraulic Balancing: Ensure balanced flow in the network to minimize energy losses.
- Pipe Insulation: Use advanced insulation materials to reduce heat losses during transmission.
- Decentralized Systems: Incorporate decentralised heating and cooling units closer to end-users to reduce distribution losses.

D. Data-Driven Optimization
- Energy Management Systems (EMS): Implement software platforms that analyse consumption data for performance optimization.
- Digital Twins: Create virtual models of the DHC system to simulate scenarios and identify improvement opportunities.

- AI and Machine Learning: Use AI to predict demand patterns and optimize operational strategies.

E. Regulatory and Economic Measures
   - Dynamic Pricing Models: Introduce time-of-use pricing to encourage consumers to reduce peak demand.
   - Incentives for Efficiency: Provide subsidies or tax benefits for adopting energy-efficient technologies in DHC systems.
   - Regulatory Standards: Ensure compliance with energy efficiency and emission reduction standards.

F. End-User Engagement
   - Energy-Efficient Buildings: Promote retrofitting buildings with better insulation and smart thermostats.
   - Consumer Awareness: Educate users on how to minimize energy consumption and take advantage of pricing incentives.
   - Interactive Platforms: Users can monitor and control their energy usage via mobile apps.

G. Innovation in Cooling Technologies
   - Absorption Chillers: Use waste heat or solar energy for cooling instead of electricity.
   - District Cooling with Chilled Water: Enhance the efficiency of centralized cooling systems using advanced refrigerants and storage.
   - Free Cooling: Use naturally cool water sources like lakes or rivers to meet cooling demands without active refrigeration.

H. Lifecycle and Environmental Considerations
   - Lifecycle Assessment (LCA): Conduct LCA to identify energy inefficiencies and environmental impacts at every stage.
   - Carbon Neutrality Goals: Transition towards low-carbon or carbon-neutral energy sources in DHC systems.
   - Circular Economy: Reuse waste materials and integrate recycled components into system infrastructure.

In the sense of specific objective: Encouraging multi-stakeholder, cross-sectoral public-private cooperation for DHC optimisation, we want to develop and testing of solutions addressing the most important common supply and demand side challenges.

Pilot actions will namely aim at demonstrating cost-effective solutions that can contribute to certain key goals, such as enhancing:

- multi-stakeholder collaboration,
- transnational cooperation
- uptake up/roll-out of durable and transferable project results.

In the next step of activities implementation, project partners will form two thematic workgroups, exploring transnationally relevant topics applicable for demand and supply side optimisation and cooperation models as well:

- financing schemes,
- digital energy performance analytics.

Pilots will continue to be organized and monitored in two groups:

- **Demand-side** – This group, referred to as the Demand-Side Community Lab for DHC, focuses on testing and optimizing energy management strategies on the consumer side. It integrates community engagement, advanced technologies, and innovative policies to enhance energy efficiency, reduce peak loads, and improve the sustainability of DHC networks.

Deliverable name	The main topics of deliverable	PP
Transnational demand-side community lab pilot 1	Testing stakeholder-inclusive process for introducing: consumption based DHC billing and comprehensive heat regulation - highlighting policy; digitalisation & financing options; citizen & municipal engagement via schools and interactive online content;	UTCLUJ EIHP 1 SCTM
Transnational demand-side community lab pilot 2	Testing stakeholder-inclusive process preparing neighbourhood level deep retrofit of multi-apartment buildings: participative planning; citizen engagement; financial planning; digital transferability tools using standardised analytical & visualisation solutions; policy discussion.	IDEFA SCTM ENEFFECT

- **Supply-side** - This group focuses on supply-side optimization interventions within DHC systems, aiming to improve energy production and distribution efficiency, reliability, and sustainability. These interventions target heat and cooling sources, infrastructure for energy supply, and network management systems.

Deliverable name	The main topics of deliverable	PP
Transnational supply-side optimisation pilot 1	Testing DH (heating) optimisation planning process: explore renewable (especially geothermal) and waste-heat, ambient heat utilisation, heat storage and digitalisation options and EU/DTP best practices in high-efficiency DH systems; in-depth analysis of their applicability/feasibility.	EIHP 2 AC-BiH PANNON LEAPOM
Transnational supply-side optimisation pilot 2	Testing applicability options of non-fossil DHC optimisation, including nature-based (cooling) solutions: exploring & showcasing best practices; analysis of various sustainability options; awareness raising among professional and civil stakeholders; linkages with other policy areas.	VIACARP

1. Introduction

The REHEATEAST project aims to reduce DHC systems' fossil energy demand by decreasing energy waste (in buildings and DHC networks) and integrating renewable energy (with a special emphasis on geothermal) and waste heat. It encourages multi-stakeholder, cross-sectoral, public-private cooperation and develops, tests, promotes and distributes applicable (process, technical and nature-based) solutions. The project also strives to drive the transition of DHC systems to reduced temperature levels which will enable the integration of local renewable energy sources (RES) to a larger extent.

The overall objective of REHEATEAST is to find and promote measures and widely adaptable solutions to the financial and environmental sustainability challenges of DHC systems in the Danube Region.

The activities leading to the development of this document have focused on identifying the most effective and feasible approaches for DHC system optimisation through pilot actions. The first step in this process is the DHC optimisation models within Activity 2.1. The models provide a structured framework of possible solutions that can be applied to improve DHC systems, both within and beyond the REHEATEST region. In the context of this report, these models have been tailored to the specific pilot concepts developed by project partners, ensuring their applicability to real-world conditions. This report identifies the best use cases for these models, selecting approaches and realistic, feasible examples that will be tested as pilot actions in REHEATEAST countries.

During the activities, project partners will also form two thematic workgroups, exploring transnationally relevant topics applicable for demand and supply side optimisation and cooperation models as well on financing schemes and digital energy performance analytics. Besides being equally relevant, the topics are also interrelated as the lack of appropriate energy performance analysis and energy management is a key barrier to financing, according to several prior projects and studies.

Two online co-working sessions will be implemented for experts in the future as part of the project and with connection to the pilots:

1. Focused on various financing schemes for building and DHC system renovation, it aims to increase the feasibility of demand—and supply-side pilots and facilitate replicability on a national and possibly Danube-region level. The workgroup's findings will be summarised in a document that partners will present to decision-makers as a lobbying tool, further supporting the pilots' sustainability and policy uptake.
2. focused on performance analysis, significantly enhancing communication & visibility for energy performance in buildings & DHC systems. Aiming to support and develop effective communication and visibility tools to translate energy performance analysis into actionable insights for stakeholders. .

Pilot themes have been selected to address key challenges in REHEATEAST countries:

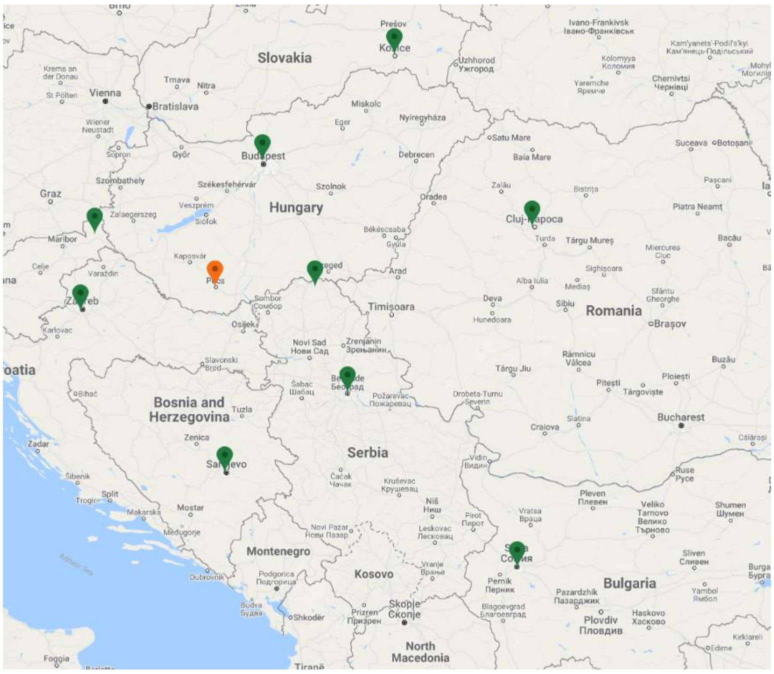
- Technical modernisation for substantial energy and cost savings
- Comprehensive heat metering and heat regulation
- Citizen engagement for energy efficiency and attracting new users
- Awareness raising among civil stakeholders and decision-makers.

2. Detailed pilot action concept description by countries

This section provides descriptions of key segments from each of the ten pilots to be conducted in different countries by the responsible partners:

1. Pilot 1 in Hungary – LP PANNON
2. Pilot 2 in Hungary – PP2 IDEFA
3. Pilot 1 in Croatia – PP3 EIHP
4. Pilot 2 in Croatia – PP3 EIHP
5. Pilot in Romania – PP4 UTCLUJ
6. Pilot in Slovenia – PP5 LEAPOM
7. Pilot in Slovakia – PP6 VIACARP
8. Pilot in Serbia – PP7 SCTM
9. Pilot in Bosnia and Herzegovina – PP9 AC-BIH
10. Pilot in Bulgaria – PP10 ENEFFECT

Figure 1: Locations of pilot actions within the Danube Region Programme area[1]



[1] Source: https://keep.eu/projects/29496/Building-local-partnerships-EN/

2.1. Pilot 1 in Hungary

2.1.1. Problem definition, key challenges addressed

The central heating units in the buildings of the Faculty of Humanities and the Faculty of Science at the University of Pécs (PTE)are ageing. These two faculties serve around 3000 students and 200 staff members. From an energy efficiency perspective, it has been identified that current hot water heating system used during the winter season is outdated and consumed a significant amount of energy. Consequently, an efficient solution is being explored to reduce this high energy demand and the associated costs.

The main objective of the optimisation is to reduce the cost of the current heating system, improving energy efficiency. This process involves careful sizing of pumps, their selection and installation. The optimisation and sizing of technical equipment will take into account the dimensions of the network piping and the limitations of the electrical network.

2.1.2. Pilot type, optimization and cooperation perspectives

During this supply-side optimisation Pilot Programme, we will identify which of the 8 heating centres in the two faculties are critical for the modernisation of the main technical units. We make a condition assessment of the critical technical units and parameterise the new equipment required. After the purchase and installation, we measure (both energy and heat data) a complete heating period. The resulting data will be compared with existing historical data, which is expected to show significant energy savings. The University of Pécs and the PÉTÁV (district heating service company) are cooperating partners.

The participants of the pilot will work closely together to assess the technical situation, identify critical intervention points and plan the optimal technical and cost-effective implementation. The participating partners will delegate experts to the pilot. Following the evaluation of the factual data, brainstorming will be carried out to identify optimisation opportunities. The ideal, most efficient implementation will then be selected. The delegated experts will collaborate in the implementation of all phases of the pilot.

2.1.3. Detailed description of the pilot action concept

The Pilot Programme will be conducted at the Faculty of Humanities and the Faculty of Natural Sciences at the University of Pécs. These buildings are served by eight boiler houses, from which the most energy-critical units will be selected for the pilot. Technical engineers and experts from PÉTÁV (the DH service provider) and the University of Pécs Directorate of Operations will participate in the survey and implementation of the pilot programme. The technical survey will examine the current condition and technical characteristics of the existing equipment. This includes analysing the original technical specifications, operational curves, and any deviations that may have developed. Once the sites and equipment have been selected, we will identify the necessary new technical equipment and units, proceed with their procurement, and their installation. Additionally, a methodology will be developed to measure the energy efficiency and thermal performance of the newly installed equipment.

Videos of the location:

- Botanical Garden: https://zoldegyetem.pte.hu/sites/zoldegyetem.pte.hu/files/dron_felvetelek/Botanikus_kert.mp4
- The whole building complex: https://zoldegyetem.pte.hu/sites/zoldegyetem.pte.hu/files/dron_felvetelek/Dron_BTK_TTKcc.mp4

Figure 2: The buildings of the Faculty of Humanities and the Faculty of Science at the University of Pécs (PTE)

Existing and newly considered technical equipment: list of pumps across buildings

Installation location (building)	Existing pumps	Planned new pumps
Buildings F, G, H, D, C, and the Botanical Garden	Type: Wilo DPn 100/200-3/4-G4B (twin configuration); Installation Length: 55 cm; Quantity: 2 units Pumps operate in pairs, with one serving as a backup for the other	Type: Wilo Stratos GIGA 2.0-I 100/1-17/2.2; Part Number: 2204766; Quantity: 1 unit; Net price: 1.260.674 HUF
Building A, Block D	Type 1: Yonos Maxo 40/0.5-12; Installation length: 25 cm; Quantity: 1 unit Type 2: Wilo P40/160R; Installation length: 32 cm; Quantity: 1 unit Pumps are paired, with one acting as a reserve for the other.	Type: Wilo Stratos MAXO 40/0.5-12 PN6/10; Part Number: 2164584; Quantity: 1 unit; Net price: 463,462 HUF
Building A, Block E	Type 1: Wilo Top S 50/7; Installation length: 28 cm; Quantity: 1 unit Type 2: Wilo P50/160R; Installation length: 34 cm; Quantity: 1 unit Pumps are paired, with one acting as a reserve for the other.	Type: Wilo Stratos MAXO 50/0.5-12 PN6/10; Part Number: 2164589; Quantity: 1 unit; Net price: 598,791 HUF
Hot Water Circulation	Type: IPL50/130-0.37/4; Installation length: 34 cm; Quantity: 2 units	Type: Wilo Stratos MAXO Z 50/0.5-9 PN6/10; Quantity: 1 unit; Net price: 655,620 HUF

All existing pumps are installed in duplicate, providing a "hot" backup for each unit. Under normal operation, only one pump in each pair is active at a time. Replacing all pumps is not necessary; upgrading one pump per pair with a modern unit will be sufficient. Total gross price of the planned new pumps amounts to 3.782.755 HUF (9.230 EUR) (= 2.978.547 HUF nett price + 1.27% VAT; 1 EUR = 410 HUF; 05/12/2024)

2.1.4. Impact of the pilot action

The primary impact of the pilot action is primarily focused on energy savings, which can be achieved by reducing energy consumption. The exact amount of savings and district heat used will be determined through precise measurements conducted during the pilot project. The measurement methodology is based on comparing baseline data with data measured after intervention. The crucial factor in the success of this methodology is the ability to measure a complete heating cycle in order to ensure the success of the comparative methodology. The success of the pilot will be measured and quantifiable, demonstrable cost and energy savings as a result of the intervention.

2.1.5. Key steps of implementation

1. Preparation: This phase involves a survey of the target buildings and their technical installations. The buildings and equipment selected for modernisation are identified. Moreover, the type, performance and other technical specifications of the new equipment required are determined.

2. Implementation: This phase begins with measuring and establishing baseline energy and heat consumption values for the selected technical equipment following the survey. Once these benchmarks are determined, the necessary new equipment is procured and installed. Following installation, a test run is conducted to ensure proper functionality and integration. At the beginning of the heating period, the system transitions into live operation, during which continuous control measurements are carried out to monitor performance and validate the effectiveness of the intervention.

3. Monitoring: Throughout the heating period, energy and cooling data will be continuously recorded and compared with historical and baseline data, as well as the operating curves of previous installations. At the end of the heating period and pilot programme, the collected data will be analysed and summarised. By monitoring performance, we expect to confirm energy savings. Based on preliminary calculations, the expected level of savings could reach up to 15% on average per year.

2.1.6. Roles and responsibilities

Several REHEATEAST ASPs are actively contributing to this pilot project.

The University of Pécs (ASP7) plays a key role with multiple departments involved. The Chancellery Directorate of Operations and Procurement takes care of technical implementation, data collection, and the installation of new equipment. The Chancellery International Pre and Post Award Management Department coordinates and administers activities at the pilot site. The Faculty of Sciences and the Faculty of Humanities and Social Sciences will provide the premises for the pilot project.

PÉTÁV (ASP12), the DH company of Pécs, will provide advisory support, supervise of the project, and participate in pilot coordination.

The technical supplier, Gienger Hungaria Kft, will contribute their expertise to ensure the successful implementation of the pilot.

2.1.7. Ownership

The equipment will be procured by Pannon EGTC through a standard procurement procedure within the applicable value limit. Ownership of devices (pumps) will remain with Pannon EGTC, while their operation will be managed by PTE at the PTE locations mentioned above. The arrangement will be formalised through a contractual legal agreement, ensuring the proper installation of the devices at the PTE site. The University of Pécs participating in the pilot will provide the buildings of the intervention points as the owner. Pannon EGTC will be the owner of the pumps to be purchased.

2.1.8. Stakeholder involvement

The **heat supplier**, PÉTÁV (ASP12), will participate in an advisory and supervision role throughout the entire implementation process, from initiation to completion.

As the **technical supplier** and based on the experience with the current pump inventory on the pilot site, the Wilo pump family has been selected. According to its technical specifications, it offers the highest efficiency within the given technical environment.

The University of Pécs (ASP7) is involved as the **end-user**, with multiple departments contributing to the pilot. Their specific roles are outlined in Chapter 2.1.6.

The cooperation process:

- Stakeholders set up a group of experts
- The expert group identifies the critical energy and intervention potential points.
- The expert group will identify the optimal new technical solutions at the intervention points.
- The expert group will collect and measure the initial technical data
- The technical equipment selected for implementation is purchased and then installed
- The expert group carries out the first test run
- The expert team will install the implemented technical equipment and start collecting measurement data.
- By the end of the pilot, the expert group will aggregate and evaluate the data and publish the results.

2.1.9. Communication and awareness-raising actions

At this stage of pilot developments, these actions are currently under discussion and in the planning phase. At least one, but preferably all three of the following options, will be implemented.

- Universitas TV, the official television channel of the University, will record key stages of the pilot action and produce a short video-report covering the entire pilot project.
- The final results will be published on the Green University webpage at https://zoldegyetem.pte.hu/.
- The Newsletter of the International Project Funding Department, distributed among students and faculty members, will feature a report on the pilot's outcomes.

The pilot action will also be shared via the webpage and social media channels of Pannon EGTC, as well as the official webpage and social media platforms of the REHEATEAST project.

2.1.10. Sustainability and transferability of the pilot actions

The installed pumps are designed to support the heating and hot water systems of the building complex for approximately 20 years. Since the buildings serve a diverse community of students, researchers, educators, and staff, the outcomes of this initiative will benefit a wide range of societal groups. The results, documented through pilot action protocols and case studies, will be adaptable for application in both clinical and educational buildings.

The technological documentation for the project will be developed collaboratively by PTE and PÉTÁV, with expert contributions from Pannon EGTC. To ensure the long-term sustainability of the pilot initiative, PTE will assume operational responsibility beyond the project's official duration. The anticipated electricity and heat savings during the pilot phase reinforce the value of maintaining these improvements over the long term. With an expected equipment lifespan of 10–20 years, the pilot action is to deliver significant and enduring benefits. Annual energy and cost savings are expected to reach 15% yearly as a result of the pilot of the previous obsolete devices.

The results are also intended for adaptation in other thermal centres, with potential for further advancements, such as the integration of digital remote monitoring to enhance efficiency. Dissemination through professional events and collaborations with PTE will facilitate the transfer of the results to broader regions and target groups.

2.1.11. Risk management

Several low-risk factors have been identified, along with proactive mitigation strategies. On potential challenge is delivery delays, which could cause a substantial phase of the pilot project to commence later than planned. To prevent this, we will select the equipment that is readily available on the market, featuring standardized technical specifications rather than unique or highly specialized components. Another low-risk factor is technical vis major, which may arise if the selected heat centre is found to be unsuitable for implementation. In such case, an alternative site will be selected from the four other heat centres. Additionally, there is the possibility that PTE may face technical difficulties preventing them to perform the initial or final measurements. To mitigate this risk, PÉTÁV will be actively involved in the implementation, providing their knowledge and necessary equipment to support the pilot as an ASP in case of unforeseen technical issues.

Moderate-risk factors include unusually mild winter weather, which could lead to insufficient data collection during the initial or final measurements. To address this, we plan to monitor a full heating cycle and use exponential scaling when comparing mild winter months with baseline data to estimate savings figures. Additionally, there is the risk of exchange rate fluctuations. To mitigate this, we are requesting quotes that remain valid until the start of implementation, marking the physical start of the pilot action.

2.2. Pilot 2 in Hungary

2.2.1. Problem definition, key challenges addressed

The pilot primarily targets the analysis and development of stakeholder cooperation models for building energy efficiency, neighbourhood retrofits, considering the technical requirements of building and related network retrofits as well.

Stakeholder cooperation has been identified as the main barrier to successful neighbourhood (building) retrofits that are referred to in the motto of the REHEATEAST project. Relevant stakeholders have different and conflicting interests and attitudes and there are major communications issues. Therefore, proper neighbourhood-level building retrofits are very rare. In Hungary, the only example is in Kaposvár, where roughly 50% decrease in (specific) heat consumption could be achieved, similar to transnational examples such as Bucharest.

2.2.2. Pilot type, optimization and cooperation perspectives

This is a demand-side pilot focusing on apartment buildings, primarily in the "Óbuda" part of District III in Budapest. District III has one of the highest district heating penetrations rates in Hungary. The pilot will analyse past experience (e.g. "Village House" EU Concerto project), the status quo, barriers and opportunities for cooperation among stakeholders, such as apartment owners, the municipality, the district heating company, civil associations, technology suppliers and financiers.

2.2.3. Detailed description of the pilot action concept

The pilot examines the conditions of energy efficiency-type intervention options related to final consumer buildings within the scope of REHEATEAST's "collaboration of interested parties".

Analysis aims to encourage residential consumers to cooperate in energy efficiency investments and to develop policy proposals for support measures.

The purpose of the analysis is to examine the factors (behavioural patterns, stakeholder relationships, procedures, regulations, communication, etc.) that hinder the energy modernization of residential buildings, and based on these findings, make recommendations to facilitate positive change, such as improvements in subsidies, legal environment, public communication and potential sanctions.

When analysing state subsidies, it will be necessary to examine how the system can be made more efficient with complementary subsidies and incentives.

In cases where several different types of stakeholders will be involved, it will be necessary to consider what level of subsidy intensity should be planned when developing the tender documentation.

The subject of the investigation is the attitude, behaviour and activities of apartment owners in a housing estate in District III, Óbuda, concerning the impact of energy efficiency in buildings served by district heating. In this area, some buildings have been subject to deep renovation such as the "Faluház", a complex with 886 apartments in the size of a village, renovated under the EU Concerto (program) Staccato project. There are also apartment buildings where no renovations have been carried out in recent decades. In such apartments, they cannot control the heating or ventilation. They maintain a suitable temperature by simply opening the windows.

2.2.4. Impact of the pilot action

The primary method of estimating the potential impact is "potential savings through reduced energy consumption", based on the current situation and possible future developments.

2.2.5. Key steps of implementation

Key steps of implementation include the analysis of the status quo (energy efficiency of the relevant apartment buildings, review of actions implemented so far, evaluation of the social, regulatory and policy environment), conducting surveys, engaging stakeholders, facilitating communications, concept development (exploring how residential energy awareness and energy efficiency actions could be stimulated through policy, good communications and other measures, especially concerning the cooperation among various types of stakeholders) and gathering feedback from the stakeholders before finalizing recommendations.

The analysis will be based on secondary and primary market research, including consultation with local stakeholders - district heating service providers, residents, apartment owners, civil association, potential energy efficiency upgrade contractors, financiers, apartment building managers and the municipalities of the District III.

The goal is to devise methods that can facilitate cooperation and information exchange among various stakeholders who often have different and sometimes conflicting interests and attitudes. The findings will serve as a foundation for developing well-informed proposals, and international best practices will be taken into account.

Among the social groups of homeowners, it is necessary to at least analyse the behavioural patterns and possible incentives for two key groups: retirees (who live on fixed income) and investors who own rental properties (but do not reside in them).

2.2.6. Roles and responsibilities

Various stakeholders include NFFKÜ (REHEATEAST partner), the Municipality of District III., civil association in District III, BKM district heating provider, potential technology suppliers, contractors, apartment building owners, tenants, managers and potential financing provides for building renovations. They are all relevant to analysing neighbourhood retrofit opportunities and barriers. The district heating company has most of the relevant energy and building-related information, building owners make investment decisions, building managers act as "gatekeepers" and influencers in investment decisions, the municipality and civil associations have communication channels that can increase energy awareness and readiness to act, while contractors, technology suppliers and financiers are essential for delivering (supply-side) solutions once there is demand. The regulatory and policy environment, especially pricing, fossil fuel subsidies play a dominant role in the decision-making.

2.2.7. Ownership

Over 90% of the apartments heated by district heating are in private ownership. That will not change because of the pilot.

2.2.8. Stakeholder involvement

Stakeholder groups relevant for neighbourhood retrofits will be involved, such as apartment owners, civil organisation, municipality, district heating provider, technology provider.

Engagement efforts shall use both offline and online tools, capitalising on media channels that reach the target population and events attended by the target population.

2.2.9. Communication and awareness-raising actions

There will be online and offline communication and awareness raising actions primarily using online media and local events targeting the local population.

2.2.10. Sustainability and transferability of the pilot actions

The long-term impact of the pilot action will be ensured by influencing public policies trough sharing findings and recommendations, increasing the awareness of the population, improving communications among various local stakeholders and focusing on communicating the benefits of specific actions to various stakeholders.

2.2.11. Risk management

Since the focus is on stakeholder engagement and communication, the most important potential risks relate to the non-responsiveness of key stakeholders. These risks are mitigated by outreach already made to the municipality and the district heating company, efforts are being made to engage a local civil organisation and the municipality and establish direct, interactive communications with representatives of relevant stakeholders.

2.3. Pilot 1 in Croatia

2.3.1. Problem definition, key challenges addressed

The district heating system in Rijeka's Podmurvice neighbourhood consists of five buildings and faces significant challenges that impact the efficiency and sustainability of heat supply.

While the buildings are older, the system has fully renovated twin-pipe pipelines and a well-functioning gas boiler. However, energy losses remain alarmingly high, reaching 35–40%, far exceeding acceptable levels for this renovated setup.

Another critical issue is the high return temperature, which differs from the supply temperature by as low as 5°C. This narrow temperature difference reduces system performance and increases operational costs due to the strain on system components (e.g. boiler).

To address these issues, critical components of the system require optimisation through the implementation of advanced equipment. These upgrades will enable precise identification and resolution of system inefficiencies.

2.3.2. Pilot type, optimization and cooperation perspectives

This pilot action focuses on the demand side of the DH system in Rijeka's Podmurvice neighbourhood, aiming for digitalisation integration to optimise the heat distribution within the system.

The optimisation framework involves analysing and improving the performance of critical components in the heat distribution system. The pilot will assess the existing infrastructure to identify bottlenecks and inefficiencies, such as heat losses in the pipeline network or suboptimal temperature regulation. Advanced monitoring tools will be implemented to collect real-time data, enabling precise adjustments to the system's operation.

The main objectives of this optimisation are to reduce heat losses, achieve better temperature control within the network and improve efficiency.

2.3.3. Detailed description of the pilot action concept

The pilot system comprises five identical, interconnected buildings in the Podmurvice neighbourhood of Rijeka that operate exclusively during winter, providing space heating without domestic hot water. Two gas-fired boilers with 2.9 MW and 2.25 MW installed capacity provide this heat. Despite being connected to a fully renovated DH network, the system experiences heat losses ranging from 35 to 40%, which is very high and highlights the need for further interventions.

The primary objective of this pilot is to tackle these significant heat losses by digitalising the system, which is crucial for accurately diagnosing the underlying problems and optimising system performance. The proposed plan includes several key steps aimed at optimising the heat distribution. A software tool for hydraulic calculations of heat networks will scan the network and identify inefficiencies. The plan is to further optimise heat distribution by installing remote monitoring on the four buildings' substations, allowing operators to track system performance continuously. Furthermore, remote control will be implemented on one substation, while automated control valves will be installed at three substations. It will enable dynamic regulation and improve efficiency.

By targeting the primary causes of heat losses, this pilot aims to implement practical solutions that will significantly reduce them by deploying appropriate equipment and system optimisation.

2.3.4. Impact of the pilot action

The impact of this pilot will be assessed by evaluating potential energy savings, which will be elaborated in the pilot report.

2.3.5. Key steps of implementation

The pilot project is set to begin in Q1 of 2025, with EIHP and Energo working together to finalize all necessary equipment requirements. EIHP will initiate the public procurement process (if needed) for the planned equipment. The equipment purchase is expected to be completed by the end of Q1, with a potential extension into Q2 if required.

Since the system is non-operational between May and September, the installation of the equipment is planned for this period, covering most of Q2 and Q3. During this time, we will also collect and analyse all available data to establish a baseline for future comparison in the pilot report.

In Q4, the system will become operational with the newly installed equipment, enabling us to measure and analyse new indicators for inclusion in the pilot report.

Finally, during Q1 2026, we plan to complete the pilot report (by the end of February), incorporating all findings and analyses.

2.3.6. Roles and responsibilities

EIHP will lead the pilot report analysis of the proposed pilot concept. Energo, as the DHC system owner and a key participant in concept development, will support EIHP by providing data, managing the installed equipment and providing feedback to enhance this analysis. This cooperation will ensure alignment with technical, regulatory, and budgetary constraints.

2.3.7. Ownership

Will be determined once clarification is received from the Joint Secretariat.

2.3.8. Stakeholder involvement

The stakeholder groups involved in this pilot include Energo, as the DH network operator, potential equipment suppliers and contractors, designers, City of Rijeka, and residents of the buildings in Rijeka selected for this pilot. EIHP and Energo will hold regular meetings to ensure open communication and coordination. Other stakeholders, including the general public, will receive updates on the pilot's progress through media channels.

2.3.9. Communication and awareness-raising actions

The pilot's results and potential replicability will be shared through EIHP's and Energo's communication channels to highlight the success and scalability of the approach. The dissemination will target local and regional stakeholders who may benefit from implementing similar solutions within their DHC networks. Engagement efforts will include offline and online tools, utilising media channels and events that effectively reach the audience. These communication actions aim to showcase the pilot's impact and support long-term model adoption in other regions.

2.3.10. Sustainability and transferability of the pilot actions

The primary goal of this pilot is to develop a sustainable, scalable model adaptable to different parts of Rijeka's DH network. The pilot focuses on producing a pilot report that sets a model for how the digitalisation of the system can optimise the heat distribution of a given system. Based on the study's findings, Energo may consider investing in and scaling it in Rijeka's DH network. The vision is for this report to serve as a model that could be replicated across multiple locations, optimising operations and delivering cost savings for all stakeholders.

By establishing a replicable model, this pilot has the potential to reduce heat losses and optimise system efficiency across regional DH systems.

2.3.11. Risk management

Potential risk includes a limited budget for equipment. We have planned and reallocated resources to prioritise essential equipment. To optimise compliance with the budget, we will monitor expenditures closely throughout the project, making adjustments as necessary to ensure efficient resource use. In this way, we aim to address constraints and stay within the allocated resources.

2.4. Pilot 2 in Croatia

2.4.1. Problem definition, key challenges addressed

The Dubrava neighbourhood, located at the edge of Zagreb's DH network (owned by HEP Toplinarstvo), was initially designed with a capacity of 130 MW coming from the electric boiler at the TE-TO Zagreb Power Plant. However, the network currently operates at around 30 MW, as the anticipated expansion of consumers has not materialised. Out of the 63 buildings in Dubrava, only 21 are connected to domestic hot water from the DH network, while the remaining buildings meet their domestic hot water needs through other sources. Approximately 18 MW is consumed by the 21 buildings, with an estimated 20% allocated for domestic hot water. This suggests a requirement of only 3.7 MW for domestic hot water for the distant buildings in Dubrava.

The distance to the nearest neighbourhood of DH consumers is approximately four kilometres (Sigečica), which, combined with the limited number of consumers in Dubrava, results in significant underutilisation and inefficiency. Namely, the main pipeline - dimensioned for 130 MW - continues to operate for only a few buildings during summer to provide domestic hot water in Dubrava. At the same time, other heating substations (currently approximately 42 of them) are shut down.

This situation highlights the challenge of maintaining high-capacity infrastructure to serve a few buildings, resulting in high energy losses and operational inefficiencies within these sections of the DH network.

2.4.2. Pilot type, optimization and cooperation perspectives

The outlined challenges make a case for exploring localised domestic hot water solutions. By transitioning to local sanitary water production, the main heating pipeline could be deactivated during periods of low demand, i.e. in the summer, which would directly impact the avoided heat losses and improve the overall efficiency of the DH system.

The pilot project focuses primarily on supply-side improvements, evaluating alternative methods for providing domestic hot water during the summer. A pre-feasibility study will assess two main options: photovoltaic solar panels combined with electric boilers and heat pumps (potentially supported with photovoltaic solar panels). This approach envisions each building operating independently, with the DH network offline during summer and individual heating units activated as needed.

2.4.3. Detailed description of the pilot action concept

The project seeks to reduce dependence on centralised heating by introducing localised domestic hot water production, allowing the main pipeline to be shut down during summer. The pilot project will test alternative means of providing domestic hot water for buildings that require it during the summer. Local renewable energy sources are introduced to reduce heat losses and optimise energy efficiency. A pre-feasibility study will be conducted to evaluate two options:

- Photovoltaic solar panels combined with electric boilers
- Heat pumps (potentially supported with photovoltaic solar panels)

HEP Toplinarstvo, as the DHC system owner, is actively involved in validating the concept, while EIHP provides the analysis through a pre-feasibility study. This collaboration ensures alignment with technical, regulatory, and budgetary constraints.

This pilot will explore the mentioned options, offering solutions for individual buildings within the DH network that are offline during summer. Ultimately, this pilot project offers a practical model that could be replicated in any part of a network which faces similar underutilisation issues (in Zagreb and other networks), providing a scalable solution to improve efficiency across the DHC system.

2.4.4. Impact of the pilot action

The impact of this pilot will be evaluated by assessing potential energy and financial savings, which will be elaborated within the pilot report, i.e. pre-feasibility study.

2.4.5. Key steps of implementation

The pilot project will begin in Q1 of 2025, with EIHP and HEP Toplinarstvo extracting all necessary data from the existing monitoring system.

Throughout Q2 and Q3, from 15th May to 15th September 2025, we will collect data on heat consumption to gather the relevant information for analysis.

In Q4, an analysis of the defined options will be conducted and compiled into the pilot report.

A buffer period is allocated in Q1 of 2026 until the end of February to accommodate any challenges, delays, or necessary adjustments to the report.

2.4.6. Roles and responsibilities

EIHP will lead the pre-feasibility analysis to evaluate the proposed pilot concept. HEP Toplinarstvo, as the DHC system owner and a key participant in concept development, will support EIHP by providing data, managing the equipment and providing feedback to enhance this analysis. This cooperation will ensure alignment with technical, regulatory, and budgetary constraints.

2.4.7. Ownership

The intended outcome of this pilot is a pre-feasibility study, and HEP Toplinarstvo will retain ownership of this analysis. This will enable them to leverage the analysis in the future to make well-informed decisions based on its findings.

2.4.8. Stakeholder involvement

The stakeholder groups involved in this pilot include HEP Toplinarstvo, as the DH network operator, potential equipment suppliers and contractors, City of Zagreb, and residents of the buildings in Dubrava selected for this pilot. EIHP and HEP Toplinarstvo will hold regular meetings to ensure open communication and coordination. Other stakeholders, including the general public, will receive updates on the pilot's progress through media channels.

2.4.9. Communication and awareness-raising actions

The pilot's results and potential replicability will be shared through EIHP's and HEP Toplinarstvo's communication channels to highlight the success and scalability of the approach. The dissemination will target local and regional stakeholders who may benefit from implementing similar solutions within their DHC networks. Engagement efforts will include offline and online tools, utilising media channels and events that effectively reach the audience. These communication actions aim to showcase the pilot's impact and support long-term model adoption in other regions.

2.4.10. Sustainability and transferability of the pilot actions

The primary goal of this pilot is to develop a sustainable, scalable model adaptable to different parts of Zagreb's DH network. The pilot focuses on producing a pre-feasibility study to assess the technical and economic viability of localised renewable domestic hot water production. Based on the study's findings, HEP Toplinarstvo may consider investing in and implementing the model in Zagreb's DH network and potentially in other cities within its portfolio.

The vision is for this study to serve as a model to be replicated across multiple locations, optimising operations and delivering cost savings for all stakeholders.

By establishing a replicable model, this pilot has the potential to drive long-term energy savings and improve efficiency across regional DH systems.

2.4.11. Risk management

Potential risks include a limited budget for equipment and regulatory challenges.

To optimise compliance with the budget (the first risk), we will monitor expenditures closely throughout the project, making adjustments as necessary to ensure efficient resource use. In this way, we aim to address constraints and stay within the allocated resources.

In identifying viable options to investigate, we considered potential regulatory obstacles regarding using electric boilers, specifically their compliance with EU energy efficiency rules for district heating. As a result, we closely looked at the EU requirements. According to Article 24 of Directive (EU) 2023/2413, electric boilers powered by renewable electricity can contribute to energy efficiency targets for DH systems if renewables provide a portion of this energy. Member States may count renewable electricity used in DH systems towards the required annual average increase of 2.2 percentage points in renewable energy share for DHC. Since this pilot will explore powering the electric boilers with photovoltaic solar panels, it will directly contribute to meeting EU objectives. Therefore, this explanation addresses regulatory standards and mitigates the risk of non-compliance with EU energy efficiency targets.

2.5. Pilot in Romania

2.5.1. Problem definition, key challenges addressed

The pilot focuses on developing an effective practice framework aimed at minimizing consumption, costs, and emissions by leveraging digitalization while experimenting with various configurations and operational conditions on the demand side. It seeks to improve system functionality through the implementation of advanced measurement and monitoring systems and explores low-temperature heat supply by installing fan coil units. The pilot aims to enhance forecasts and predictive maintenance, with an expected reduction in heating demand of 10-15%. Additionally, it works to increase public consciousness regarding the reduction of energy through the promotion of efficient and sustainable energy practices, facilitated by the pilot results dissemination. The pilot also aims to improve user experience with the digitalization of the district heating system and provide insights for scaling up district heating optimization strategies across other regions.

2.5.2. Pilot type, optimization and cooperation perspectives

This pilot focuses on the demand side of district heating, with the goal of enhancing energy efficiency through system optimization through digitalization of processes and management.

By utilizing data-driven insights, a better understanding of consumption patterns will be achieved, allowing for more accurate energy management. One of the key objectives is to identify and analyse demand trends, which can lead to improved coordination between consumers and the heat provider. The system's efficiency is increased by synchronizing consumption with its supply capabilities thus reducing peak loads and minimizing energy losses.

The pilot lab will also investigate the viability and benefits of supplying heat at lower temperatures. A low-temperature heat supply can enhance system performance, support better integration with renewable energy sources, and reduce heat losses in distribution networks.

Thus, the pilot seeks to promote the shift toward more intelligent and flexible district heating systems.

For the constraints in the network supply, network pipe diameter is related to the fluid flow rates. To maintain efficient heat transfer, especially when supply temperatures are lowered, higher flow rates are needed. We will schedule pilot implementation activities during the non-heating season to ensure uninterrupted heat supply for the consumer.

The engagement of community is crucial. Participation will be fostered through the user-friendly tools to encourage smart consumption practices. Researchers and technical personnel from the university will provide guidance on the conceptual, analytical, and experimental aspects of the pilot laboratory.

Certain contractors and technology suppliers will be involved, serving as external experts in designing and conceptualizing of the hydraulic circuit of the thermal system for the pilot, as well as in designing and conceptualizing of data acquisition and software development. From the equipment budget, the suppliers will also be responsible for installation works and electrical installation works.

The heat producers will connect the pilot project team with end-users (households, businesses) to explain the purpose and benefits of the initiative.

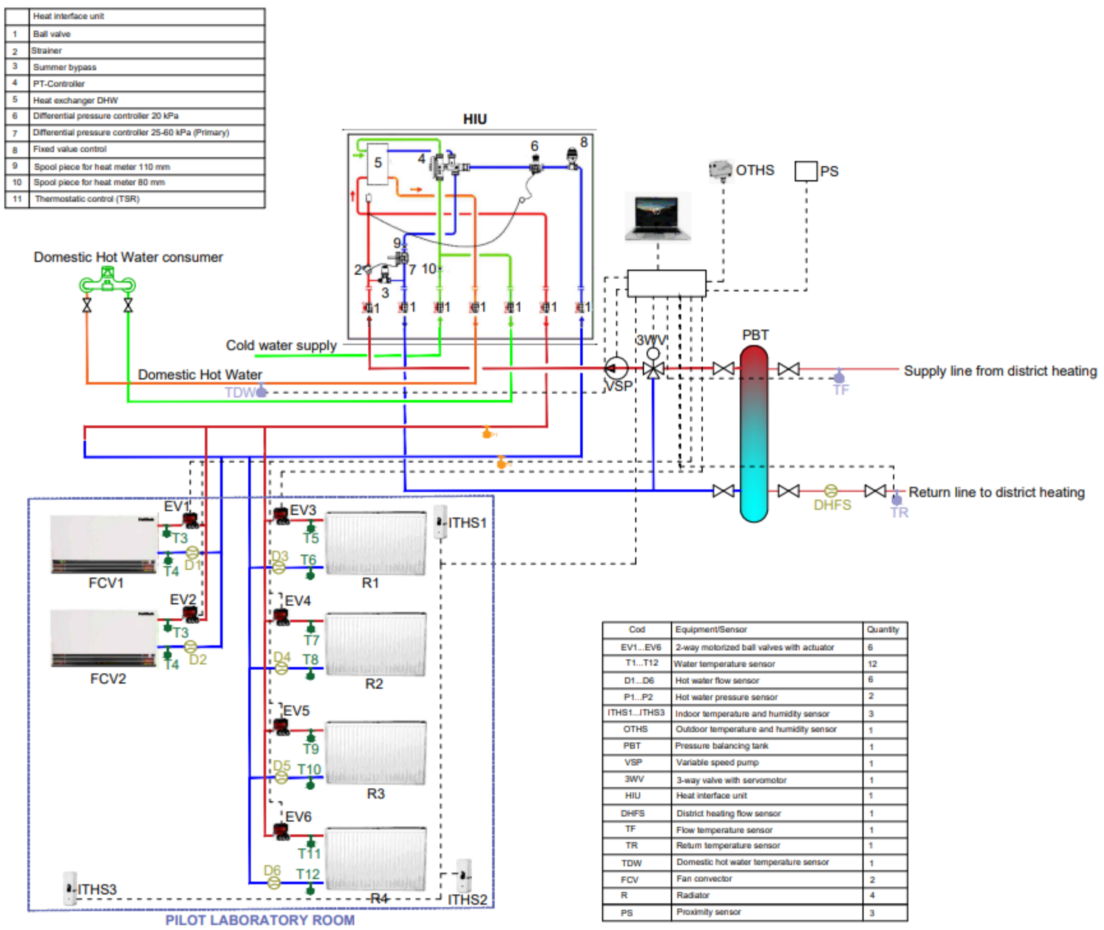
Local authorities will promote awareness and ensure alignment with public policy goals, such as carbon neutrality and energy efficiency.

2.5.3. Detailed description of the pilot action concept

Location: Technical University of Cluj-Napoca, Faculty of Automotive, Mechatronics and Mechanical Engineering, Department of Mechanical Engineering, Room D03

The thermal energy for the university's facilities is provided by a gas-fired thermal power plant through a distribution thermal network. Currently the room is heated by 4 radiators.

Figure 3: Schematic diagram of the pilot system



	Heat interface unit
1	Ball valve
2	Strainer
3	Summer bypass
4	PT-Controller
5	Heat exchanger DHW
6	Differential pressure controller 20 kPa
7	Differential pressure controller 25-60 kPa (Primary)
8	Fixed value control
9	Spool piece for heat meter 110 mm
10	Spool piece for heat meter 80 mm
11	Thermostatic control (TSR)

Cod	Equipment/Sensor	Quantity
EV1...EV6	2-way motorized ball valves with actuator	6
T1...T12	Water temperature sensor	12
D1...D6	Hot water flow sensor	6
P1...P2	Hot water pressure sensor	2
ITHS1...ITHS3	Indoor temperature and humidity sensor	3
OTHS	Outdoor temperature and humidity sensor	1
PBT	Pressure balancing tank	1
VSP	Variable speed pump	1
3WV	3-way valve with servomotor	1
HIU	Heat interface unit	1
DHFS	District heating flow sensor	1
TF	Flow temperature sensor	1
TR	Return temperature sensor	1
TDW	Domestic hot water temperature sensor	1
FCV	Fan convector	2
R	Radiator	4
PS	Proximity sensor	3

The existing installation will undergo modifications to enhance its monitoring and performance capabilities. The supply and return pipelines will be equipped with temperature sensors (TF for the supply line and TR for the return line) along with a flow meter (DHFS), enabling accurate assessment of heat consumption. A pressure balancing tank (PBT) will be added to ensure hydraulic separation of the circuits.

The primary thermal agent will circulate from the pressure balancing tank into the existing heat interface unit (HIU).

The integration of the existing thermal module is essential for efficient management of the thermal agent's preparation for both heating and domestic hot water supply.

On the primary circuit, the following equipment is also needed: a variable-speed pump (VSP), that allows primary flow rate adjustment, and a 3-way valve (3WV), that allows temperature regulation by mixing primary flow water with return water, in order to achieve the desired temperature is delivered to the consumers.

The heat interface unit (thermal module) incorporates a single heat exchanger for domestic hot water preparation while the space heating is supplied directly through the unit from the primary supply. The module also includes a temperature control valve which allows the DHW heat exchanger to operate on demand only and gives the DHW 100% priority over the space heating. A temperature sensor is installed on the domestic hot water supply line (TDW).

The heating circuits coming from the module will supply the four existing radiators and two fan cooling units to be acquired. The integration of the two fan cooling units is intended to investigate the potential for lower supply temperatures; A comparison between standard radiators and Fan Coil Units in terms of energy efficiency, heat distribution, and adaptability will be performed.

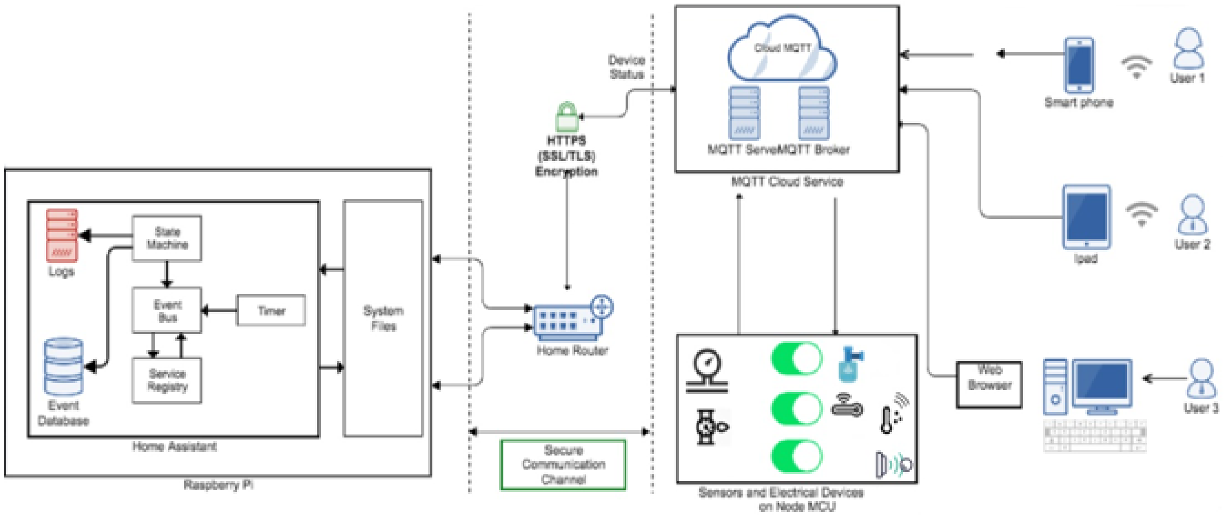
Each heating equipment will be equipped with temperature sensors (for supply and return lines T1.......T12), flow sensors (D1....D6), and 2-way motorised ball valves with actuators (EV1....EV6.)

The proximity sensors (PS) and temperature and humidity sensors will be installed in the pilot laboratory room.

Sensor data will be collected and transmitted to a server. A software application will be developed to handle sensor data acquisition, calibration, conversion, and storage. This software will also facilitate the interpretation of the measured data and the calculation of additional relevant parameters, such as the thermal energy consumed.

The preliminary schematic illustrating cloud integration is provided in Figure 4.

Figure 4: Cloud integration scheme



2.5.4. Impact of the pilot action

A. Potential saving by reducing the use of energy

The figures below illustrate the variations in heating demand for the pilot lab room on an hourly and monthly basis.

Figure 5: Hourly variation in heating demand for the pilot lab

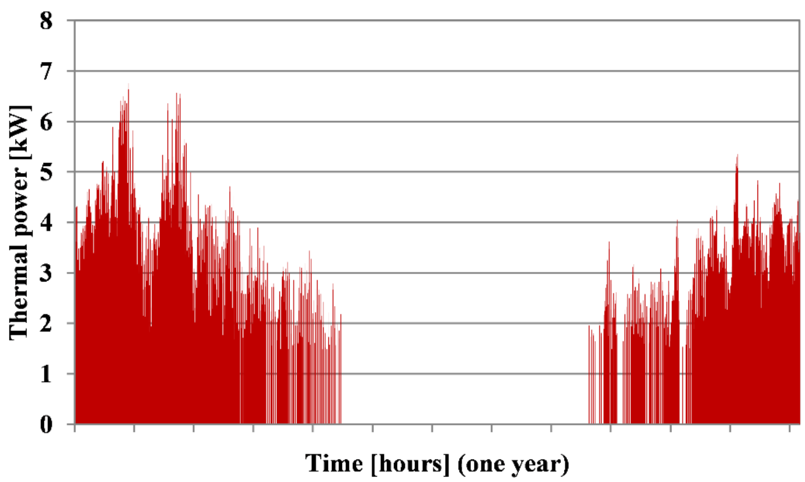
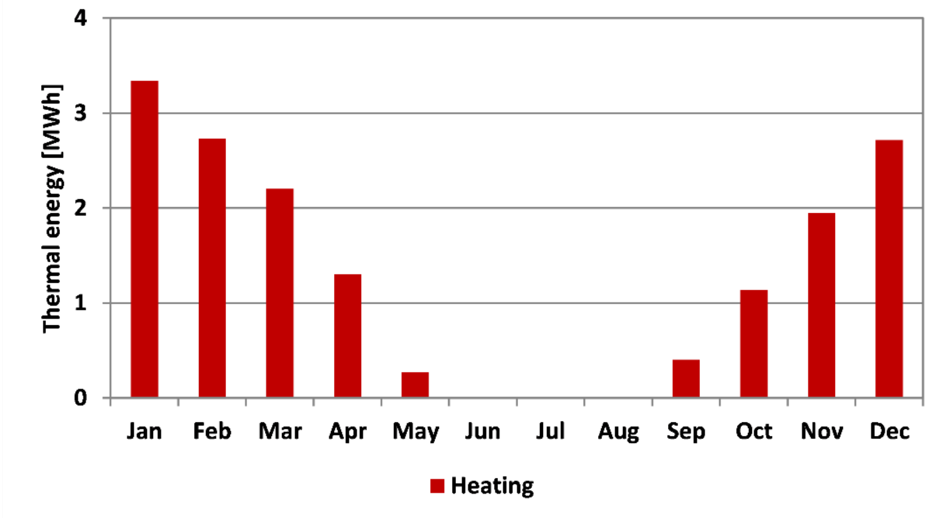


Figure 6: Monthly heating demand profile of the pilot lab



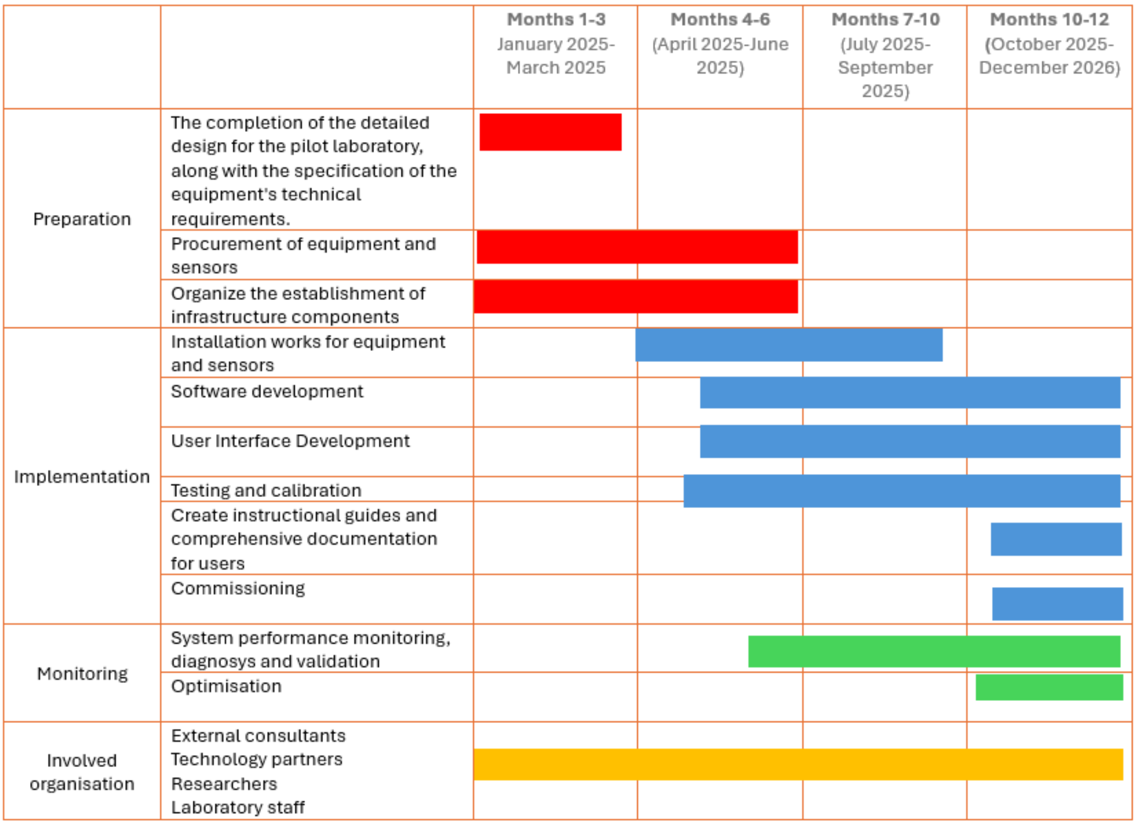
The heating system is inactive from May 15 to September 15. Heating is required when the outside temperature drops below 12 °C. The current annual heating demand for the pilot lab is 16.0 MWh. With the implementation of monitoring and control measures, the heating demand is expected to decrease by about 10-15%, leading to an estimated annual demand between 12.8 and 14.4 MWh, with an average estimate of 13 MWh.

B. CO2 emissions reduction

The greenhouse gas emissions factor for natural gas is 0.205 kg CO_2/kWh. Based on the projected decrease in heating demand, the annual CO_2 emission reduction for the laboratory room is estimated between 300-650 kg CO_2 per year.

2.5.5. Key steps of implementation

Figure 7: Implementation stages of the pilot project



2.5.6. Roles and responsibilities

These have already been outlined in the section “Pilot type, optimization and cooperation perspectives”.

2.5.7. Ownership

The pilot is located within a facility that owned by the Technical University of Cluj-Napoca. Upon the conclusion of the REHEATEAST project, ownership of the pilot will be transferred to the university. Maintenance of the system will be provided by REHEATEAST project members who are engaged in research and educational activities within the building housing the pilot.

2.5.8. Stakeholder involvement

Stakeholder involvement is crucial because their input will influence the success of the pilot action.

The target groups and stakeholders involved in the pilot action development and implementation include consumers (end users), technology providers and contractors, district heating operators, authorities and regulators, as well as financiers and investors.

The **consumers** (students, academics and technical staff) directly benefit from the pilot, so their needs and feedback are vital for shaping the pilot action. Given that the pilot lab will be implemented in a classroom, thermal comfort and air quality are critical factors for ensuring a productive and comfortable learning environment.

Furthermore, the academic community and laboratory personnel at the university can contribute valuable technical and scientific knowledge, interpret the results of the project, and assist in disseminating its findings.

Technology providers and contractors will contribute technical knowledge, instruments, and resources for the pilot laboratory, and will remain actively engaged throughout the development of the pilot lab.

The early engagement of this group during the design phase is essential for establishing a robust technical foundation for the project. This approach ensures alignment with the project's objectives and the integration of the most effective tools and technologies.

Involving stakeholders during the implementation and testing stages helps ensure smooth system integration, supports effective troubleshooting, and contributes to the provision of training and feedback.

This group will provide continuous upgrades, maintenance, and support for the technologies supplied.

District heating operators, authorities and regulators, along with financiers and investors, are key stakeholders in the dissemination phase of the pilot lab project. Their participation guarantees that the project's outcomes are conveyed effectively and that the results can be utilized for wider adoption, scalability, or policy impact.

2.5.9. Communication and awareness-raising actions

Continuous engagement will be ensured throughout the development of the pilot lab via various channels, including newsletters, updates on social media, reports, and academic publications. An online training session will be organized for professionals and municipalities in the REHEATEAST countries, focusing on local collaboration and optimization strategies. Additionally, regional stakeholder conferences will be held to share insights acquired from the pilot project, highlighting its advantages, outcomes, and future potential. Furthermore, knowledge sharing and dissemination efforts will involve presenting the pilot's findings at professional gatherings to encourage interaction with the academic and professional communities.

2.5.10. Sustainability and transferability of the pilot actions

The long-lasting effect of the pilot action beyond the project duration is ensured by *implementing the pilot action in an educational and research facility,* that could lead to numerous significant outcomes, such as boosting academic and professional development for participants, enhancing students' learning experiences and fostering interdisciplinary cooperation. It is also guaranteed by *community outreach and engagement*. Active involvement of the local community will ensure their needs and perspectives are aligned with the project's goals, benefits, and potential impacts. The long-lasting effect of the pilot action is also established by *knowledge sharing and dissemination*. This includes the elaboration of manuals, reports, or articles based on the pilot action.

The results of the pilot laboratory, along with the methodologies and software developed, as well as the insights and practices acquired, can be disseminated to other communities and regions to promote replication.

Stakeholder involvement is essential to transferring the results of the pilot action to other groups.

2.5.11. Risk management

Technological risks could arise if the pilot configuration becomes excessively complex or if the required equipment and technology experience malfunctions, leading to potential delays or heightened costs. To mitigate this, a technology feasibility assessment will be conducted, involving project members and stakeholders to pinpoint potential technical challenges.

Operational risks may occur due to a lack of resources, whether human, physical, or financial, which can lead to operational failures. Unanticipated delays and maintenance challenges can also worsen these risks.

To mitigate this, a thorough assessment of resources will be conducted, ensuring that a proper allocation of human, financial, and physical resources is set up from the outset. A comprehensive project schedule will be developed, outlining specific milestones and deadlines. Additionally, a regular maintenance schedule will be established to verify that all equipment operates effectively.

Financial risks are also a concern, as the pilot lab may exceed the initial budget. To mitigate this risk, a thorough evaluation of the expenses related to equipment, labor, and external consultancy will be conducted. A detailed pilot project plan will be formulated to guarantee budget compliance, while establishing clear deliverables and timelines.

2.6. Pilot in Slovenia

2.6.1. Problem definition, key challenges addressed

The pilot project addresses several critical challenges in the operation and expansion of District Heating and Cooling (DHC) systems. One of the main issues is the significant transmission losses in distribution heat pipes, which are often difficult to measure accurately. These losses contribute to increased operational costs and reduced overall system efficiency. Furthermore, the reliability of energy supply is at risk due to the potential for damage to ageing of heating pipes. Another key challenge is the expansion of DHC network which requires effective strategies for attracting and integrating new users into the system.

2.6.2. Pilot type, optimization and cooperation perspectives

The pilot focuses on supply-side optimization, aiming to enhance the overall energy performance. The primary objective is to enhance operational efficiency by reducing heat losses and maximising the use of existing heat production facilities. Secondary objectives include minimizing both investment and operational costs, as well as reducing the temperature levels in the supply pipeline. However, there are constraints, such as the size of the network pipeline and the existing heating capacity, which may limit the extent of achievable optimizations.

From a cooperation perspective, the pilot will involve potential new clients and explore a cooperative business model.

2.6.3. Detailed description of the pilot action concept

The pilot action will be implemented in the Municipality of Cankova, where the local DHS currently has 31 connected customers, including the municipal administration building, a health center, a primary school, a kindergarten, several private businesses, and residential buildings. Since its commissioning in 2003, the system has delivered approximately 800 MWh of heat annually. The cooperative managing the system generates stable revenues from heat sales, which support its ongoing operations and provide capital for future investments.

The initial step of the pilot action involves the development of the DHC model, encompassing heat generation, transmission, and distribution. Clear optimization objectives will be defined, such as reducing energy costs, improving system reliability, and increasing the share of renewable energy sources (RES). Key performance indicators (KPIs) will be defined to track progress and the effectiveness of the optimization efforts. Data collection and study implementation will be conducted to identify heat losses in specific sections of the existing heating pipeline.

The pilot report will evaluate heat losses in the system, along with projections and assessments for the entire pipeline. This will include an analysis of losses at customer heat exchangers, considering factors such as positioning, installation conditions, and insulation quality, as well as distribution system losses, which could be reduced by higher insulation standards and other influencing factors.

In the second phase, the focus will be on modelling and optimizing the expansion of the biomass-based DHS to connect to new users. This will include elimination of the heat losses identified in the initial phase to improve system efficiency and establish the basis for system expansion. Additionally, an assessment of the maximum capacity of the existing biomass furnace, the availability of a reserve furnace for peak load coverage and the potential integration pf heat storage will be conducted. This will help determine the maximum consumption capacity of the system and estimate the number of new users it can support.

To ensure the expansion is successful, a community engagement campaign will be launched. This will involve the creation of a local "community lab" (living lab – LL) and analysis potential new customers' interests to encourage their participation in the DHS.

2.6.4. Impact of the pilot action

The primary method of estimating the potential impact is through the evaluation of "energy savings resulting from reduced energy consumption". This involves calculating the expected reduction of losses in the heating pipeline following the proposed measures, and determining the corresponding share of energy saved.

The impact of this pilot will be assessed based on the potential energy savings, which will be quantified and elaborated after the pilot implementation is compete.

The impact of the pilot will be reflected by the following two indicators:

- energy savings, representing the reduction in energy use (measured in MWh)
- CO_2 emission reductions, representing the decrease in emissions resulting from reduced reliance on fossil-fuel-based energy sources, particularly for newly connected users to the DHS (measured in kg CO_2).

2.6.5. Key steps of implementation

The pilot will begin in 2025, in cooperation with the Municipality Cankova and our ASP – Sončna zadruga. By the end of 2024, the necessary equipment will be purchased - LEA Pomurje will acquire an IR thermal camera.

The loss analysis will be conducted and completed by the end of June 2025, while the entire process (including LL) should be completed by the end of 2025.

2.6.6. Roles and responsibilities

LEA Pomurje plays a key role, but close cooperation between the DHS owner - the Municipality of Cankova and the concessionaire Sončna zadruga is essential and required.

Certainly, the most significant contribution will come from an external expert who will support the technical aspects of the analysis. This expert will be selected through a public procurement procedure at the beginning of 2025.

2.6.7. Ownership

The ownership of the pilot will remain with the Municipality of Cankova, as it has been so far. The Municipality grants a concession for the operation of the DHS Cankova. The pilot itself is not directly linked to ownership, as it does not involve direct investment or financing of the system.

2.6.8. Stakeholder involvement

Stakeholder involvement is essential for the successful implementation and operation of the DHS Cankova. The key stakeholders include the municipality, the concessionaire and the consumers/households.

The municipality and concessionaire play a crucial role in facilitating the development and management of DHS. Through policy-making, regulatory frameworks, and financial support they ensure that the system aligns with local needs and sustainability goals.

Consumers and households, as end-users, are essential to the system's success. Their active engagement helps ensure DHS meets their expectations regarding energy pricing, reliability, and service quality. It is important to maintain strong communication with consumers to promote energy efficiency, gather feedback, and improve the system's performance.

The active involvement of all stakeholders ensures a collaborative approach that can lead to the efficient, sustainable, and successful operation of the DHS.

2.6.9. Communication and awareness-raising actions

A comprehensive community engagement campaign plays a pivotal role in expanding the DHS system by fostering strong relationships with the local population and key stakeholders. This campaign will include the establishment of a local "community lab," which serves as an interactive space where residents, businesses, and other stakeholders can engage, share ideas, and explore opportunities related to the DHS.

In parallel, the campaign will include a detailed analysis to identify potential interested parties.

This will encompass individuals, businesses, institutions, and other entities that could benefit from connecting to the DHC system. By understanding the diverse needs of these potential clients, tailored outreach strategies can be designed to engage them effectively.

2.6.10. Sustainability and transferability of the pilot actions

By showcasing the successful concept for installing DH based on wood biomass as a best practice, the pilot demonstrates the potential for renewable energy solutions to transform local heating systems, enhance energy security, and foster community involvement. This model can be used as a template for other regions seeking to develop their own sustainable, locally managed energy solutions. By replicating this approach, broader adoption of renewable district heating systems can be encouraged across other regions.

2.6.11. Risk management

Effective risk management is crucial for the successful implementation of the pilot. An initial risk assessment was already conducted during the pilot's planning phase.

To mitigate identified risks, LEA Pomurje has planned to purchase equipment and engage an external expert. In-depth consultations were held with key actors: the Municipality of Cankova and the concessionaire, to ensure strong cooperation.

The main risks identified include:

- early end of the 2025 heating season – this may prevent the completion of full IR thermography;
- delay in selecting an external expert – this could impact the timeline and scope of the IR thermography;
- lack of interest from potential new users (to participate in LL) may result in fewer connections to DHS.

2.7. Pilot in Slovakia

2.7.1. Problem definition, key challenges addressed

Focusing on renewable heating sources is crucial for reducing environmental impact, improving energy efficiency, and achieving sustainable development. The use of renewable energy sources, can significantly reduce greenhouse gas emissions, improve air quality, and help protect natural resources. It is important to discuss these alternatives because many people and municipalities are still unaware of the available solutions that are more cost-effective and environmentally friendly than traditional heating methods based on fossil fuels. Additionally, addressing this topic is essential for contributing to the reduction of emissions, a goal to which both Slovakia and the European Union have committed. The EU has set a target to reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, which requires a substantial decrease in the use of fossil fuels. Discussing renewable heating sources promotes their wider adoption, reduces dependence on fossil fuels, and contributes to creating energy-efficient and environmentally friendly communities.

2.7.2. Pilot type, optimization and cooperation perspectives

The GEO map represents demand and supply side pilot actions by mapping optimal energy sources and potential district heating demand.

Via Carpatia EGTC aims to improve the visibility of district heating by creating a GEO map on the GIS platform managed by the Košice Self-Governing Region.

The main goal of pilot action through this map is to provide a clear overview of the possibilities and benefits of district heating systems (DHS) in specific areas of the region. The Geo Map will support the optimization of energy use by identifying the most suitable energy mix for local communities of the Košice region, with an emphasis on renewable energy sources. At the same time, it serves as a communication tool to raise public awareness about district heating, showing how different type of heating or cooling systems can positively impact daily life.

This pilot project also serves as a best practice model for other regions in Slovakia by demonstrating how detailed geographic and energy data can be used to improve planning, promote renewable energy use, reduce fossil fuel dependency and GHG emissions, and promote transition to sustainable energy systems. The GEO map offers a replicable approach for supporting adoption of cleaner energy practices.

2.7.3. Detailed description of the pilot action concept

The pilot action for the GEO portal in the Košice region aims to establish a multi-layered mapping tool that provides a comprehensive view of potential energy sources and environmental conditions across the area. This portal will include detailed layers displaying various energy analyses, such as identifying the optimal energy mix per region, assessing solar exposure, wind patterns, and other environmental factors relevant for energy planning.

The primary objective is to use the map and accompanying documentation to raise awareness of energy-efficient heating options, especially in less developed areas where solid fuels remain the dominant heating source. These analyses will yield valuable insights for potential investors interested in sustainable energy projects.

The pilot project's output will be a targeted brochure designed for regions identified as most suitable for district heating, with a special focus on areas with lower socio-economic profiles.

By increasing awareness and making this data more accessible, the pilot aims to encourage a shift toward more efficient and environmentally friendly heating methods, ultimately contributing to improved air quality and to a healthier environment in the region.

2.7.4. Impact of the pilot action

The number of GEO map viewers will serve as an indicator of interest from the target audience.

In the future, the Energy Department of the Košice Self-Governing Region (KSK) may use data and information from the GEO map to determine which energy strategy - such as photovoltaic systems, heat pumps, or other alternative heating solutions - are most suitable for implementation in their territory.

The main goal of this pilot is representing information and insights from the analysis and highlight key findings as a best practice model for other regions in Slovakia and beyond.

2.7.5. Key steps of implementation

The monitoring phase will take place from January to April 2025, and will include an assessment of available data sources, as well as an evaluation of the map layers that provide the most relevant information to support the pilot's objectives. This will be followed by the implementation phase, running from April to December 2025. Finally, from December 2025 to February 2026, a monitoring period will take place. This phase will focus on fine-tuning the content, validating results, and conducting an awareness campaign to promote the pilot's findings and encourage wider engagement.

2.7.6. Roles and responsibilities

Via Carpatia will oversee and coordinate the strategic partners involved in the pilot action. All selected strategic partners bring the necessary expertise and competencies to the pilot's focus area. Via Carpatia has a long-standing collaboration with the key stakeholders who will contribute knowledge to this project and provide essential information for proper setup and implementation of the pilot. The associated partner, the Košice Self-Governing Region, will serve as an advisory body throughout the implementation phase, supporting the proper structuring of the analysis to ensure the GEO map provides valuable and actionable insights. Additionally, we will consult with the REHEATEAST partner IDEFA to align methodologies and ensure the pilot is effectively executed. Their involvement is crucial to tailoring the technical and strategic aspects of the pilot to local needs and helping achieve the project's goals. The Technical University in Košice and Faculty of Mining, Ecology, Management and Geotechnology will also participate in the development of the pilot. Their technical expertise will provide valuable information in our areas of interest.

2.7.7. Ownership

The GEO map will be hosted and managed by the Košice Self-Governing Region (KSK). The brochures created from the analysis will also be owned by KSK. These brochures can be used by the local government as informational tool to help households understand and transition from fossil fuels to renewable energy sources. KSK will retain ownership of the complete analysis and will be able to use it in the future for making informed decisions, such as identifying suitable areas for district heating systems. After the project's completion, KSK will be responsible for maintaining the GEO map and making data updates as needed.

2.7.8. Stakeholder involvement

The pilot involves a wide range of stakeholders, including municipal and regional authorities, (potential) investors, as well as consumers and households.

2.7.9. Communication and awareness-raising actions

Key findings from the GEO map will be communicated through a brochure. The Košice Self-Governing Region will distribute these brochures in areas where the insights can help residents make informed decisions about the most suitable heating options. Additionally, outreach visits to municipalities will be organised, where we will present and discuss the potential of district heating (DH) systems, especially in regions that currently rely on fossil fuels. These actions will raise awareness and provide practical guidance to help local communities transition toward more sustainable heating solutions. The brochure will also be beneficial for a secondary target group – investors - helping them identify promising locations for investments in renewable and DH infrastructure.

2.7.10. Sustainability and transferability of the pilot actions

The GEO map will remain accessible on the KSK website after the project ends, ensuring the long-term sustainability of the pilot action. The findings and insights from the project will continue support local governments and households in ongoing awareness efforts and informed decision-making on heating solutions. The overall outcome of the project can serve as a best practice example for other regions in Slovakia, demonstrating an effective way to raise understanding and awareness about district heating and bring this topic closer to residents. This approach is adaptable and transferrable to other areas, offering a valuable model for promoting the adoption of sustainable heating solutions across the country.

2.7.11. Risk management

Several potential risks have been identified for the successful implementation of the GEO map pilot.

Data availability and accuracy pose a risk, as limited or outdated data could compromise the reliability of the map. To mitigate this, local authorities and research bodies will partner to obtain verified data and apply quality checks.

Technical challenges are also a concern, as developing a complex, multi-layered mapping tool may lead to software or integration issues. To manage this risk, skilled GIS experts will be engaged, regular testing will be conducted, and the flexible platform design will be established to allow for adjustments as needed.

Limited stakeholder engagement could reduce the project's impact, particularly if local authorities or investors choose not to participate. To mitigate this risk, workshops and targeted outreach will be implemented to highlight the benefits and practical applications of the GEO map portal.

Community awareness could also be a challenge, as there may be resistance to transitions away from fossil fuels, especially in underdeveloped areas. This will be mitigated through educational campaigns and by involving community influencers to communicate the benefits of sustainable energy solutions.

Financial constraints, such as budget limitations, may also hinder development and maintenance of the GEO map. To mitigate this, additional funding will be sought through government, NGOs, and sustainability grants, with a phased project plan prioritizing key features to ensure progress even with limited resources.

2.8. Pilot in Serbia

2.8.1. Problem definition, key challenges addressed

Multi-story apartment buildings connected to the district heating system (DHS) in the Municipality of Priboj are facing significant energy inefficiencies due to the lack of maintenance and standards that were in effect at the time of construction. As a result, buildings suffer from high energy consumption, reduced quality of district heating service for users, elevated heat production costs, and increased greenhouse gas emissions. Energy renovation is urgently needed to improve living conditions, reduce energy costs, and contribute to green and fair energy transition in Priboj.

Renovating multi-apartment buildings in Serbia, and specifically in Priboj, presents a range of challenges, influenced by legal, financial, technical, and social factors.

Ownership complexity is one of the primary challenges, as most apartments are privately owned, while common areas (like staircases and facades) are jointly owned. Achieving consensus among all apartment owners for renovation decisions is often difficult. High costs also present a significant barrier, as energy-efficient renovations require significant investments that many residents cannot afford.

Limited government support further complicates the situation. Although some national programs exist to support energy efficiency, the funding is often insufficient or difficult to access. Additionally, there is a lack of financial mechanisms tailored to multi-apartment buildings, such as low-interest loans for renovations, which are not widely available.

Low owner cooperation is another challenge, as aligning the interests of multiple apartment owners can be challenging, as some may resist changes due to costs or personal preferences. Low awareness among residents about the long-term benefits of renovations, especially energy efficiency improvements, is also a key obstacle. Furthermore, not all buildings have effective homeowners' associations capable of managing renovations and resolving disputes among owners. Lastly, the absence of energy audits and technical documentation for energy renovation poses a problem in attracting funds, as it reduces the technical expertise and capacity needed.

2.8.2. Pilot type, optimization and cooperation perspectives

This demand-side pilot focuses on apartment buildings in the Municipality of Priboj that are connected to the DHS. The primary goal is to develop a methodology that will create preconditions for performing energy renovation of multi-residential buildings. The methodology will include energy audits, proposals of various energy renovation options, identifying different types of barriers, and educating tenants and owners on the benefits and options for energy retrofit of their buildings.

The impact of the pilot will be measured by the potential reduction of energy consumption in the target residential buildings, along with the corresponding reduction of CO_2 emissions.

These savings will be calculated based on the reduced consumption of the energy source used in the DHS of Priboj - wood chips.

The Priboj pilot will serve as a best-practice model for local self-governments in Serbia that operate DHC systems. It will demonstrate how energy renovation of the apartment buildings (end users of DHC systems) can reduce energy consumption and CO_2 emissions, while also enhancing stakeholder collaboration and public engagement in local energy saving projects.

2.8.3. Detailed description of the pilot action concept

This demand-side pilot project targets apartment buildings in the Municipality of Priboj that are connected to the existing DHS. The initiative aims to develop a replicable methodology to enable comprehensive energy renovations in multi-residential buildings. By addressing both technical and behavioural aspects, the pilot strives to achieve optimal energy savings, enhance indoor comfort, and reduce heating costs, setting a benchmark for similar urban communities.

The key objectives of the pilot are developing an energy renovation methodology, identifying and overcoming barriers, educating and engaging stakeholders, and supporting the development of public policy for energy retrofits.

The pilot has several main characteristics. Regarding the scope, the project will initially target up to five multi-residential buildings, selected to represent diverse building typologies and energy performance levels. In terms of stakeholder collaboration, the pilot will foster cooperation between the municipality, DHS operators, energy auditors, financial institutions, and residents. With respect to technology and tools, advanced energy modelling software and monitoring devices will be used for pre- and post-renovation analysis. As for community impact, the pilot will directly benefit residents through reduced energy bills and improved living standards while fostering a culture of energy awareness.

2.8.4. Impact of the pilot action

The primary method of estimating the potential impact is “potential savings by reducing the use of energy”, based on the current situation and the potential development.

2.8.5. Key steps of implementation

The first key step in the implementation process is to **develop an energy renovation methodology** from January to May 2025. This will involve conducting detailed energy audits to assess the energy performance of selected buildings and identify energy-saving opportunities. Tailored energy renovation solutions will then be proposed, including insulation upgrades, window replacements, and optimization of heating systems. Renovation scenarios will be evaluated and prioritized based on cost-effectiveness, feasibility, and tenant/owner preferences.

The second step is to **identify and overcome barriers** between March and July 2025. This will involve mapping institutional, financial, and technical barriers to implementing energy retrofits. Strategies will be suggested to address these barriers, such as securing funding, streamlining administrative processes, and fostering collaboration between stakeholders.

The third step is to **educate and engage stakeholders** from June to September 2025. Workshops and informational campaigns will be organized to raise awareness about the economic, environmental, and health benefits of energy renovations. Tenants/owners will be equipped with knowledge of available financing options (e.g., grants, loans, or subsidies) and practical guidance e on how to initiate retrofitting in their buildings.

The fourth step is to **support the development of public policy for energy retrofits** from September to November 2025. Collaboration with the Municipality of Priboj will be essential in drafting and implementing public policies aimed at facilitating energy retrofits for multi-apartment buildings. A framework for municipal support will be established, including incentives such as tax reductions, grants, or subsidies for energy renovation projects. Regulations will be developed to standardize energy audit practices, renovation criteria, and quality assurance mechanisms to ensure long-term energy savings. Lessons learned from the pilot will be integrated into municipal planning documents, creating a roadmap for the large-scale adoption of energy retrofits across the municipality. Public-private partnerships (PPPs) will also be promoted to attract investments and expertise for energy efficiency initiatives.

2.8.6. Roles and responsibilities

The main actors include SCTM (REHEATEAST partner), selected consultant (to be tendered), Municipality of Priboj, PUC District Heating Priboj, and tenant associations of selected buildings.

Below is a breakdown of their roles and responsibilities.

Municipality of Priboj:

- Overall project coordination: ensures that all stakeholders collaborate effectively.
- Policy development: Drafts and implements public policies to support energy retrofits.
- Regulatory framework: Develops municipal regulations for energy audits and renovations.
- Financial support & incentives: Establishes funding mechanisms, tax reductions, or grants.
- Stakeholder engagement: Facilitates communication between tenants, PUC District Heating, and other partners.

Standing Conference of Towns and Municipalities (SCTM):

- Knowledge sharing & best practices: Provides expertise based on experiences from other municipalities.
- Institutional support: Assists in drafting policies and standardizing energy audit procedures.
- Capacity building: Organizes training sessions for municipal representatives.

- Advocacy & networking: Promotes the project at the national level to attract further funding and policy support.

External consultant:

- Technical expertise: Conducts energy audits and develops tailored renovation solutions.
- Scenario analysis: Evaluates and prioritizes renovation scenarios based on cost-effectiveness and feasibility.
- Barrier assessment: Identifies institutional, financial, and technical barriers and proposes solutions.
- Policy recommendations: Assists the Municipality of Priboj in designing supportive policies.
- Stakeholder training: Leads educational workshops and awareness campaigns.

PUC District Heating Priboj:

- Technical implementation: Supports heating system optimisations and integration with energy-efficient solutions.
- Data provision: Provides data on current energy consumption and heating efficiency.
- Collaboration on policy: Works with the municipality and consultant to establish heating regulations.
- Tenant engagement: educates residents on efficient heating practices.

Tenant Associations of Selected Buildings:

- Community engagement: Mobilizes residents to participate in energy renovations.
- Feedback & decision-making: Represents tenants' interests in selecting renovation scenarios.
- Financial participation: Facilitates access to financing options and co-funding contributions.
- Awareness-raising: Disseminates information about benefits and processes of energy retrofits.

Each party plays a crucial role in ensuring the successful development and implementation of energy renovation solutions in Priboj.

2.8.7. Ownership

The beneficiaries of the pilot will be tenants and apartment owners in the selected multi-apartment buildings, while full ownership of the project results will be held by the Municipality of Priboj and PUC District Heating Priboj. SCTM will retain the right to share and promote the developed methodology among other local governments in Serbia.

2.8.8. Stakeholder involvement

The **SCTM** will provide strategic guidance and expertise based on similar initiatives under REHEATEAST. They will facilitate knowledge-sharing and dissemination of best practices to ensure replicability. Additionally, SCTM will support advocacy efforts for policy development and alignment with national energy goals.

A **selected consultant** (to be tendered) will conduct energy audits and develop tailored renovation proposals for the pilot buildings. They will identify and address technical, financial, and legal barriers and lead capacity-building efforts by organizing training sessions and workshops for stakeholders, including tenants and municipal staff.

The **Municipality of Priboj** will act as the primary project coordinator, ensuring alignment with local development plans. They will provide administrative support and assist in drafting and implementing public policies for energy retrofits. The municipality will also facilitate access to funding mechanisms and ensure regulatory compliance for the pilot.

The **Public Utility Company (PUC) District Heating Priboj** will collaborate on the technical aspects of building connections to the district heating system, ensuring the optimal integration of energy efficiency measures. They will provide operational data and input for the energy audits and support public awareness campaigns by highlighting the benefits of reduced heating demand and improved system efficiency.

Finally, the **tenant associations of selected buildings** will serve as the primary interface between residents and project implementers, ensuring tenant needs and concerns are addressed. They will promote active participation in awareness campaigns, decision-making processes, and the adoption of energy retrofits.

2.8.9. Communication and awareness-raising actions

Communication and awareness-raising actions will include workshops, informational sessions and personalised consultations. The objective of these actions is to provide clear and detailed information about retrofit options and financing. To achieve this, in-person consultation sessions will be hosted within the Municipal Energy Info Center. In addition, in-person workshops and webinars featuring experts and Q&A sessions will be organized. One-on-one meetings with energy and financial advisors will also be offered.

2.8.10. Sustainability and transferability of the pilot actions

The long-term sustainability of the pilot is ensured through several key factors. Lasting impact on energy efficiency is achieved as the pilot establishes a replicable methodology for energy renovation that can be applied to other buildings within Priboj. This ensures continued improvements in energy efficiency and a reduction in heating demand. Regarding institutional capacity building, training workshops and capacity-building efforts empower municipal staff, tenants, and consultants with knowledge and skills that extend beyond the pilot's duration. The integration of project outcomes into municipal policies ensures ongoing support for energy efficiency measures. In terms of community engagement, awareness campaigns foster a cultural shift toward energy-conscious behaviour among tenants and apartment owners. Empowered stakeholders are more likely to pursue additional renovations and advocate for similar projects.

Transferability of the pilot is a key focus. A scalable methodology is crucial for transferability. The comprehensive approach, which includes energy audits, tailored solutions, and stakeholder engagement, can be adapted to other municipalities or regions with similar heating and building stock conditions. Tools, templates, and lessons learned will be documented for replication. Policies developed in collaboration with the Municipality of Priboj can serve as a model for other local governments, promoting region-wide adoption of energy retrofits. Knowledge sharing plays an important role in transferability. The pilot outcomes and best practices will be shared through the SCTM and REHEATEAST networks, enabling other municipalities to benefit from the experience. Public recognition of the project's success will inspire interest and confidence among stakeholders in other areas. Regarding collaboration opportunities, partnerships established with consultants, district heating providers, and financing institutions during the pilot can be leveraged to expand similar projects.

2.8.11. Risk management

During the preparation of the pilot idea, several potential risks were identified. Below is a summary of the most important risks, their potential impact, and proposed mitigation strategies.

The first risk is **insufficient stakeholder engagement**, where limited participation or resistance from tenants and building owners may arise due to a lack of understanding or mistrust in the project. To mitigate this, targeted awareness campaigns will be conducted, emphasizing the financial and comfort benefits. Tenant associations will be engaged early in the planning process to foster trust and co-ownership of the initiative. Additionally, clear and transparent communication about costs, timelines, and benefits will be offered.

Another risk are **technical challenges**, specifically unforeseen technical issues during energy audits. To mitigate this, detailed pre-assessments will be conducted to identify potential challenges.

Experienced consultants and contractors with expertise in similar retrofitting projects will be involved, and flexibility will be built into the project timeline to accommodate any unforeseen difficulties.

Lastly, **low scalability and replicability** may present a risk if the pilot methodology cannot be easily scaled or adapted to other buildings or municipalities due to contextual differences. To mitigate this, all processes, outcomes, and lessons learned will be documented, creating a flexible and adaptable methodology. Collaboration with SCTM and REHEATEAST will ensure knowledge transfer and the sharing of best practices to support scalability and replicability.

2.9. Pilot in Bosnia and Herzegovina

2.9.1. Problem definition, key challenges addressed

The Tuzla DH system currently relies on a coal-fired thermal power plant (TPP) as its source of heat. The connected thermal power is 245.1 MWt in the heating installation, the system has 1633 hot water substations and 196.8 km of hot water network. Heat is supplied to 25,930 users (23,476 households, 168 institutions and 2,286 business buildings), covering a total heated area of 1,965,878 m^2. The existing coal-fired TPP has sufficient capacity to meet current heat demands of the city of Tuzla, but heaving in mind the fact that BiH committed to achieve full decarbonization by 2050 and with the energy sector expected to decarbonize even earlier, it is essential to start implementing concreate projects that will gradually replace the present heat source, namely coal-fired TPP, with renewable sources.

Modern heating systems tend to develop DH networks and place heat sources as close as possible to the users, ideally near or within housing units. This approach significantly reduces distribution losses, enhances system efficiency, and aligns with the core goal of minimizing energy consumption while maintaining comfort levels.

This pilot action aims to demonstrate a cost-effective, sustainable RES solution that will contribute to the decarbonization of Tuzla's heat production, reduce GHG emissions and support the development of 4^{th} generation DH, based on diversified and renewable energy sources.

2.9.2. Pilot type, optimization and cooperation perspectives

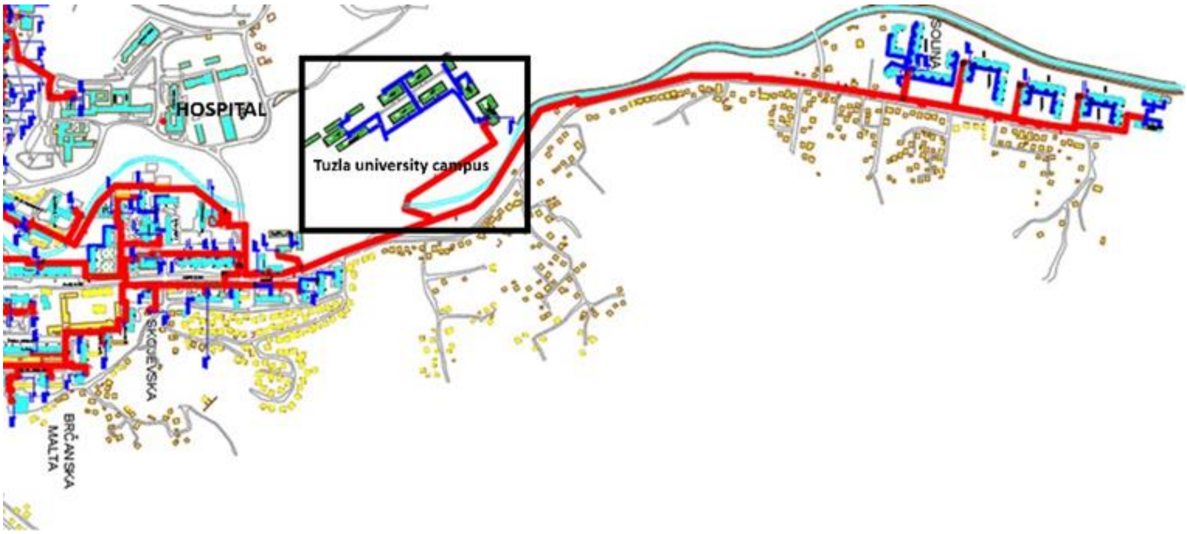
The pilot project will address the supply side of the district heating system which will promote energy and cost efficiency, facilitate the reduction of use of fossil fuels, and improve regulatory and policy framework. It will also create opportunities to share applicable solutions and address transformative issues, such as fostering multi-stakeholder collaboration focused on the use of renewable energy sources - solar thermal and photovoltaics, ambient heat, heat pumps and seasonal heat storage. The main goal of this pilot project is to develop technical project documentation for the implementation of sustainable heat supply solutions that will reduce fossil fuel dependency and pave the way for a more resilient and low-carbon DHS.

2.9.3. Detailed description of the pilot action concept

The pilot is located in the Tuzla University campus compound (see map below). Its primary objective is to develop detailed technical documentation for the construction of an alternative renewable heat source to serve the campus and the adjacent local community of Solina, that are presently connected to the Tuzla DHS.

The proposed solution involves the integration of renewable energy sources and technologies, namely solar thermal and photovoltaic, combined with seasonal heat storage and heat-pumps. The documentation will outline the design and implementation of a system capable of supplying heat to the campus, local community Solina, and potentially also for hot sanitary water of the nearby hospital. This new source is intended to replace the present coal-fired TPP that is providing heat to the Tuzla DHS. At present the heat demand of the campus and Solina local community is 7 MW and with the planned expansions, with projected growth to 12,4 MW for the campus and 15 MW for the adjacent local communities. The campus has around 8000 m^2 of available land for the installation of seasonal heat energy storage and solar thermal collectors and photovoltaic panels. The newly developed sources will be integrated into the existing DH network.

Figure 8: The map of pilot action in Tuzla



2.9.4. Impact of the pilot action

As explained above, once implemented, the pilot will replace 7 MW of thermal power, currently ensured by the coal-fired thermal power plant with energy produced from renewable sources. This transition is expected to result in a reduction of CO_2 emissions, potentially down to 0 for the replaced capacity. The exact potential impact will be calculated based on the final technical documentation developed through this pilot and detailed in the final implementation report.

2.9.5. Key steps of implementation

1st quarter of 2025– Preparation of the Terms of Reference TOR (AC BiH + ASP 4 and ASP 14)

2nd quarter of 2025 – Identification of potential experts/consulting companies and tender procedure (AC BiH)

3rd / 4th quarter of 2025 – Production of the technical project documentation and dissemination / promotion of the results

2.9.6. Roles and responsibilities

Aarhus Center will coordinate the whole process, carry out the tender procedure and disseminate / promote the results.

ASP 4 and ASP 14 will provide all relevant technical inputs necessary for the preparation of the TOR and the specific data and expertise needed for the creation of the technical project documentation. Once the technical project document is developed, the finalized technical documentation will be jointly owned by both ASPs, who will use it as a basis to raise funding and proceed with project implementation.

2.9.7. Ownership

The pilot site is owned by Tuzla University (ASP14), while the DH network is operated by Centralno grijanje Tuzla (ASP4), a company owned by the Municipality of Tuzla. Once the pilot is completed (technical project document is produced), both ASPs will hold ownership of the document. As mentioned above, they plan to cooperate in the next phase – the actual construction and installation - using the documentation to secure funding and eventually implement the project. During this process the final ownership and maintenance issues will be agreed between the parties involved: Tuzla University, Centralno grijanje Tuzla and the Municipality of Tuzla.

2.9.8. Stakeholder involvement

Both ASPs will be involved in the implementation of the pilot – ASP4 as the owner of the pilot location, and ASP14 as the operator and owner of the DH network. In addition, the Municipality of Tuzla will be involved in the process, given its role as the owners of Centralno grijanje (ASP 4).

2.9.9. Communication and awareness-raising actions

The results of the pilot will be shared through the project and AC social media platforms and will be presented at the regional Sarajevo Energy and Climate week conference in autumn 2025.

2.9.10. Sustainability and transferability of the pilot actions

If successful, the approach developed through this pilot can and will be transposed to other parts of the Tuzla DH system.

2.9.11. Risk management

The biggest potential risk is possible lack of commitment from some of the involved stakeholders to proceed with the follow-up activities and actual construction of the RES solutions, despite the availability of the prepared technical project documentation. This hesitation could stem from external pressure exerted by the fossil fuel lobby and the state owned company that currently supplies heat to the Tuzla DH system.

2.10. Pilot in Bulgaria

2.10.1. Problem definition, key challenges addressed

District heating (DH) systems in Bulgaria face significant challenges in achieving energy efficiency (EE) and sustainability. Only 4% of residential buildings have undergone energy renovation. Despite DH being a primary heating source in cities like Plovdiv, Sofia, and Varna, many building systems remain outdated, operating for over 30-40 years without upgrades.

Vertical pipe installations in multi-family buildings, typically built in the late 70s and 80s, lead to high heat losses, increased costs, and limited control over energy use. Transforming to horizontal systems can significantly improve efficiency, reduce heat losses, and enable better control of energy consumption.

Digital tools like data loggers play an important role in optimizing DH systems. By enhancing the monitoring and operation of domestic hot water (DHW) substations, these tools can identify inefficiencies, optimize energy use, and reduce operational costs. Additionally, using digital visualizations, such as energy maps, can help raise awareness and motivate building owners to adopt EE measures. These tools make the benefits of system upgrades and building renovations clear and tangible, fostering greater community engagement and action.

By piloting solutions in Plovdiv, such as scenarios for transforming vertical systems in combination with EE measures, optimizing DHW substations, and using digital tools for awareness and engagement, this pilot project aims to reduce energy consumption, lower costs for households, and create a replicable model for DH modernization across Bulgaria.

2.10.2. Pilot type, optimization and cooperation perspectives

The pilot project is focused on the demand side and integrates three interconnected components to address key challenges in district heating (DH) systems and improve energy efficiency in multi-family buildings.

The first component is scenario development for consumption optimization, which involves creating scenarios to model how energy consumption in buildings will change when vertical pipe installations are replaced with horizontal layouts. These scenarios will combine technical and economic data to evaluate the impact of these changes alongside energy efficiency measures for building envelopes, such as improved insulation and energy-efficient windows. By analysing the potential reductions in energy consumption and heat losses, the project aims to provide evidence-based insights into the benefits of these transformations, both for individual households and the broader DH system.

The second component is deployment of digital data loggers in DHW substations, which focuses on improving the performance of domestic hot water (DHW) substations. Digital data loggers will be installed in 20 substations identified as having unusually high energy losses or costs.

The collected data will be analysed to identify inefficiencies and develop optimization plans tailored to each substation. The goal is to reduce energy losses, lower operational costs, and enhance the overall efficiency of the DH network.

The third component is development of a digital map for building owners, which involves creating a publicly accessible digital map of selected multi-family buildings in Plovdiv. Available on the district heating company's website, this map will provide building owners with information on the necessary steps for replacing vertical pipe systems with horizontal ones. It will also include forecasts of the expected benefits based on the scenarios developed in the first component and showcase examples of successful transformations. This tool aims to raise awareness, motivate action, and support owners in making informed decisions about upgrading their building systems.

Together, these three components are designed to optimize energy consumption, reduce costs, and strengthen consumer engagement. By collaborating with building owners, municipalities, and technical experts, the pilot will create a replicable model for improving DH systems and supporting Bulgaria's energy efficiency and decarbonization goals.

2.10.3. Detailed description of the pilot action concept

The pilot project will be implemented in Plovdiv, Bulgaria. EVN Toplofikatsia Plovdiv serves 31,000 households, with 1,270 substations and 187 km of heat distribution network. 80% of the multi-family buildings in Plovdiv have low energy-efficient vertical heating installations. EVN Toplofikatsia Plovdiv, an associated strategic partner in the REHEATEAST project, has prior experience in transforming vertical to horizontal heating installations on building level. This experience will be further analysed and upgraded during the pilot phase with the development of optimization scenarios.

Main characteristics of the pilot project include transformation of vertical to horizontal installations. The pilot will analyse various transformation, combining the shift from vertical to horizontal installations with building envelope energy efficiency measures. These scenarios will evaluate the impact on reducing energy losses and consumption in buildings. Technical and economic data will guide the selection of the most effective solutions.

Digital loggers will be installed in 20 DHW substations identified with high energy losses and operational costs. The collected data will be analysed to develop optimization plans for these substations, aiming to reduce energy waste and costs.

A digital map of selected multi-family buildings in Plovdiv will be developed and made accessible on the EVN Toplofikatsia Plovdiv website. The map will provide information on the necessary steps for replacing vertical pipe systems, forecast the potential benefits of these upgrades based on the developed scenarios, and showcase examples of successfully completed transformations.

The pilot project will enhance energy efficiency, reduce heating costs, and strengthen consumer engagement through transparency and easily accessible information. The pilot will also contribute to the decarbonization of district heating systems, supporting Bulgaria's green transition.

2.10.4. Impact of the pilot action

To assess the impact, two evaluation methods will be applied: (A) potential energy savings, measured in kWh, and (B) annual financial savings, calculated in €, including an estimate of the payback period for the pilot investment, expressed in years. The findings from method B will serve as a key tool for communicating benefits directly to the company's end customers.

2.10.5. Key steps of implementation

1. Transformation of Vertical to Horizontal Installations (January 2025 – January 2026)

1.1. Develop scenarios for renovation of heating installations in multifamily residential buildings (January-May 2025)

1.2. Promotion of the results among DH clients (May 2025 – January 2026)

2. DHW optimisation (January 2025 – February 2026)

2.1. Purchase and installation of data loggers (January 2025 – April 2025)

2.2. Collecting data and analysing possible improvements (April 2025 – October 2025)

2.3. Optimise the work of DHW substations (November 2025 – December 2025)

2.4. Promotion of the results among DH clients (December 2025 – February 2026)

3. Digital building mapping (May 2025 – February 2026)

3.1. Development of the digital map (May 2025 – September 2025)

3.2. Promoting the map on the website of EVN Toplofikatsia Plovdiv (September 2025 – February 2026)

2.10.6. Roles and responsibilities

EVN Toplofikatsia Plovdiv is the key ASP (Associated Strategic Partner) and owner of the pilot site. Its role includes joint coordination together with EnEffect of all technical activities, such as deploying digital loggers in DHW substations, collecting and analysing operational data, and developing optimization plans. The company's existing experience in transforming vertical to horizontal heating installations will be critical for defining and validating technical and economic scenarios. EVN Toplofikatsia Plovdiv's involvement ensures alignment with real-world operational needs and the potential for scaling successful measures across its network.

EnEffect team will provide expertise and support in designing and executing the pilot action. Their role includes developing methodologies for data collection, scenario analysis, and optimization, as well as providing technical guidance and knowledge transfer to ensure the project aligns with international best practices. The EnEffect team will order the digital loggers and, together with the associated partner, carry out the monitoring and analysis of the results.

Building Owners and Residents of the pilot buildings will provide essential data on energy consumption and cooperate during the implementation of optimization measures. Their feedback will be crucial for refining technical solutions and promoting replicability in similar buildings.

2.10.7. Ownership

All pilot project results will be public and freely accessible. Technically, the associated strategic partner will have the care of the digital map and loggers after the pilot phase. Ownership of the results from the pilot activities will remain with EnEffect as a project partner. All outcomes of the pilot projects will be public and freely accessible.

From a technical perspective, the associated strategic partner will be responsible for promoting the digital map on their website and use the data loggers after the pilot phase for the duration of their service life.

2.10.8. Stakeholder involvement

The pilot project engages diverse stakeholder groups, ensuring that all key perspectives will be incorporated, and the outcomes will be broadly beneficial and replicable.

The results of the pilot project will be shared with other district heating (DH) companies across Bulgaria and beyond. This will include presentations at forums, tailored reports and communications, and informational events, enabling other DH providers to learn from the pilot's outcomes and apply successful measures to their systems.

Regulatory bodies will be encouraged throughout the pilot to align activities with national policy objectives. Regular updates, policy recommendations, and invitations to key events will foster collaboration and encourage the integration of pilot findings into policy frameworks.

The economic effectiveness of the piloted actions will be a focal point in discussions with financial institutions and investors, particularly during roundtable sessions and events, such as those organized under the SMAFIN Expanded project. These discussions aim to showcase the business case for energy efficiency (EE) and heating system modernization, fostering investment in similar projects.

Pilot activities, such as digital maps and visualizations, will empower consumers to make informed decisions, adopt energy-conscious behaviour, and participate in future large-scale retrofit programs.

Media outlets will play a crucial role in disseminating information about the pilot project, raising public awareness, and highlighting its benefits. Regular press releases, interviews, and promotional content will ensure wide-reaching communication of the project's progress and outcomes.

2.10.9. Communication and awareness-raising actions

The pilot project's communication and awareness-raising activities aim to engage stakeholders, inspire public interest, and ensure the widespread dissemination of results. These actions will combine digital tools, community interaction, and media outreach to maximize impact. A key element will be the creation of an interactive digital map, hosted on the EVN Toplofikatsia Plovdiv website. This map will visually demonstrate scenarios for transforming vertical installations into horizontal ones, combined with energy efficiency improvements to building envelopes. Workshops/round tables and consultations will provide platforms for dialogue between stakeholders. Consumers, authorities, financial and technical experts will have opportunities to explore the pilot's activities, discuss its relevance, and contribute their perspectives. These events will not only raise awareness but also build a shared commitment to the pilot's goals. Media outreach, including social media, press releases, articles, and interviews, will highlight the pilot's progress and real-life examples from the pilot, inspiring replication.

2.10.10. Sustainability and transferability of the pilot actions

The long-lasting impact of the pilot actions will be ensured by integrating the outcomes into EVN Toplofikatsia Plovdiv's operational strategies and sharing the results with stakeholders. The digital map of buildings, technical-economic scenarios, and lessons learned from the optimized heat substation operations will remain accessible on the utility's platform, on EnEffect and EcoEnergy network websites and at REHEATEAST project library, providing a resource for ongoing consumer engagement and decision-making.

The pilot results will serve as a blueprint for similar initiatives in other regions. The technical and economic analyses of transforming vertical to horizontal installations and the optimized substation performance will be presented to other district heating companies and regulators through events, press releases and communication. This will encourage replication and further development. In addition, engaging with investors and stakeholders could support the scaling of the pilot's solutions in line with Bulgaria's energy efficiency and decarbonisation goals.

2.10.11. Risk management

Effective risk management is essential to the successful implementation of the project, ensuring smooth execution and stakeholder engagement. The key risks identified relate to consumer resistance, data accuracy, and compliance with data protection regulations. The following measures will be implemented to address these challenges:

Homeowner resistance may arise due to a lack of awareness or concerns about costs, leading to scepticism toward the proposed measures. To mitigate this, the project will emphasize clear and transparent communication, providing detailed scenarios and digital visualizations to illustrate the benefits, including cost savings and energy efficiency improvements. Engaging consultations will further help build trust and encourage participation.

Ensuring data accuracy and availability is another critical aspect. Inaccurate or incomplete data from loggers or technical assessments could hinder analysis and decision-making. To address this, the project will implement regular monitoring, strict quality control measures, and contingency plans for potential equipment failures. Close collaboration with the district heating company will be maintained to ensure data reliability.

Additionally, the legal framework regarding data protection must be carefully examined, particularly regarding the information displayed for each building in the digital map, to ensure full compliance with relevant regulations.

3. Conclusion

Scoping pilot locations, stakeholders, and technologies for a District Heating and Cooling (DHC) optimization pilots involves in any case a strategic approach and consideration at the level of each partner to select the most suitable example.

Within the framework of the scoping analyses, proposed pilot concepts have been grouped into four categories based on their mutual characteristics and approaches to tackle identified challenges. The table below summarizes the deliverables originally envisioned in the Application Form and the project partners responsible for their completion based on their respective pilots.

Table 1: Overview of the pilot implementation by characteristics and approaches

Deliverable no.	Deliverable name	The main topics of deliverable	PP
D.2.3.1	Transnational demand-side community lab pilot 1	Testing stakeholder-inclusive process for introducing: consumption based DHC billing and comprehensive heat regulation - highlighting policy; digitalisation & financing options; citizen & municipal engagement via schools and interactive online content;	UTCLUJ EIHP 1 SCTM
D.2.3.2	Transnational supply-side optimisation pilot 1	Testing DH (heating) optimisation planning process: explore renewable (especially geothermal) and waste-heat, ambient heat utilisation, heat storage and digitalisation options and EU/DTP best practices in high-efficiency DH systems; in-depth analysis of their applicability/feasibility.	EIHP 2 AC-BiH PANNON LEAPOM
D.2.3.3	Transnational demand-side community lab pilot 2	Testing stakeholder-inclusive process preparing neighbourhood level deep retrofit of multi-apartment buildings: participative planning; citizen engagement; financial planning; digital transferability tools using standardised analytical & visualisation solutions; policy discussion.	IDEFA SCTM ENEFFECT
D.2.3.4	Transnational supply-side optimisation pilot 2	Testing applicability options of non-fossil DHC optimisation, including nature-based (cooling) solutions: exploring & showcasing best practices; analysis of various sustainability options; awareness raising among professional and civil stakeholders; linkages with other policy areas.	VIACARP