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REHEATEAST

# Analysis of Challenges, Gaps and Good Practices in District Heating and Cooling

Deliverable 1.2.1

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# Project partners

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# Content

# Executive summary

The document provides a comprehensive analysis of the district heating and cooling (DHC) sector, focusing on the REHEATEAST region, and identifies challenges, gaps, and best practices, while also outlining possible strategic and technical solutions to modernize and expand DHC systems. The analysis combines insights from stakeholder engagement, comparative evaluations of DHC conditions across countries, and also highlights several regional best practices to guide future investments and policy development.

The report provides an overview of the DHC sector in the participating countries, including Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Romania, Serbia, Slovakia, and Slovenia. A significant disparity in DHC development is evident across the region. While some countries rely heavily on fossil fuels, there is growing interest in integrating renewable energy sources (RES), such as geothermal, biomass and solar thermal. However, aging and inefficient systems remain a critical barrier to modernization in most countries of the region.

Heat supply trends also vary across the region, with some countries experiencing steady growth in DHC adoption and others facing declines. This fluctuation is often driven by a complex combination of factors, including energy efficiency (EE) improvements in buildings, the uneven prioritization of centralized versus individual heating solutions (often favouring the latter), and the lack of strategic local heat planning. These challenges present significant obstacles for utility operators and pose threats to the sector's future development. Additionally, insufficient incentives for RES integration and misaligned policies exacerbate these difficulties across the region.

The report identifies several common challenges in the DHC sector, such as outdated infrastructure, policy gaps, economic barriers, social acceptance issues, and technological constraints. Despite these challenges, the REHEATEAST region demonstrates strong potential for significant DHC expansion and modernization, aligning with EU directives and long-term sustainability targets.

The document also highlights successful regional and European projects and initiatives that support DHC modernization. These examples showcase a wide range of aspects, including the integration of RES, improvements in system efficiency and infrastructure upgrades, the implementation of effective policy frameworks to encourage renewable adoption, stakeholder collaboration, and innovative financing models that mobilize investments in DHC modernization.

Furthermore, the report proposes a set of comprehensive sustainability criteria for DHC systems, covering environmental, economic, social, technical, and governance domains. These criteria serve a dual purpose: defining clear targets and providing indicators for ongoing monitoring and reporting. The optimization models being developed within the REHEATEAST project will be guided by the selection of these criteria, ensuring alignment with broader sustainability objectives.

# Abbreviations and acronyms

| | |
|---|---|
| BiH | Bosnia and Herzegovina |
| BG | Bulgaria |
| CapEx | Capital expenditure |
| CBA | Cost-benefit analysis |
| CCGT | Combined-Cycle Gas Turbines |
| CHP | Combined heat and power (cogeneration) |
| DC | District cooling |
| DH | District heating |
| DHC | District heating and cooling |
| DHS | District heating system |
| EE | Energy efficiency |
| EED | Energy Efficiency Directive |
| ERDF | European Regional Development Fund |
| EU | European Union |
| GHG | Greenhouse gas |
| H&C | Heating and cooling |
| H2020 | Horizon 2020 (EU Research and Innovation Programme) |
| HP | Heat pump |
| HR | Croatia |
| HU | Hungary |
| LA | Local authority |
| LIFE | LIFE Programme (EU's funding instrument) |
| NECP | National Energy and Climate Plan |
| NG | Natural gas |
| OpEx | Operational expenditure |
| PP | Project partner |

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| RES | Renewable energy sources |
| RO | Romania |
| ROI | Return on investment |
| SHC | Solar heating and cooling (programme, International Energy Agency) |
| SK | Slovakia |
| SLO | Slovenia |
| SO | Specific Objective |
| SRB | Serbia |
| WH | Waste heat |

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# 1. Introduction

The REHEATEAST project seeks to reduce fossil energy demand in DHC systems by minimizing energy waste in buildings and networks while integrating renewable energy – particularly geothermal – and WH. It encourages multi-stakeholder, cross-sectoral, public-private cooperation and develops, tests, promotes and disseminates practical, technical, and nature-based solutions that support large-scale rehabilitation programs and climate adaptation measures.

Through knowledge-sharing, awareness-raising, and stakeholder cooperation, REHEATEAST promotes catalytic, adaptable solutions to decrease fossil energy reliance. It advocates a holistic approach over siloed strategies, facilitating transformative investments in EE, WH recovery, heat storage, geothermal energy, and improved billing practices. Its communication campaign, "Over 10 under 100", aims to lower annual heat consumption of buildings with at least ten apartments in cities with over 10,000 DHC users to below 100 kWh/m$^2$. This aligns with the Energy Efficiency Directive (EED), which emphasizes 'energy efficiency first' in all policy and investment decisions. Achieving targets under the EU Energy Performance of Buildings Directive (EPBD) is unfeasible without efficient DHC systems.

On the supply side, REHEATEAST aims to meet EED criteria for "Efficient DHC," requiring at least 50% RES, 50% WH, 75% cogenerated heat, or a combination of these sources. This must align with sound energy planning and management principles, ensuring capacities meet demand without waste.

Specific Objective 1 (SO1) focuses on understanding the technical, regulatory, social, and financial conditions of DHC systems, highlighting challenges and best practices within the REHEATEAST region. The objective aligns with the broader aim of strengthening stakeholder engagement to address the financial and environmental sustainability challenges of DHC systems. Through intensive stakeholder involvement, the project examines the regional status quo and specific challenges, fostering a deeper understanding of stakeholder interests while raising awareness.

Activity A.1.2, which underpins the development of this deliverable, focuses on identifying the challenges, barriers, and opportunities for creating energy-efficient, economically viable, and environmentally sustainable DHC systems. Leveraging insights from the stakeholder analysis (D.1.1.5), this analysis delivers essential knowledge to establish a robust and effective cooperation framework within the REHEATEAST project.

# 2. Methodology

A.1.2 builds on the status quo analysis and stakeholder-sourced information of A.1.1, (*Stakeholder involvement and DHC survey on technical, regulatory, operational, and financial conditions to identify opportunities for energy efficiency improvement and GHG emissions abatement*), explores DHC challenges in REHEATEAST regions concerning economical-environmental sustainability, based on a comparative analysis of gaps, good practices and trends in various countries, and concludes with the implementation of benchmarking analysis of the DHC status across the region. The outcomes of A.1.2 are presented in two key deliverables: D.1.2.1 - Analysis of Challenges, Gaps and Good Practices in District Heating and Cooling, and D.1.2.2 - Comparative analysis of institutional, legal and financial status quo of DHC.

To conduct the analyses mentioned above, project partners (PPs) collaborated by providing and sharing data to address the questions and topics outlined in Chapters 4 and 6. The objective of D.1.2.1 is to identify obstacles, gaps, and barriers, while also highlighting potential success factors, exploring good practices, and examining the regulatory framework for renovating, expanding, or deploying DHC systems.

The development of deliverable D.1.2.1 follows a structured process involving data collection, review, refinement, and organization into a coherent output. Numerous DHC projects and initiatives, along with specific outcomes, were identified in the project application and provide a strong foundation for analysis and dissemination. Key information sources, primarily from EU projects and initiatives, are detailed in Chapter 3, while country-specific DHC data outlined in Chapter 4 are being gathered by the respective project partners (PPs). Each PP bears responsibility for selecting and describing best practice cases (Chapter 6) that showcase advancements in their country's DHC sector.

To support this effort, a desk study and interviews were conducted to collect relevant information and identify suitable cases for analysis. An interactive presentation, available on the project website, showcases the state-of-the-art in the DHC sector and provides detailed insights into best practice cases from REHEATEAST countries.

The sustainability criteria essential for evaluating and improving DHC systems have been introduced, highlighting their pivotal role in addressing challenges, overcoming barriers, and leveraging opportunities through a comprehensive multidimensional framework.

The outputs of this deliverable are being translated into the local languages of REHEATEAST project partners and shared also on their respective websites. This ensures that DHC professionals and other stakeholders can easily access targeted knowledge while overcoming language barriers within REHEATEAST countries.

This analysis, along with the survey results (D.1.1.5), form the basis for a comparative analysis on institutional, legal and financial circumstances within the DHC sector in the REHEATEAST region (D.1.2.2).

## 2.1. Sustainability criteria for DHC

To effectively identify challenges, barriers, and opportunities for DHC, it is essential to establish clear sustainability criteria. These criteria enable policymakers, stakeholders, and operators to comprehensively assess and improve the sustainability of DHC systems.

Sustainability is widely understood as the integration and balance of environmental, economic (viability), social, governance and technical dimensions. A multidimensional approach is required to evaluate sustainability, incorporating criteria across these domains. These criteria serve a dual purpose: they guide objective management and development toward defined targets while also acting as indicators for ongoing monitoring and reporting.

Additionally, the optimisation models being developed in the REHEATEAST project will rely on the selection of these criteria. To maximize their effectiveness, criteria should be assessed with a holistic perspective, considering their overall impact on the sustainability goals of DHC systems.

### 2.1.1. Environmental criteria

The focus is on minimizing the ecological footprint and enhancing resource efficiency.

- *Structure of energy sources and integration of RES and WH*: Share of renewable and low-carbon energy sources (e.g., biomass, geothermal, waste heat, solar thermal).
- *GHG emissions*: Total carbon dioxide ($CO_2$) associated with the system and equivalent emissions per unit of heat or cooling delivered by the system.
- *Energy efficiency*: Overall system efficiency across all stages, including generation, distribution, and supply to consumers.
- *Resource use*: Sustainability and efficiency of raw material inputs (e.g., biomass supply chain sustainability, water use), integration of circular economy principles.
- *Air quality impact*: Reducing pollutants like NOx, SOx, and particulate matter (PM2.5, PM10).
- *Efficient land use*: (Minimizing) ecological disruption and incorporating green spaces into system planning.

### 2.1.2. Financial and economic criteria

The criteria evaluate the financial viability and economic impact on stakeholders.

- *Cost-effectiveness and market competitiveness*: Competitive pricing for heating and cooling (H&C) compared to alternatives (e.g., HP, fossil fuels; individual or centralised); Initial investment costs versus long-term operational and maintenance costs.
- *Affordability for users*: Accessibility of H&C costs for households and businesses.
- *Investment requirements*: Capital expenditure (CapEx) needed for systems development, upgrades, and expansions.

- *Return on investment (ROI)*: The payback period and profitability for stakeholders.
- *Operational costs*: Long-term operating expenses (OpEx) and maintenance needs, along with variability and predictability of energy costs for end-users.
- *Economic resilience*: Ability to sustain operations amid fluctuations in energy market prices.
- *Subsidy dependence*: Reliance on public funding and incentives for financial viability and the integration of RES.
- *Job creation*: Contribution to local employment and economic development, including employment opportunities generated during system construction and operation phases.

### 2.1.3. Social criteria

The criteria consider the impacts on communities and factors influencing public acceptance.

- *Energy accessibility*: Equitable and universal access to reliable H&C for all users, including vulnerable populations.
- *User satisfaction*: Reliability, quality, and comfort of services delivered through DHC.
- *Public health*: Contribution to improved health outcomes via better indoor/outdoor air quality and reduced emissions.
- *Public acceptance*: Community support for DHC projects through transparent communication, awareness campaigns, and fair practices, supported by stakeholder involvement in planning and implementation of project.
- *Public participation*: Opportunities for public engagement in planning and decision-making processes.
- *Societal and cultural compatibility*: Adaptability to local habits, preferences and local norms related to H&C.
- *Liveability*: Appropriate spatial planning and equitable distribution of benefits from DHC systems and public infrastructure.

### 2.1.4. Technical criteria

The criteria evaluate the technical aspects of DHC systems, focusing on its robustness and adaptability.

- *Reliability*: Stability and consistency of supply with minimal disruptions or outages.
- *Flexibility*: Ability to integrate diverse energy sources, adopt new technologies and adapt to fluctuation and changes in energy demand.
- *Scalability*: Potential for expansion to accommodate increasing demand over time.
- *Infrastructure lifespan*: Durability and maintenance requirements of pipelines, plants, and other critical infrastructure components.

- *Integration with urban systems and infrastructure optimisation*: Coordination with other utilities such as water, electricity, gas, transportation, and waste management, for holistic urban development.
- *Smart system integration and digitalization*: Utilization of advanced technologies (e.g., smart meters, AI-driven demand forecasting) for enhanced monitoring, control, and optimization of system performance.
- *Spatial planning with zoning and H&C demand/supply density considerations*: The suitability of DHC system evaluated on the basis of population density and urban layout.

### 2.1.5. Governance and policy criteria

The criteria assess the effectiveness of institutional and regulatory frameworks.

- *Policy alignment*: Compliance with national and international sustainability objectives (e.g., Paris Agreement, EU Green Deal).
- *Regulatory support*: Existence of policies that encourage RES integration and EE within DHC.
- *Transparency*: Clarity and openness in decision-making process and financial reporting.
- *Subsidies and incentives*: Effectiveness of financial support mechanisms to drive adoption and development of DHC systems.
- *Long-term planning*: Integration DHC into local, regional and national energy strategies.

# 3. Insights from EU and regional DHC projects and initiatives

In this review, key insights and best practices in the field of DHC are thoroughly explored. The desk-based analysis incorporates findings from EU-funded projects, initiatives, scientific literature, and selected case studies. This comprehensive examination highlights the current state of the art and cutting-edge innovations, emphasizing opportunities for system improvement, collaborative approaches, and best practices across both the supply and demand sides of DHC networks. Additionally, it showcases proven strategies and pioneering solutions aimed at maximizing the potential of DHC systems for sustainable energy management.

## 3.1. Review of selected projects and initiatives focused on DHC development

The development of DHC has been significantly influenced by various EU-funded projects, initiatives, and support activities. These efforts provide a rich source of innovative approaches for integrating RES and WH sources, modernizing heat networks, and advancing supportive policy frameworks. This chapter presents a comprehensive review of initiatives launched or implemented over the past five years, focusing on key lessons and replicable practices relevant to the REHEATEAST regions. A broader analysis of projects initiated between 2016 and 2022 is available in the EU publication "Advancing District Heating & Cooling Solutions and Uptake in European Cities," though only a selection of these efforts is highlighted below (*).

Further investigation has identified more recent projects; however, these typically yield less tangible outcomes and results, making them less suitable for sharing as best practices or models for replication. The advantage of ongoing projects and initiatives lies in their potential for networking with the REHEATEAST project, actively sharing knowledge and experiences, and collaborating to draw greater attention to demonstration cases and exemplary practices.

Key focus areas critical to advancing DHC are explored and presented below. These include the integration of RES and WH, building renovation, stakeholder engagement, strategic energy and spatial planning, system optimization, innovative investment models, business strategies, capacity building, smart data management, and the development of modular DHC networks.

### 3.1.1. Focus: Integration of RES and WH

***WEDISTRICT** (Smart and local reneWable Energy DISTRICT heating and cooling solutions for sustainable living; H2020; project in progress): The project aims to showcase innovative fossil-free H&C solutions for both new and existing DHC systems. These solutions integrate diverse RES and excess heat from data centres, employ advanced thermal storage to balance heat distribution by decoupling supply and demand, and leverage smart technologies to optimize system efficiency. The proposed solutions have been successfully demonstrated at several demo sites.

**CE-HEAT** (Comprehensive model of waste heat utilization in Central Europe regions; Interreg Central Europe; project completed) – The WH Platform (waste-heat.eu) includes transnational WH mapping tool and cadastre, a WH recovery calculator for industry, and a prefeasibility study to assist policymakers in identifying the most effective incentive schemes to make WH recovery an attractive investment. The platform also showcases best practice examples from HR, CZ, SLO, and other regions.

***KeepWarm** (Improving the performance of district heating systems in Central and Eastern Europe; H2020; project completed): It includes a review of the regulatory framework and barriers review to retrofitting DHS, along with related action plans. It features an online Learning Centre (keepwarmeurope.eu/learning-centre), offering a variety of training and knowledge-sharing resources on DHC, some of which are available in the local languages of key focus countries, including CZ, HR, SLO, SRB, and UA.

**HeatNet NWE** (Transition strategies for delivering low-carbon district heat; Interreg North-West Europe project): It developed the integrated transnational approach for supplying renewable and WH to residential and commercial buildings, addressing the challenges associated with 4$^{th}$ generation of DHC systems. Developments were tested and demonstrated through six case studies. The knowledge library provides guidance and transition roadmaps for several EU regions beyond REHEATEAST.

***ReUseHeat** (Recovery of Urban Excess Heat; H2020; project completed): Its objective was to demonstrate advanced, modular and replicable systems enabling the recovery and reuse of excess (waste) heat at the urban level. Building on CELSIUS, Stratego and HRE4 projects, the Handbook for increased recovery of urban WH was developed. Additionally, four large-scale demo cases highlighted the technical feasibility and economic viability of WH recovery.

**Support DHC** (Supporting a fast implementation of low-grade renewable energy and waste heat for district heating and cooling; LIFE22; project in progress): The initiative supports the rapid implementation of low-grade renewable energy and WH for DHC in Europe by assisting DHC operators in developing transformation plans that lead to efficient DHC systems. It also focuses on building the capacity of DHC operators to manage and steer these processes, as well as equipping specific service providers and other stakeholders to support transformation and investment planning.

**Low2HighDH** (Developing methodologies for the integration of low-grade energy sources into high-temperature district heating networks; LIFE22; project in progress): The objective is to develop methodologies for integrating low-grade RES into high-temperature DHSs. It aims to provide a portfolio of technical and financial solutions tailored to the most common scenarios, create investment plans for 30 cases, and generate and disseminate capacity-building materials for all types of stakeholders. BG and SK are covered.

**DARLINGe** (Danube Region Leading Geothermal Energy; Interreg Danube Transnational Programme; project completed): The key output is the provision of data and information services on deep geothermal energy resources in the southern part of the Pannonian basin, covering territories of BA, HR, HU, RO, SRB and SI, with additional updates for UA and SK. It includes the transnational Danube Region Geothermal Strategy, a report on EU legislation and policies, best practices and the Danube Region Geothermal Information Platform (darlinge.eu) with an extensive knowledge-sharing database.

**TRANSGEO** (Transforming abandoned wells for geothermal energy production; Interreg CE; project in progress): Investigates the potential of abandoned gas and oil wells for producing and storing geothermal energy. It develops a transnational strategy and regional action plans, involving also the regions of HR, HU and SLO.

**HEAT 35** (Transforming district heating systems of Central Europe into sustainable and efficient heating and cooling systems by 2035; Interreg CE; project in progress): It aims to develop innovative solutions to increase the share of RES and WH in DHS, targeting a minimum of 50% by 2035. These solutions will be demonstrated in several DHS, including systems in CZ, HR and SLO. In addition to capacity building for stakeholders, guidelines and tools for DHS operators are being prepared to support the implementation of these solutions while considering environmental quality management.

**USES4HEAT** (Underground Large Scale Seasonal Energy Storage for Decarbonized and Reliable Heat; Horizon Europe; project in progress): The project aims to demonstrate two innovative, large-scale, cost-effective underground seasonal thermal energy storage (UTES) technologies alongside six enabling solutions to enhance flexibility, availability, and robustness in the heating sector. It will utilize AI-driven energy management systems, big-data analytics, and predictive operation and maintenance (O&M) to validate the effectiveness and techno-economic-social viability of seasonal UTES. The UTES units will be integrated into two district heating networks, replicated in four additional systems (including one in HR), and accompanied by a knowledge toolkit for training and dissemination.

### 3.1.2. Focus: Building renovation

**ComAct** (Community-tailored actions for energy poverty mitigation; H2020; project completed in 2024): Focuses on energy-efficient upgrades in multi-family apartment buildings across the CEE (Central and Eastern Europe) and CIS (former Soviet Union republics) regions. It offers resources on financing models tailored to the needs of energy-poor households, guidelines for community involvement and stakeholder engagement, and educational material specifically for BG, HU and UA.

**RENOVERTY** (Home Renovation Roadmaps to Address Energy Poverty in Vulnerable Rural Districts; LIFE21; project in progress): Aims to foster energy-efficient building upgrades in energy-poor households by creating a methodological and practical framework for building renovation roadmaps for vulnerable rural districts. The approach emphasizes financial viability and social justice. It provides tools and resources to help local and regional actors design and implement operational roadmaps for single- or multi-household renovations in rural areas, with examples also in HR, HU, and SLO.

### 3.1.3. Focus: supportive activities for engagement of stakeholders

**TARGET-CE** (Capitalizing and exploiting energy efficiency solutions throughout cooperation in Central European cities; Interreg CE; project completed in 2022): The OnePlace energy efficiency web platform (https://oneplace.fbk.eu/) was leveraged to support public authorities, citizens and energy planners in effective energy management and achieving energy savings in public buildings. The platform offers a broad array of information on EE solutions, including best practices, expert databases, strategies, action plans, tools, educational resources and financial roadmaps. Case studies cover SLO, HR, HU, CZ and others.

**RenoHUb** (H2020; project completed): Offers reports on motivations for improving EE in residential buildings, along with financing tools and technical-engineering aspects in HU. The research also delves into homeowners' motivations, drivers and obstacles.

**BungEES** (Building Up Next-Generation Smart Energy Services Offer and Market Up-take Valorising Energy Efficiency and Flexibility at Demand-Side; LIFE; project in progress): Develops a "one-stop-shop" package of novel smart EE services integrating different energy sectors, such as electricity with H&C, innovative financing and rewarding solutions and analyses the integration of non-energy benefits and services. Focus is on identifying and overcoming market, regulatory and other barriers for integrated EE. It covers SK and CZ.

**ConnectHeat** (Community engagement for clean heat; LIFE21; project in progress): The project is developing a supportive policy framework to advance community energy initiatives aimed at decarbonizing the H&C sector. This effort includes collaboration among key stakeholders, the transfer of knowledge and best practices, the implementation of seven real-life community energy pilot cases in the H&C sector, and the creation of appropriate support schemes to ensure their stable growth. BG and HR are represented.

### 3.1.4. Focus: Strategic energy and spatial planning

**Act!onHeat** (From heating and cooling strategies to action: how public authorities can strategically plan the decarbonisation of the heating and cooling sector and initiate impactful projects; H2020; project in progress): The project identifies the key success factors of a robust and efficient existing H&C plans and develops a strategic planning workflow utilizing existing open-source tools.

**REDI4Heat** (Supporting the implementation of key EU legislations on heating and cooling; LIFE; project in progress): To facilitate the deployment of renewable H&C systems, the project aims to identify and address bottlenecks in national energy strategies. It will develop a Knowledge Sharing Platform and toolboxes tailored for public authorities at all levels of governance. Among the five EU Member States in focus is HR.

***Heat Roadmap Europe** (HRE) and **Stratego** (H2020; projects completed): A platform is focused on providing information and resources related to heat planning and EE initiatives, mostly aimed at policymakers, researchers, and professionals in the field of sustainable energy. The Stratego built on HRE and developed low-carbon H&C strategies - Heat Roadmaps.

***HotMaps** (The open-source mapping and planning tool for heating and cooling; H2020; project completed in 2020): The primary outcome is an open-source toolbox designed to support local, regional, and national H&C planning processes. It includes a user manual and an initial open-data set for the EU28, aimed at lowering the entry barrier for using the tool.

**ENTRAIN** (Enhancing renewable heat planning for improving the air quality of communities; Interreg Central Europe; project completed in 2022): It provides an online training toolbox for four target groups - public authorities, technical actors, interest groups, and economic actors – covering topics such as project development, funding, emissions, operation and quality management. It also includes country-specific guidelines for planning small DHC (by considering heat maps), a guideline for spatial multi-criteria analyses, financing and support tools, and pilot cases for heat planning that showcase also HR and SLO.

**IN-PLAN** (Integrated Energy, Climate and Spatial planning to enable local and regional authorities to effectively implement their plan; LIFE; project in progress): The project is establishing a sustainable support structure to help local and regional authorities effectively implement their SECAPs. This includes capacity building for local and regional development agencies and authorities. It will also analyse gaps, barriers, and best practices in current spatial planning, using these insights to enhance planning processes. The focus countries include HR and RO.

**SENERGY NETS** (Increase the synergy among different energy networks; EU-funded project; in progress): It identifies technical, environmental and social challenges associated with energy sector integration and develops tools and platforms designed to optimise the planning of DHC systems and distribution grids, taking sector coupling into account. These solutions also enable the provision of flexibility services to Distribution and Transmission System Operators. One of the demo cases is located in SLO and involves a DHC operator.

### 3.1.5. Focus: Optimization and low-temperate DH

***TEMPO** (Temperature Optimisation for Low-Temperature District Heating across Europe; H2020; project completed in 2022): The focus is on temperature optimization for low-temperature district heating (DH), introducing technical innovations that enable DH networks to operate at lower temperatures - these innovations were tested at two demo sites. The project provided an analysis of crowdfunding in the DHC and detailed the development process value propositions for the solution packages and technological innovations.

***COOL DH** (Cool district heating; H2020; project completed in 2023): It analysed the innovations in DHC across the demand, distribution and supply sides, producing publicly available reports with insights on how to improve the DHC systems efficiency. The results also include comprehensive thematic workshop proceedings, organised separately for demand, distribution and supply sides.

***REWARDHeat** (Renewable and Waste Heat Recovery for Competitive District Heating and Cooling Networks; H2020; in progress); The project's deliverables include an analysis of customer comfort requirements, service quality, and economic perspectives, all aimed at enhancing end-user engagement in H&C solutions. Additionally, a PESTLE (Political, Economic, Social, Technical, Legal, and Environmental) analysis was conducted to identify factors influencing the effective replication of Low Temperature DH networks across seven European countries, including HR.

## 3.1.6. Focus: Investment models and funding for energy renovation initiatives

**E-FIX** (Energy Financing Mix; H2020; project completed): It sought to enhance access to new funding sources for EE and renewable energy projects by offering a catalogue of evaluation methods for the systemic assessment of sustainable energy projects. It also provided training materials on innovative financing mechanisms and included case studies, such as those from HR and CZ, as practical examples of energy financing projects.

**SMAFIN** (Smart Financing Implementation; H2020 project) **/ SMAFIN Expanded** (LIFE; project in progress): Links smart financing with EE in buildings, industry, and SMEs by offering updates on the barriers and needs for boosting EE investments, along with a best practices reports (BG, HR, RO, SLO) highlighting successful financing schemes and initiatives that have driven significant investments in EE.

**BeSMART** (Bulgarian Energy Efficiency Forum on Smart Finance for Smart Buildings; H2020; project completed): The initiative supports the development of a sustainable financing scheme for renovating multi-family residential buildings in BG by engaging stakeholders, disseminating best practices, initiatives, and tools, and creating a web platform to share knowledge and experiences.

**MESTRI-CE** (Smart Management and Green Financing for Sustainable and Climate Neutral Buildings in CE; Interreg CE; project in progress): Introduces a new investment model to finance more climate-friendly and sustainable buildings. This model addresses both the supply and demand side of the renovation market, leveraging data collected, tools and green standards. The initiative is being implemented (also) in HR and SLO.

**EEnvest** (Risk Reduction for Building Energy Efficiency Investments; H2020; project completed): Offers a review of EE business models, a structured framework for evaluating risks in energy-efficient building renovation, and an investment evaluation platform with a benchmarking tool supported by a diverse set of data.

**QualitEE** (Driving Investment in Energy Efficiency Services Through Quality Assurance; H2020; project completed): It offers technical, financial, and procurement guidelines, along with handbooks on quality assurance for EE services, complemented by training materials. These resources are available in multiple languages, including UK, CZ, BG, SK and SLO.

**REFINE** (Supplying sufficient and attractive financing sources for Energy Efficiency Improvement investments through the enhancement of refinancing schemes; H2020; project completed): The online knowledge centre (https://refineproject.eu/refine-knowledge-centre) offers a collection of handbooks on refinancing of EE service projects, featuring tools for mainstreaming refinancing schemes and specialized training modules on this topic.

**RenOnBill** (Residential building energy renovations with on-bill financing; H2020; project completed): Its knowledge resource includes practical guidelines for developing on-bill financing offer for the deep energy renovation of residential buildings, and a tool designed to enhance the evaluation of EE interventions.

### 3.1.7. Focus: Business models and support facility for investments

**D2Heat** (Croatian district heating sector support facility; LIFE21; project in progress): It develops a tender dossier for DH investments that incentivises the adoption of innovative technologies and equipment based on the "energy efficiency first" principle. Additionally, it establishes a technical support facility to offer essential services and guidance to stakeholders in the sector in HR.

**ENABLE DHC** (Enabling strategies and investment plans for efficient, multi-energy and digitalized DHC; LIFE23; project in progress): The project aims to drive the transition of DHC networks toward efficient systems, as defined by the EED, by developing nine investment case studies across seven countries (AT, HR, IE, IT, LV, SLO, UA) with diverse framework conditions. These plans will be created in close collaboration with DHC utilities, focusing on digitalization, investment risk assessment, and sector coupling as key features. Additionally, intensive policy efforts will result in the creation of seven policy roadmaps tailored to the project countries.

**DHC SwEEtch** (Integrated tool chain for decarbonization roadmaps and investment plans towards efficient district heating and cooling systems; LIFE23; project in progress): The project aims to support operators of existing DHC networks in developing 2050 decarbonization roadmaps and 10-year investment plans aligned with the revised EED criteria for efficient DHC and local energy transition targets, such as those in SECAPs. A key objective is to engage the DHC community by leveraging the CONSTRUCTION21 platform to facilitate participation in training and dissemination activities, thereby maximizing replicability. The project spans three EU countries, including HR.

**3DIVERSE** (Decentralisation, Diversity and Dynamic Load Regulation – novel approaches to tangible energy transition with the diversification of production sources; LIFE21; project in progress): Aims to replace the traditional fragmented and sectional approach to energy transition investments with a novel strategy that integrates and aggregates investment actions across four interconnected sectors, including DHC. The project is being implemented in SLO.

**HeatMineDH** (Low-Grade Renewable and Waste Heat Mapping and Investment Planning for Efficient District Heating; LIFE22; project in progress): It develops business models and 10-year roadmaps to support utilities and municipalities efficiently implement DH by integrating low-grade renewable and WH sources. This includes conducting eight feasibility studies and creating practical investment plans, which also cover HR.

**ReDEWeB** (Renewable District Energy in the Western Balkans Programme; EBRD; project in progress): The programme aims to support the establishment of a market for renewable district energy (ReDE) investment through various measures. These include integrating ReDE into municipal energy and urban plans, preparing preliminary designs and feasibility studies, and establishing policy frameworks that encourage the private sector to propose the developments of ReDE infrastructure. The programme's beneficiaries include BiH, SRB, AL (Albania), KS (Kosovo), MN (Montenegro) and NMK (Northern Macedonia).

### 3.1.8. Focus: Capacity building

**SET_HEAT** (Supporting energy transition and decarbonisation in district heating sector; LIFE22; project in progress): It seeks to find approaches for mobilisation of DH companies to join the collaborative strategic planning process for modernisation, reconfiguration, and decarbonisation of DH systems together with other stakeholders. The focus is on knowledge sharing and providing training material, identifying and overcoming barriers, and developing strategic investment plans. The effort targets four Eastern European countries, including HR and RO.

### 3.1.9. Focus: Smart building data management

**DigiBUILD** (High-Quality Data-Driven Services for a Digital Built Environment towards a Climate-Neutral Building Stock; EU funded project; in progress)**:** Aims to shift the traditional "silo" approaches, where stakeholders manage their own building data independently, towards creating an interoperable and smarter data space for EE in buildings; exemplified by a pilot project in RO.

### 3.1.10. Focus: Modular DHC networks

***CoolHeating.eu** (Market uptake of small modular renewable district heating & cooling grids for communities; H2020; project completed in 2018): The project delivered exemplary techno-economical assessments for developing DHC systems in five target communities, and created a range of handbooks, guidelines and tools to support the launch of new small modular renewable DHC grids in the SEE region, including BiH, HR, SI and SRB.

*BioVill** (Bioenergy Villages - Increasing the Market Uptake of Sustainable Bioenergy; H2020; project completed in 2019): The project aimed to foster the development of the bioenergy sector in selected European countries (including HR, NMK, RO, SLO, and SRB). Its focus was on strengthening the role of locally produced biomass as a main contributor for energy supply on the local level, and exploring opportunities to set-up biomass-based CHP plants and small DH networks.

## 3.2. Projects and initiatives tackling the wider contexts in support of DHC development

DHC systems are pivotal for realizing a future integrated energy system driven by RES. As a scalable, flexible, and efficient energy solution, DHC supports the implementation of smart city and energy community principles by enabling decarbonization, fostering strategic urban planning, and seamlessly integrating with other smart city technologies. Centralized emission controls inherent in DHC systems contribute to reduced air pollution through technically sound and closely monitored environmental management. The adaptability and scalability of DHC systems ensure they remain future-proof, capable of evolving with technological advancements while enabling the interconnection of various energy sectors – a critical process known as sector coupling. This integration enhances the overall efficiency, resilience, and sustainability of urban environments. Moreover, DHC systems are vital in achieving climate neutrality and building climate resilience. They offer reliable, adaptable, and sustainable energy services that can withstand the impacts of climate change. By facilitating the decarbonization of urban areas and promoting sector coupling, DHC systems play a crucial role in the transition toward a more sustainable and resilient future.

The following projects showcase innovative approaches and best practices that address these broader contexts, offering valuable insights for the REHEATEAST regions. They cover diverse areas such as the development of Positive Clean Energy Districts, nature-based urban solutions, air quality improvement initiatives, and integrated urban energy planning. Together, these initiatives provide actionable knowledge that can support the advancement of DHC systems and the broader energy transition.

**ASCEND** (Accelerate Positive Clean Energy Districts; Horizon Europe; project in progress) focuses on developing Positive Clean Energy Districts (PCED) in two lighthouse cities, while promoting PCED concept across six multiplier cities, including Alba Iulia (RO) and Budapest (HU).

***ATELIER** (AmsTErdam BiLbao cItizen drivEn smaRt cities; H2020; project in progress) is aiming to create and replicate Positive Energy Districts (PEDs) within two lighthouse cities and six fellow cities, including HU and SK capitals.

**NetZeroCities** (H2020; project in progress): The project's objective is to help cities overcome barriers to achieving climate neutrality by 2030. It develops and promotes new and existing tools, resources and expertise, all integrated into a one-stop platform accessible to all cities via the online portal *netzerocities.eu*. This portal offers publicly available resources, including a comprehensive Knowledge Repository that also covers DHC, as well as a Finance Guidance Tool.

**Ready4netzero** (Long-term Climate-Neutrality Strategies in Towns and Cities; EUKI; project in progress): To support the development and implementation of local strategies for achieving climate neutrality in small and medium-sized cities in HR, HU, RO and PL, the project provides written guidance on advancing toward climate neutrality, along with practical capacity-building activities.

**GreenScape CE** (Climate-proof landscape through renaturing urban areas in Central Europe, Interreg CE project): Pilots the application of nature-based solutions and green infrastructure approaches against urban heat islands in five cities, including cities with major DHC systems like Zagreb (HR), Ptuj (SLO) and Szeged (HU).

**HungAIRy** (Improving air quality at eight Hungarian regions through the implementation of air quality plan measures; LIFE17 project): Aims to enhance air quality in 10 Hungarian municipalities by developing emission databases, establishing a national network of experts and consultants, and conducting comprehensive awareness-raising activities that also promote DH.

***SmartEnCity** (Towards Smart Zero CO2 Cities across Europe; H2020; project completed in 2022): The project developed a highly adaptable and replicable systemic approach towards urban transition into sustainable, smart and resource-efficient cities in Europe - the strategy Cities4ZERO. This is a step-by-step methodology for local authorities, able to guide them through the process of developing the most appropriate plans and projects for an effective urban energy transition. The method was applied in 3 lighthouse and 2 follower cities, one from BG (Asenovgrad).

***MySMARTLife** (Transition of EU cities towards a new concept of Smart Life and Economy; H2020; project completed in 2022): The project developed an Advanced Urban Planning instrument that integrates planned city interventions with active citizen engagement in the decision-making process and incorporates a structured business model, referred to as the city business model. Among the three lighthouse cases, Nantes (France) showcased a district heating (DH) optimization approach, while Rijeka (HR) was featured as one of the follower cases. Related reports and additional information are available in the public deliverables.

**CLEVER Cities** (Co-designing Locally tailored Ecological solutions for Value added, socially inclusivE Regeneration in Cities; H2020 project): The initiative employed strong local partner clusters to engage diverse stakeholders in the development of nature-based solutions (NBS) for sustainable urban regeneration at every stage. The resources provided include insights into barriers, success factors, and guidance on the co-creation of NBS, along with a dedicated Data hub offering open-source data.

## 3.3. Selected scientific literature and studies related to DHC

This section highlights key scientific publications, feasibility assessments, and international reports offering insights into market dynamics, policy frameworks, and technological innovations within the DHC sector. The reviewed studies cover regulatory frameworks, decarbonization pathways, RES integration, and EE strategies. Notable contributions include analyses by the European Commission and the International Energy Agency. These works explore market regulation, consumer engagement, sector coupling, and emerging technologies like low-temperature district heating (LTDH) and large-scale solar integration.

The EC Study Overview of Heating and Cooling: Perceptions, Markets and Regulatory Frameworks for Decarbonisation (2023) includes the final report, executive summary and five deliverables, which reflect on (1) factors governing decisions in H&C, address the (2) perception and image of H&C technologies by current DH and heat pump (HP) users and non-users from industrial, residential and public sector, provide an (3) overview of incentives for the uptake of DHC and HP and (4) costs for providing H&C with HP and DH to European end-users, and highlights (5) the role of H&C in the context of energy efficiency obligation schemes (EEOS).

The EC DG Energy publication District Heating and Cooling in the European Union - Overview of Markets and Regulatory Frameworks under the Revised Renewable Energy Directive (2022) provides results of a deep analysis of the DHC market (Block A), as well as the policy framework (regulation and support measures) and urban regulations affecting DHC use in buildings and industries (Block B). Current best practices of DHC systems using renewables and waste heat/cold sources are illustrated through ten European case studies (Block C).

The EC JRC publication Consumers in district heating and cooling - Background report on how to evaluate the sustainability of district heating and cooling (2023) discusses various calculation methodologies for quantifying the energy performance and RES share of DHC networks. It also explores different indicators used to present the sustainability of heat or cold supply within specific DHC system.

The EC DG Energy report Renewable heating and cooling pathways - Towards full decarbonisation by 2050 (2023) offers a comprehensive analytical basis for developing and implementing policies that will enhance a seamless pathway to full decarbonisation of the H&C sector by 2050. The analysis also covers the decarbonisation strategy for DH along with the related challenges and barriers, and outlines key policy set elements necessary for expanding and decarbonising DH. The report focuses on EU MS countries, including RO, HU, SLO, BG, HR, CZ and SK.

The EC JRC study Integrating renewable and waste heat and cold sources into district heating and cooling systems - Case studies analysis, replicable key success factors and potential policy implications (2021) examines the design and operation of eight efficient DHC systems in different EU MS (DK, FR, DE, IT, LT, ES). Using a holistic approach, the analysis identifies key success factors that facilitate the integration of RES and WH/C, as well as the drivers and conditions for replicating good practices in other cities and communities. It also suggests policy guidelines to support the integration of local and low-carbon energy sources through DHC.

The feasibility study Decarbonisation of heating and cooling sector - promotion of green district heating in the Danube Region (Interreg Danube, 2022) offers a detailed overview of the DH sector in six DR countries (BiH, HR, RO, SK, SLO, SRB), as well as their geothermal potential, aiming the transition of these fossil-fuel based systems to greener alternatives.

The UN Environment Programme publication DISTRICT ENERGY IN CITIES - Unlocking the Potential of Energy Efficiency and Renewable Energy (2015) provides an overview of early best practice cases in EE improvements and renewable energy integration in the H&C sector at the city level. It highlights specific policy provisions, financing mechanisms, and technological solutions implemented up to 2015.

The article Evaluation of district heating patterns for Hungarian residential buildings: Case study of Budapest (Energy and Buildings, 2023) analyses the heat consumption of 218 multifamily buildings in Hungary's capital, grouping them by typology. Energy signature diagrams were used to evaluate the DH consumption and assess the impact of building characteristics to the energy demand.

The IEA DHC project Annex TS2: Implementation of Low Temperature District Heating Systems aimed to facilitate the deployment of 4$^{th}$ generation district heating (4GDH) by providing a framework for the exchange of research findings from international initiatives and national projects. The conditions necessary for implementing the low-temperature district heating (LTDH) have been gathered and compiled in the Low-Temperature District Heating Implementation Guidebook, which also features 15 examples of successful LTDH system implementation.

The IEA DHC initiative Annex TS5: Integration of Renewable Energy Sources into existing District Heating and Cooling Systems focuses on integration of RES into existing DHC systems. This includes large-scale solar thermal, large HP, renewable power-to-heat (P2H) systems, geothermal, biomass and large heat storages in combination with CHP and surplus heat. To date, the initiative has compiled the State-of-the-art country report on the topic, covering ten primarily EU countries, and the Annex Concept.

IEA Task 55 SHC - Integrating Large Scale Solar Heating & Cooling Systems in DHC Networks – serves as a platform for diverse stakeholders to explore options and strategies for leveraging solar thermal energy in DHC systems. This initiative addresses both the benefits and challenges associated with integrating solar thermal energy and offers a wide range of publications and exemplary case studies on the subject.

IEA Task 68 SHC - Efficient Solar District Heating Systems enhance heat delivery efficiency – is a platform dedicated to improving heat delivery efficiency by optimizing integration of solar heat into DHC systems, advancing digitalization, and exploring new business models to increase attractiveness of solar DHC systems.

The World Bank Group report BULGARIA District Heating Project - Project Performance Assessment Report (2018) evaluates the development effectiveness and sustainability of the World Bank–financed District Heating Project in Bulgaria (2003–2008). The record is part of the follow-up on the achievements of the project, which aimed to improve the quality of DH services in the capital city of Sofia and the nearby town of Pernik.

The paper District heating potential in the EU-27: Evaluating the impacts of heat demand reduction and market share growth, presents a new approach to modelling the gradual reduction in heat demand and the expansion of DH networks for assessing DH potential in EU member states (MS). It introduces methods to evaluate the impact of connection rates below 100% on heat distribution costs in both dense and sparse areas. Based on an EU decarbonization scenario, heat demand is projected to decrease from 3,128 TWh in 2020 to 1,709 TWh by 2050. The approach provides insights into economic DH areas, DH potential, and average distribution costs. The study highlights that over 40% of the EU's heat demand is in regions with high DH potential.

The publication DISTRICT ENERGY - Energy Efficiency for Urban Areas (2018) serves as a comprehensive "white paper" that outlines key insights for expanding the use of district energy systems. It addresses critical aspects such as system design, regulatory frameworks, planning, energy source efficiency and flexibility, storage, and future outlooks, supported by relevant global case studies. The publication is especially valuable as it leverages over 100 years of expertise in district energy development, drawing from Denmark's extensive experience as well as international practices.

## 3.4. Other platforms and tools

**ManagEnergy** (https://managenergy.ec.europa.eu): The initiative aims to empower regional and local energy agencies to lead the energy transition and accelerate sustainable energy investments in regions and cities by providing them with information, expertise, visibility, and networking opportunities.

**heatandthecity.org.uk**: The research platform is offering information on innovative policy and practice for clean heat supply and low energy buildings.

# 4. DHC sector characteristics in REHEATEAST countries

This overview of the DHC sector across REHEATEAST partner countries highlights their unique characteristics, challenges, and opportunities. It examines the key historical developments, current energy mix, system capacities, infrastructure, regulatory frameworks, and modernization efforts shaping DHC operations. The analysis also identifies emerging trends, offering a foundation for understanding each country's strategic position and potential for future advancements in the sector.

## 4.1. DHC sector in brief

**Bosnia and Herzegovina**

In 2017, BiH had 29 major companies - 11 in Republika Srpska (RS) and 18 in the Federation of Bosnia and Herzegovina (FBiH) - operating about 32 DH systems. By 2018, these systems covered a total heated area of approximately 10 million m², with the largest networks in Sarajevo (3 mio m²), Banja Luka (1.35 mio m²), and Tuzla (1 mio m²). In 2015, heat distribution losses averaged 6.5%, and between 2011 and 2015, heat production declined by an average of 3% annually, with 2015 production at 88.5% of 2011 levels. That year, DH accounted for about 8% of the total heat consumption of 71 PJ (19.7 TWh). In recent years, this trend has gradually shifted, with an increase in thermal energy generation for DH. For instance, Elektroprivreda BiH, which supplies DH systems in Tuzla, Lukavac, and Kakanj from two coal-fired power plants, reported heat production of 131.60 GWh in 2016, increasing to 146.60 GWh in 2023.

In RS, 94% of district heat is generated by DH plants, with the rest supplied by the Ugljevik Thermal Power Plant. Fuels include fuel oil (e.g., Istočno Sarajevo, Banja Luka, Prijedor), coal (e.g., Doboj, Bijeljina, Čelinac, partly Pale), biomass (e.g., Pale, Sokolac, Gradiška, Prijedor, Banja Luka), and natural gas (Zvornik). As of 2018, the installed capacity of heating plants in RS was 513.5 MW (without Brod and Derventa), covering 2.3 million m² of residential (in appr. 40 thousand apartments) and 460,000 m² of office space. Heat production declined by 3.8% annually from 2011 to 2015, with 2015 production at 85.7% of 2011 levels.

In FBiH, heat is supplied by local thermal plants (e.g., Tuzla, Lukavac, Kakanj) and industrial sources (Zenica). The largest and most efficient systems are in Sarajevo, using natural gas, and Tuzla, using heat from TPP Tuzla. Distribution losses in 2015 were 7.3%, and heat production declined by 2.8% annually between 2011 and 2015, reaching 89.3% of 2011 levels. About 97 thousand residential units are heated by DH systems in FBiH.

**Bulgaria**

District heating (DH) serves as the primary source of heating and hot water in densely populated cities across Bulgaria, supplying approximately 30% of urban households, predominantly using natural gas. Sofia hosts the largest DH system in the country, accounting for about 65% of the national heat supply and serving over 440,000 consumers, mainly through CHP plants. Notably, this system is the only one owned by the municipality. According to a 2018 World Bank report[1], the DH sector in Bulgaria is recognized as the most economical and environmentally sustainable option for heat supply. The sector is regulated by the Energy and Water Regulatory Commission (EWRC), which oversees licensing, tariff setting, and compliance, ensuring consumer protection through fair pricing, reliable service, and transparent billing. The Ministry of Energy also plays a crucial role in shaping and implementing policies that affect DH operations.

DH companies must adhere to various regulatory requirements, including obtaining licenses, following tariff regulations, and adopting EE measures while integrating RES. Additionally, they are obligated to report to the EWRC to demonstrate compliance with national and EU standards regarding emissions and renewable energy.

The DH systems in Bulgaria were originally constructed in the 1950s and 1960s to provide a collective, subsidized heat supply without catering to individual consumer needs. This rigid design limited consumers' ability to adjust their heat consumption on demand, thereby restricting opportunities to reduce supply costs. Over the years, inadequate funding for maintenance and new investments has led to a decline in the condition of DH assets, resulting in low operational efficiency and, in some cases, poor service quality, particularly evident in cities like Gabrovo.

**Croatia**

In 2022, approximately 2 TWh of heat was delivered by DH countrywide. Heat production, distribution, and supply for tariff customers were carried out by 11 companies operating in 16 towns. These systems provided hot water for space heating and sanitary hot water preparation for over 160 thousand customers, primarily in larger cities of continental Croatia and Rijeka, with households accounting for more than 95% of all users. Heat was generated in CHP plants located in Zagreb, Osijek, and Sisak, as well as in heating plants, block and boiler houses serving various settlements. This heat was distributed through a DH network spanning over 447 kilometres. Additionally, process steam for industrial use and partially for space heating was produced and supplied in Zagreb, Osijek, and Sisak.[2]

Most of Croatia's DH systems are classified as 2$^{nd}$ generation, utilizing pressurized hot water with supply temperatures exceeding 100°C. However, the condition of the existing building stock, which remains largely inefficient, presents significant challenges. High supply temperatures must be maintained to meet heating demands, resulting in elevated energy losses and reduced operational efficiency.

The DH sector relies on a diverse fuel mix, including natural gas (NG), renewables, oil and petroleum products used in CHP and local boiler plants. Over the past decade, notable shifts have occurred in the dominance of these fuels. For example, the use of NG has increased, compared to oil and petroleum products, while the share of renewables, particularly biomass, has been steadily growing. In 2022, NG and oil/petroleum products accounted for 67% of the fuel mix, while renewables made up 27%.

[1] *https://ieg.worldbankgroup.org/sites/default/files/Data/reports/ppar-bulgariadistrictheating.pdf*

[2] *Energy in Croatia 2022, EIHP*

**Hungary**

About 17% of residential buildings are connected to DH systems, while 78% rely on individual heating solutions. The individual systems primarily rely on natural gas (NG) (50%) and alternative fuels like firewood[3]. Hungary's DH systems remain heavily dependent on NG, which accounted for nearly 70% of its energy mix in 2022, with renewable sources contributing 23.7%[4]. The reliance on imported NG poses significant economic and supply vulnerabilities, especially during geopolitical tensions that drive up oil and gas prices, further intensifying these risks. This dependence impacts not only DH systems but also the 2.7 million households that use NG for heating. As renewable energy adoption grows, the reliance on NG, also in DH is expected to decline, though it will likely remain a major component for some time.

**Romania**

In Romania, the public service for the supply of thermal energy in a centralized system is managed, coordinated, and overseen by local public administrations. According to the 2022 report by the Romanian Energy Regulatory Authority (ANRE), there were 47 active operators of district heating systems in 2021, managing 49 systems across 50 locations in 28 counties and the Municipality of Bucharest. Data from these operators indicates a total of 1,095,551 DHS consumers nationwide, comprising 1,082,212 residential consumers (apartments and houses), 2,437 public institutions, and 10,902 economic operators. The combined thermal capacity installed in DHS-owned plants reached 7,501 MW, with 4,174 MW dedicated to cogeneration and 3,353 MW to separate thermal energy production. These figures exclude capacities from independent producers supplying DHS operators in 2021.

The energy mix for DHC is predominantly natural gas (NG) at almost 80%, followed by coal (14.3%), biomass (2.3%), fuel oil (2.1%), nuclear energy (0.7%), and geothermal energy (0.6%). Romania's reliance on NG in its DH energy mix is significantly higher than the EU-27 average, which stands at approximately 30%.

Operating as a third-generation model, the system functions at temperatures below 100°C, with average energy losses estimated at 35%. The pipeline network extends 4,624 kilometres, averaging 2.42 km per capita. Notably, heat consumption from DHS has consistently declined, with an average annual decrease of about 7.7% over the past three years. This decline reflects a broader trend in Romania, where the number of cities with DH systems has dropped dramatically - from 315 cities around 30 years ago to just 61 by 2015, and more recently, to fewer than 50. While Romania's DH sector faces challenges such as high energy losses and a declining consumer base due to a shift towards individual heating solutions, initiatives focused on modernization and diversification of energy sources are essential for revitalizing and sustaining these systems.

**Serbia**

DH systems began significant development in the latter half of the 20$^{th}$ century. Initially reliant on coal and fuel oil, the use of natural gas (NG) commenced with the completion of the Mokrin-Kikinda-Elemir-Velika Greda-Pančevo gas pipeline in 1963.

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[3] *KSH, 2020*

[4] *MEKH-MaTáSzSz, 2022*

Currently, there are 64 entities responsible for the production, distribution, and supply of thermal energy, with heat sources boasting an installed capacity of approximately 6.4 GW[5]. In 2022, DH systems produced 6.7 TWh of thermal energy[6]. The 2022 census recorded 657,019 households – 25 % of all households – connected to DH, covering a total area of 46.6 mio $m^2$, including 36.3 mio $m^2$ of residential space and the remainder serving commercial users. Primary energy sources for DH include NG (78.1%), fuel oil (6.4%), coal (13.3%), and renewables, mainly biomass (2.2%). Coal's significant share stems from heat supplied by coal-fired thermal power plants in some cities. The DH distribution networks span 2,776 km, predominantly utilizing two-pipe systems, with some three-pipe networks supplying hot water. The networks, with an average age of almost 24 years, feature various construction methods (overhead, underground, or in protective pipes) and insulation types (pre-insulated, mineral wool, multi-component bitumen, etc.). Heat losses across these systems averaged 13% in 2022, though individual systems reported losses ranging from 2% to 30%. Heat from the DH network is primarily transmitted indirectly via heat transfer stations. Of 27,236 transfer stations in 2022, over 95% were metered, with an average age of almost 15 years. Transfer station management varies, encompassing systems without regulation, local regulation, and remote regulation. At the consumer level, approximately 10% of heat energy consumption is metered.

**Slovakia**

The development of DH systems in Slovakia took off in the 1960s and 1970s, spurred by the need to address the increasing heating demands of rapidly growing urban areas. Today, over 200 such systems are in operation across the country, providing heat to nearly 1.8 million residents. These systems primarily serve large residential complexes, industrial zones, and city centres, covering about 30% of Slovakia's heating needs. Their focus remains on multi-family buildings and urban environments.

While natural gas continues to dominate heat production, coal is being phased out in favour of cleaner energy sources in alignment with EU environmental directives. Currently, around 20% of the heat supplied through DH systems comes from RES, including biomass, geothermal energy, and solar thermal technology. This transition to RES forms a key part of national broader strategy to reduce GHG emissions and enhance EE.

The Slovak government, in collaboration with local authorities, is actively modernizing DH infrastructure to improve operational efficiency. These efforts include increasing the share of renewables in heat production, upgrading aging systems, and implementing energy-saving measures. Looking ahead, projections suggest a significant rise in the share of RES in DH, supported by EU funding and national incentives for green energy. The country is also exploring heat storage solutions and smart grid technologies to enhance the flexibility and reliability of DH systems.

Despite progress, the sector faces challenges, including the need for further infrastructure modernization, adoption of advanced technologies, and maintaining affordability for consumers. However, continued investments in renewable energy and efficiency measures position Slovakia to achieve meaningful advancements in sustainable DH. As part of the nation's transition to a

[5] *Energy Balance of the Republic of Serbia, 2024*

[6] *Business Association of DH of Serbia*

cleaner and more energy-efficient future, the role of DH is expected to grow, contributing significantly to both local and EU climate objectives.

**Slovenia**

District heating (DH) is predominantly present in cities and larger settlements in Slovenia, with wood biomass systems dominating in smaller urban areas. There are over 100 DH systems being present in one third of the municipalities, collectively supplying approximately 2 TWh of heat annually. Most existing systems are high-temperature, second-generation systems, with only a few third-generation systems, making the integration of RES and WH challenging. For several years, DH systems have primarily relied on heat from combined heat and power (CHP) plants, accounting for around 85% of the primary energy share between 2017 and 2020. However, in 2021, increased heat production from natural gas (NG) and wood biomass boilers temporarily reduced this share to 72%. RES contributes about 15% of CHP-based heat production, while the combined share of RES and WH in total DH heat production has ranged from 16% to 20% in recent years. The share of heat produced in efficient DHS has consistently exceeded 80%.

Despite dispersed settlement patterns, there is substantial potential for expanding existing DHS and developing new, smaller systems or microsystems. Analyses show that over three-quarters of the current country's heat demand (2.2 TWh) is concentrated in areas with a demand density exceeding 200 MWh/ha, making these areas prime candidates for low-temperature systems. Expanding existing DH systems in such areas could add up to 500 GWh of heat supply, with an additional 150 GWh in areas where heat demand density exceeds 350 MWh/ha. For new smaller systems, the estimated potential is between 200 and 400 GWh, while microsystems could contribute 400 to 600 GWh. The total economic potential for heating buildings through DHS is momentarily estimated at up to 2.8 TWh annually, representing over 30% of the current useful heat demand in buildings.

A key challenge remains the integration of new sustainable heat sources and ensuring compliance with efficiency requirements under the Energy Efficiency Directive (EED), which affects more than a third of existing systems. According to the NECP, energy consumption in DH systems is expected to decline due to energy renovations in buildings. However, accelerated construction of new systems and expansion of existing networks could offset this trend and even drive growth. Integrating reliable and competitively priced WH sources could provide additional momentum for DHS development and network expansion.

### 4.1.1. Supply side

Key aspects of the DHC supply side reviewed include the number and size of DHCS, installed capacities, fuel mixes, and classifications based on production and thermal power. The overview also highlights system efficiency according to EED standards, energy sources used, and heat distribution characteristics, providing a detailed snapshot of the current state of DHC infrastructure in PP countries.

### *Number and scale of DHC systems*

Table 1: Extent and capacity of DHC systems

| COUNTRY: | BiH | BG | HR | HU | RO | SRB | SK | SLO |
|---|---|---|---|---|---|---|---|---|
| Total count of DHS | 29 | 10 | 60(ii) | 213 | 49 | 64(iii) | 200 | 101 |
| Classification:<br>- by production of heat[A]:<br>micro / small /<br>medium / large<br>- by thermal power[B]:<br>micro / small /<br>medium / large | | 0 / 0 /<br>4 / 6<br><br>(-) | (-)<br><br>0 / 47 /<br>8 / 5 | (-) / (-) /<br>22 / 11<br><br>(-) / (-) /<br>40 / 13 | 0 / 14 /<br>16 / 18 | (-)<br><br>0 / 11<br>33 / 8 (iiii) | 20 / 35 /<br>10 / 5<br><br>30 / 20 /<br>8 / 3 | 45 / 40 /<br>12 / 4<br><br>40 / 42 /<br>14 / 5 |
| Total installed capacity of DH systems (GW) / DC systems (MW) | DH: 1.82(i)<br>DC: (-) | DH: 5.3<br>DC: 0.5 | DH: 1.84<br>DC: 0 | DH: 8.18<br>DC: (-) | DH: 7.5<br>DC: (-) | DH: 6.4(iii)<br>DC: (-) | DH: 2.3<br>DC: 50 | DH: 1.97<br>DC: 3.9 |
| Total pipelines length (km) | | 3,205 | 448 | 1,962 | 4,624 | 2,776(iiii) | 2,800 | 910 |
| Number of DHS with thermal storage / heat capacity (MWh) | 0 / 0 | (-) / (-) | 1 / (-) | 0 / 0 | 0 | (-) | (-) / 5000 | 7 / 900 (5i) |
| DH cooling production / distribution (GWh) | (-) | (-) | 0 | 0 | (-) | (-) | 18 / (-) | 1.8 / 1.3 |

(-) no data
[A] Classification by heat production: micro – up to 1 GWh; small – 1-10 GWh; medium - 10-100 GWh; large – above 100 GWh.
[B] Classification by thermal power: micro – up to 1 $MW_{th}$; small – 1-10 $MW_{th}$; medium - 10-100 $MW_{th}$; large – above 100 $MW_{th}$.
(i) BiH: UNDP Study of the renewable energy sources with focus on biomass, geothermal and solar energy in BiH, 2019
(ii) HR: 11 operators (DH utility companies)
(iii) SRB: Energy Balance of the RS, 2024
(iiii) SRB: Data from the Association of DHS.
(5i) SLO: Appr. 26,000 $m^3$ volume.

### *DHC efficiency according to Energy Efficiency Directive (EED)*

Table 2: Efficiency of DHC systems

| COUNTRY: | BiH | BG | HR | HU (ii) | RO | SRB | SK | SLO |
|---|---|---|---|---|---|---|---|---|
| The shares of DHS …<br>… with at least: | | | | | | | | |
| 50 % RES | | | 3.49% | 28 | 9(iii) | 8% (5 DHS) | 10-15% | 53% |
| 50 % waste heat | | | 0.0% | 0 | 0 | 0 | 10% | 0% |
| 75 % of cogenerated heat | | | 64.26%(i) | 7 | 9 | 0 | 80-90% | 10% |
| 50 % of a combination of the above | | 78% | (0) | 14 | | 0 | 5% | 68% |

(-) no data
(i) HR: The share of high-efficiency cogeneration: 44.61%.
(ii) HU: In 2022, "efficient" DHC systems supplied 55% of the total heat delivered to networks. By 2024, 36 DHC systems met the efficiency criteria, an increase of two compared to 2022. The figures represent the number of DHS that meet the relevant efficiency criteria.
(iii) RO: 6 biomass and 3 geothermal DH systems.

### *Heat supply sectors, fuel and technology mix*

Table 3: Share of DH in heat supply and energy sources

| COUNTRY: | BiH | BG | HR | HU | RO | SRB | SK | SLO |
|---|---|---|---|---|---|---|---|---|
| Share of DH in heat supply (in %) | | | | | | | | |
| - total | | | 8.2 | | 20 | | 30 | |
| - households | | | | 17[(i)] | | | | 10 |
| - households and commercial | | | | | | 25[(ii)] | | |
| - services | | | | | | | | 20 |
| - industry | | | | | | | | 7 [(iii)] |
| Breakdown of energy sources used for DH (in %) | | | | | | | | |
| RES: | | 3[(6i)] | | | | 2.26 | 23 | |
| biomass | | | 23.0 | 10.5 | 2.3 | | 17 | 19 |
| biogas | | | 4.0 | | | | | |
| geothermal | | | | 16.3 | 0.6 | | | 0.2 |
| solar | | | | | | | 0.4 | |
| WH: | | | | | 0.7 (nuclear) | | | 0.3 (indus.) |
| Waste: | | 3 | 0 | 5.0 | | | | 3.3 [(iiii)] |
| Non-RES: | | 94 | | | | 97,74 [(ii)] | | |
| Oil & petro. products | | | 5.6 | 0.1 | 2.1 | | | 0.4 |
| Natural gas | 27 | | 67.4 | 66.1 | 80.0 | | 62 | 40 |
| LPG | | | | | | | | 0.6 |
| Coal | 39 | | | 0.1 | 14.3 (lignite) | | 0.7 (brown) | 36 |
| Other | | | | 2 | | | | 0.2 |
| RES in the DHC supply (%) | | 3 (approx.) | 27 | 26.8 | 3.6 | 2.18 [(ii)] | 36 | 19.5 |
| Share of CHP in total DH installed capacity (%) | | 42 | 89 | 48 | 55 | 11 [(5i)] | 80-90 | 68 |

[(i)] HU: Total DH consumption in households 5,440 GWh, in other sectors 1,655 GWh.
[(iii)] SRB: Data from the Association of DHS.
[(iii)] SLO: Total DH consumption in households 860 GWh, services 540 GWh, industry 610 GWh.
[(iiii)] SLO: 1.7% bio waste, 1.6% other waste
[(5i)] SRB: Energy Balance of the RS, 2024
[(6i)] BG: RES, primarily biofuels, account for 2.55% of the energy mix, with NG being the dominant fuel at 94%. In public combined power plants, the share of RES was 26.75% (in 2019). (Source: Ministry of Energy, Comprehensive Assessment of the Potential for Implementation of High Efficiency CHP and Efficient DHC Systems in the Republic of Bulgaria, 2021)

### *DH system temperature levels and heat distribution losses*

Table 4: DHS generations and losses

| COUNTRY: | BiH | BG | HR | HU | RO | SRB | SK | SLO |
|---|---|---|---|---|---|---|---|---|
| Estimated structure of DHS generations (the approximate shares of 2nd, 3rd and 4th gen.) | | | | | | | | |
| 2nd (T > 110 °C); | 100% | (*)[(i)] | 100%[(ii)] | | | | 40% | 60% |
| 3rd (110 °C < T < 70 °C) | | | | 100%[(ii)] | 100% | | 50% | 40% |
| 4th (T < 70 °C) | | | | | | | 10% | |
| Average losses across DH distribution systems (%) | | 24% | 19.6%[(iiii)] | 11.7% (937 GWh) | 35% | 13.1%[(5i)] | 10-20% | 18%[(6i)] |

[(i)] BG: Systems originally operated with supply temperatures of 130°C and return temperatures of 70°C. However, many are transitioning to lower temperature operations, with some systems now classified as 3rd DH generation.
[(ii)] HR: The hot water supply temperatures are consistently exceeding 100°C.
[(iii)] HU: Systems predominantly with T>100 °C.
[(iiii)] HR: The total average, incl. production and distribution.
[(5i)] SRB: Data from the Association of DHS.
[(6i)] SLO: Between 5 - 25%, some even above 30%; median 16%.

## 4.1.2. Demand side – consumers

The overview of the DHC demand side focuses on the number and types of consumers connected to DHC systems across the partner countries, highlighting trends in consumer growth, heat consumption, and projections for future market development. It examines residential, commercial, public, and industrial sectors, providing insights into their respective shares of total heat demand and the extent of building stock connected to DHC networks. Additionally, changes in consumer numbers, heat consumption patterns, and market development projections are analysed, offering a snapshot of the current state and evolving dynamics of DHC demand in the region.

***Number and type of consumers***

Table 5: Profile and number of DH consumers

| COUNTRY: | BiH | BG | HR | HU | RO | SRB | SK | SLO |
|---|---|---|---|---|---|---|---|---|
| Total number of users connected to DH | | 652,760 | 160,395 | 687,848(i) | 1,095,551 | 657,019(ii) | 1.8 mio (approx.) | 152,700(iii) |
| Shares of total heat demand (%) | | | | | | | | |
| - residential buildings | | 66.16% | 58.9% | 76.2% | 81.4% | (-) | 60-70% | 11%(5i) |
| - commercial buildings | | 16%(iiii) | 5.5%(iiii) | | 9.2% | (-) | 15-20% | 19% |
| - public buildings | | | | | 9.4% | (-) | 10-15% | 20% |
| - industrial facilities | | 18% | 35.6% | | | (-) | 5-10% | 7% |
| Share of building stock connected | (-)(6i) | 20% (approx.) | (-)(7i) | 14% | 11.0% | 30.6% | 50% (approx.) | 16%(8i) (approx.) |

(-) no data

(i) HU: The no. fee payers: households - 674,399, other - 13,449.

(ii) SRB: Data for residential users.

(iii) SLO: The number of users in 2023: 143,000 households, 8,800 services, 930 industry. The number of consumers in households is 41% higher compared to 2022; however, this increase is solely the result of correcting an error in record-keeping by some major heat suppliers in previous years. (Source: Report on the State of Energy in Slovenia in 2023; Energy Agency)

(iiii) BG, HR: All services (commercial and pubic).

(5i) SLO: The share of DH: multi-family buildings - 52%, single-family buildings - 1.5%.

(6i) BiH: Total heated area: about 10.05 mio $m^2$ (data from 2019).

(7i) HR: Total heated area: 11,828,367 m2 (https://www.hera.hr/hr/docs/HERA_izvjesce_2022.pdf).

(8i) SLO: Service sector 4.5 mio $m^2$ (20% sectoral share); single-family 0.5 mio $m^2$; multi-family 9.3 mio $m^2$. The total area in residential and service sector is 87 mio $m^2$.

***Trends regarding the number of DHS consumers in the last decade and the expectations for the next 5-10 years***

**Bosnia and Herzegovina**: Over the past decade, the number of DH consumers has grown by 1–1.5% annually, while the heated area has expanded by 1.5–2% per year. For instance, data from Tuzla's DH system indicates a 1.26% annual increase in the number of users and a 1.9% annual increase in heated area, rising from 1.53 mio m² in 2013 to 2.05 mio m². This growth trend is expected to continue.

**Bulgaria**: Between 2019 and 2022, DHS consumers grew by 0.7% annually on average, with stable numbers in some regions but declines in smaller cities. Efforts to improve air quality and phase out polluting fuels may drive more consumers to DHS in cities. However, in milder-climate cities like Plovdiv, Burgas, and Varna, DH consumer numbers may decline unless companies improve services and diversify offerings to remain competitive. This will be vital as the electricity market liberalizes and households may shift back to DH once subsidies for domestic consumers end.

**Croatia**: The number of users remained relatively stable from 2012 to 2015, followed by a notable 3% increase between 2015 and 2016. However, this growth was partially offset by a 1.5% decline in 2017. From 2017 to 2022, user numbers grew steadily by 4% over five years, averaging an annual increase of 0.6–1%. Looking ahead, the overall trend suggests sustained growth, indicating that this pattern is likely to continue in the coming years.

**Hungary**: Between 2018 and 2021, the annual growth rate was approximately 0.2%. However, this more than doubled to around 0.5% in 2022, with an addition of 4,000 new units. Looking ahead, the market share is expected to remain stable.

**Romania**: The number of consumers steadily decreased from 1.18 million in 2017 to 1.08 million in 2021. However, the Romanian Energy Strategy aims to reverse this trend, setting a target of connecting at least 1.25 million apartments to DH by 2030.

**Serbia**: Between 2020 and 2022, the average annual growth rate reached 1.02%. This trend is expected to continue.

**Slovakia**: The number of consumers connected to DH systems is steadily increasing, with growth expected to accelerate over the next 5 to 10 years. Ongoing modernization efforts, the integration of renewables, and strong government support are making DH an increasingly appealing solution for both households and businesses.

**Slovenia**: The total number of users has remained relatively stable, with annual fluctuations of up to ±3%. Between 2015 and 2022, household users increased from 95 thousand to 99 thousand, while users in the services and industry sectors combined grew modestly from 9,000 to 9,800. A steady state is anticipated over the next five years, with a potential slight annual increase of up to 0.2%.

***Heat consumption from DH systems (DHS) – trends in the last few years***

**Bosnia and Herzegovina**: In recent years, the growth rate of DH consumption has ranged between 1% and 2%. Heat consumption has also fluctuated depending on average outdoor temperatures.

**Bulgaria**: The annual growth rate ranged between 1.5% and 2%.

**Croatia**: From 2018 to 2022, annual heat delivery consistently ranged between 1.95 and 2.05 TWh, with the exception of 2021, when it peaked at 2.23 TWh.

**Hungary**: Between 2018 and 2022, heat consumption ranged between 6.94 and 7.22 TWh (25,000–26,000 TJ), averaging 7.1 TWh. The notable exception was 2021, when consumption spiked to 7.71 TWh (27,750 TJ), marking an increase of nearly 9% above the average.

**Romania**: DH supplied heat showed notable variation over recent years, with a peak of 9,887 GWh (9.9 TWh) in 2019, followed by a decline to 8,442 GWh (8.4 TWh) in 2020 and 8,377 GWh (8.4 TWh) in 2021.

**Serbia**: Data from the national Association of DH operators shows that heat production in DHS remained relatively stable between 2018 and 2022, ranging from 6.66 TWh in 2020 to 6.93 TWh in

2018 and 6.90 TWh in 2022. In contrast, the heat supplied to consumers varied, from 5.70 TWh in 2020 to 6.05 TWh in 2021 and 5.85 TWh in 2022.

**Slovakia**: The annual growth averaged between 1% and 2%.

**Slovenia**: Between 2014 and 2017, the volume of distributed heat grew steadily at an annual rate of 2–4%. However, in 2018, it declined by 5% compared to the previous year and then stabilized, remaining relatively constant through 2020. In 2021, distributed DH heat peaked with an 8% increase, but this was followed by a sharp annual decline of 6%. By 2023, the distributed heat had dropped to 1.7 TWh, returning to levels last seen in 2014.

# 4.2. Strategic role of DHC

The strategic importance of DHC in policy frameworks is explored, highlighting how PP countries incorporate DHC into national strategies, set development goals, and pursue energy supply modernization. Key policy areas, such as accessibility, affordability, consumer protection, and technical feasibility, are also addressed, emphasizing the essential role of municipalities and public utilities in fostering sustainable DHC development.

## 4.2.1. Role of DHC in national strategies

The leading question: *What role does DHC play in the national or regional strategy, particularly regarding infrastructure, energy supply, environment, construction sector, and building renovation?*

**Bosnia and Herzegovina:** According to the BiH Framework Energy Strategy (FES) and the Strategy for adaptation to climate change and low-emission development of Bosnia and Herzegovina for the period 2020–2030, the future development of the heating industry should be grounded in optimal techno-economic decisions while addressing the fundamental heating needs of households and other consumers. To improve the current situation, a series of measures must be implemented to enhance the overall efficiency of heat production and distribution, thereby increasing the competitiveness of companies in the thermal energy sector.

The BiH FES outlines the following strategic guidelines for the heating sector:

- Expansion and modernization of the heating sector through the development of DHS. This includes planning for infrastructure enhancements, the introduction of sanitary hot water systems from DHS, and the utilization of DH thermal energy in industrial processes, thereby expanding the market.
- Several models have been proposed for the development and expansion of district heating systems, including:
  - The creation and continuous updating of a thermal map to serve as a foundation for investments in DHS.
  - Upgrading existing boilers and replacing fuel oil with biomass.

- Keeping track of EU initiatives aimed at increasing the share of DH to 30% by 2030 and 50% by 2050.
- Increasing the capacity of CHP plants (especially biomass) to meet heating demands.
- Harnessing WH from coal-fired boilers and other sources, in alignment with developments in the thermal power plant sector and the industrial sector wherever feasible.
- Implementing biomass condensing boilers when deemed the optimal solution.
- Further incorporating RES into DHS.

**Bulgaria:** The primary national strategic documents that address DHC are the NECP 2021-2030 and the Energy Strategy of Bulgaria until 2030, with a Horizon to 2050. These plans recognize DHC as crucial for achieving energy efficiency and decarbonization targets. They emphasize the need for modernization of DH systems and their transition to RES, such as biomass, geothermal energy, and WH, to help meet the country's GHG reduction goals in line with the EU's 2030 climate objectives.

**Croatia**: DH holds significant potential for the future and is recognised as a priority in the country's energy policy. Key opportunities for upgrading and improving current DH systems include increasing EE across production units, infrastructure, and end-user equipment, as well as enhancing supply security. There is a strong emphasis on maintaining and upgrading existing DH systems, incorporating thermal storage solutions, integrating RES and transitioning DH production to renewable technologies and energy sources.

**Hungary**: While the EU emphasizes secure, sustainable, competitive, and affordable energy markets, the HU National Energy Strategy 2030 follows similar principles, focusing on three main pillars: (1) increasing competitiveness, (2) ensuring sustainability, and (3) guaranteeing energy supply security. In the heat sector, the objectives include reducing high natural gas consumption, increasing the uptake of RES, ensuring affordable energy, and enhancing EE. The second National Climate Change Strategy for 2018-2030, which looks ahead to 2050, highlights the need to promote the efficiency of DH infrastructure and the use of alternative energy sources such as biomass, geothermal, and waste, as well as CHP. DH systems play a crucial role in ensuring a reliable heat supply.

**Romania**: DHC plays a crucial role in the National Energy Strategy, particularly in the objective of improving EE, where a specific goal refers to the "integrated approach to centralized H&C of buildings, with the coordination of investment projects along the entire value chain". This aims to introduce and adopt the most efficient technologies, linking them to an optimized centralized H&C system, supported by the development of high-efficiency CHP plants. Increasing the share of centralized energy systems, along with the integration of RES, will improve the efficiency of primary energy resource use. The promotion of DH systems is key to achieving climate targets, reducing costs, and enhancing EE. Reconfiguring existing DH systems to create an optimal mix of high-efficiency CHP plants, thermal energy storage, and RES—tailored to meet seasonal energy demand – will further boost EE. Additionally, integrating diverse energy sources into a smart energy distribution network ensures the energy security of consumers connected to DHC systems.

**Serbia**: The Energy Development Strategy by 2025 for the Republic of Serbia, with projections until 2030, recognizes DH systems as a key component of the energy sector, while DC is not addressed in the document. The strategy outlines several strategic objectives, including: 1) the continuous modernization of existing DH systems; 2) the establishment of a unified tariff system for the production, distribution, and supply of thermal energy; 3) institutional coordination, as DH is regulated under two different laws by separate ministries; 4) the expansion of existing DH systems; 5) the promotion of alternative (non-fossil) energy sources and their more efficient use; 6) reducing reliance on liquid fuels and coal; 7) increasing the use of biomass, potentially through co-combustion in existing coal-fired plants; 8) utilizing communal waste; 9) enhancing the use of sanitary hot water; 10) promoting CHP; and 11) strengthening local self-government capacity for market regulation. The NECP (INEKP) that was adopted in July 2024 further supports the development of DHC systems, emphasizing the need for new infrastructure and the integration of RES. The plan includes measures to increase the use of renewable energy technologies in DH systems, with financial support for necessary investments. It also considers introducing a mandatory RES quota in DH systems and explores the launch of modern low-temperature systems, aiming to optimize energy supply and demand through integration with electricity and gas networks. The Law on Amendments to the Energy Law, adopted by parliament in November 2024, proposes a national thermal energy strategy to guide the future development of DH systems in the country.

**Slovakia**: DHC is central to the national strategy, particularly in modernizing energy infrastructure and supporting sustainable urban development. It facilitates the transition to renewable energy by incorporating sources like biomass and geothermal, enhancing EE and decreasing fossil fuel reliance. Environmentally, DHC significantly reduces GHG emissions and air pollution, which aligns with the country's climate goals. In the construction sector, DHC is integrated into building codes to promote sustainable energy in new developments and urban projects. It is also prioritized in building renovations, where DHC is part of efforts to retrofit older buildings to achieve higher EE.

**Slovenia**: A key strategic direction for optimizing energy resources in H&C is to prioritize energy-efficient DHC systems, especially in urban and densely populated areas, while encouraging heat pumps and the sustainable use of wood biomass for heating in less populated regions. The goal is to greatly reduce fossil fuel use in buildings and to maximize the use of DH systems, which provide enhanced flexibility, including the ability to integrate diverse energy sources and technologies. Wood biomass is viewed as a key resource for decarbonizing DH, especially through CHP production within both existing and new networks. DH systems are expected to transition from the more common 3$^{rd}$ generation to 4$^{th}$ generation systems, which operate at lower temperatures, facilitating efficient integration of RES and WH. These next-generation systems offer greater operational flexibility, support CHP production, enable heat storage, and enhance cross-sector integration with other energy domains, such as electricity generation, gas sector and transportation. Although DH network expansions and the establishment of new, smaller systems are anticipated, the overall use of district heating is expected to decrease slightly due to advances in building EE as projected by the NECP. Achieving energy and climate targets will also depend on increased integration across different energy sectors, with DHC systems expected to play a crucial role, especially in bridging connections between the electricity and gas sectors.

## 4.2.2. Development goals and targets for DHC

The leading questions: *What are the development goals and targets for DH and DC in your country? Specify any existing DHC-related goals in the NECP or other long-term strategies or action plans.*

**Bosnia and Herzegovina:** In line with decarbonization criteria and sustainable development goals (SDGs), the NECP outlines a strategic shift in thermal energy production within DHC systems. This plan aims to expand the capacity for heat production from biomass while reducing reliance on fossil fuel facilities. A significant increase in RES electricity generation is anticipated, with no plans to expand fossil fuel-based plants. By 2030, district heating systems will discontinue the use of crude oil as a fuel source, and coal-fired heating facilities will be reduced to approximately 30% of their current capacity, decreasing from 190 MW to 50 MW of thermal power. Additionally, the installed capacity for natural gas-based heat production in DHC is expected to rise from 472 MW to 581 MW.

To enhance the efficiency of the H&C systems, the NECP has outlined the following measures:

- Developing cost-benefit analyses (CBA) to evaluate measures aimed at improving EE in H&C.
- Performing a comprehensive assessment of the potential for implementing highly efficient cogeneration and DHC systems.
- Supporting and promoting initiatives to develop energy-efficient infrastructure in DHC, including highly efficient CHP and the utilization of waste, WH, and RES.
- Establishing a legal requirement to conduct CBA for energy projects.
- Aligning regulations related to guarantees of origin for electricity generated from highly efficient CHP and establishing conditions for supporting cogeneration and DHS.
- Establishing a robust system for monitoring the implementation of key policy measures in H&C.
- Enhancing the information system for reporting on EE within the electricity generation and H&C sectors, including efficient CHP.

**Bulgaria**: The development priorities are centred on increasing EE, reducing carbon emissions, and transitioning to RES. The NECP sets clear goals for modernizing DH systems, targeting a 32.5% improvement in EE and a greater integration of RES, such as biomass, geothermal, and solar, by 2030. A key objective is to reduce the carbon intensity of the energy supply, with DH systems playing a central role in achieving this goal. The Energy Strategy of Bulgaria until 2030 focuses on expanding DH infrastructure while decarbonizing it by transitioning from coal and gas to RES and WH recovery.

**Croatia**: The primary opportunity for advancing DH in Croatia lies in boosting EE and improving supply reliability and security through the adoption of modern technologies. Key measures include integrating RES, upgrading networks with pre-insulated pipes, and strengthening DH regulations at all levels. Enhancing EE will support improvements across production, transmission, distribution, and consumption, aided by state initiatives and financial programs that shape the speed and scale of building renovations. Although DC has clear potential in Croatia, a formal strategy to support its development has yet to be established.

**Hungary**: The DHC goals, outlined in the NECP and Energy Strategy 2030, focus on increasing the integration of RES and improving EE. The NECP aims to reduce the share of natural gas in the district heating mix to below 50% by 2030, supported by infrastructure modernization initiatives such as the Modernisation Fund. The long-term climate strategy targets climate neutrality by 2050, with DHC playing a critical role in lowering GHG emissions and incorporating smart technologies. Additionally, Hungary emphasizes expanding DHC networks and enhancing their efficiency, particularly through building renovation programs aligned with national energy strategies. Specific action plans promote the adoption of innovative technologies and RES within DHC systems, supported by EU-funded programs and national incentives.

**Romania**: Energy objectives are closely aligned with the EU's energy and climate policies, emphasizing decarbonization, renewable energy adoption, and energy poverty reduction. In line with the decarbonization goal, Romania plans to transition from coal-based capacities to gas-fired and RES. By 2036, all natural gas-powered plants, including CCGT and CHP units, will be designed to be 50% compatible with renewable gases, such as renewable hydrogen. Cogeneration units will play a critical role in enhancing energy supply security, particularly at the local level, reducing the risk of power and heat supply disruptions. In terms of renewable energy, the DH sector is witnessing a gradual shift toward sustainability. Significant growth is projected for heat pumps and solar thermal energy. Meanwhile, biomass-based DH using solid biofuels is expected to grow steadily after 2022 and continue through 2030. The country aims to increase the share of RES in DH to 9.4% by 2030, underscoring its commitment to renewable energy integration. Efforts to combat energy poverty include a targeted reduction in the share of households unable to keep their homes adequately warm, aiming to decrease it from 15.2% in 2022 to 9.8% by 2030.

**Serbia**: No specific goals have yet been set for DHC. However, as a member of the Energy Community, Serbia will need to align with the EU’s targets.

**Slovakia**: The development objectives for DHC emphasize the expansion of RES, improved EE, and reduced carbon emissions. The NECP sets an ambitious target of achieving an annual increase of at least 2.1% in RES utilization within DH systems by 2030, with a focus on biomass, geothermal energy, and WH recovery. Decarbonizing DH remains a central objective, with ongoing efforts to phase out coal and other fossil fuels, aligning with the EU's 2050 climate neutrality goals. Modernization plans for DH networks are designed to minimize heat loss and incorporate smart technologies, aiming to boost system efficiency and resilience by approximately 5–10%. National action plans complement these initiatives by prioritizing the connection of buildings to efficient DH networks and expanding DC infrastructure.

**Slovenia**: The most ambitious NECP scenario envisions a major shift in the structure of DH sources, with RES) and WH reaching over 45% by 2030 and surpassing 70% by 2040. Overall fuel and energy consumption is expected to remain around 4 TWh, with approximately 2.2 TWh in useful district heat output. Under current "business-as-usual" conditions, however, the RES and WH share would only increase to a little over 20% by 2030. The potential for wood biomass utilization in DH could grow from the current 0.5 TWh to 0.8 TWh (in 2030), enabling additional production of over 0.13 TWh of electricity. The NECP aims to phase out coal by 2030 (currently used in CHP and CCGT production facilities), replacing it temporarily with NG-powered CHP. A gradual shift from natural gas to renewable gases (including hydrogen), alongside biomass-based CHP and boilers, large-scale heat pumps, and WH recovery, is expected to support achieving the target share of renewables in district heating by 2040.

### 4.2.3. Strategic goals for RES and CHP in DHC

The leading question: *What are the strategic goals aimed at increasing the share of RES and CHP in DH systems?*

**Bosnia and Herzegovina:** The NECP[7] outlines plans to expand the capacity for producing heat energy from RES in H&C systems through various technologies. Thermal energy production from biomass is projected to remain stable until 2030, totalling approximately 1,300 ktoe (15.1 TWh). While a slight decline in biomass usage is expected across most heating sectors—such as commercial, public, and multifamily residential—heat supply in single-family residential buildings is projected to increase. Specifically, consumption in this segment is anticipated to rise from 966 ktoe (11.2 TWh) in 2022 to 1,007 ktoe (11.7 TWh) by 2030. During the same period, the utilization of heat pumps (HP) in H&C is expected to remain relatively low but will experience notable growth, particularly in the residential sector. For single-family homes, consumption is expected to increase from 1.6 ktoe (18.6 GWh) in 2022 to 2.8 ktoe (32.6 GWh) by 2030, while for multifamily buildings, it is projected to rise from 0.5 ktoe (5.8 GWh) in 2022 to 2.4 ktoe (27.9 GWh) in 2030.

**Bulgaria**: The NECP targets an increased share of RES in DH systems by promoting the use of biomass, geothermal energy, and solar thermal technologies. Meanwhile, the national Energy Strategy until 2030 aims to expand CHP installations, which are considered essential for enhancing efficiency in both heat and electricity production.

**Croatia**: Integrating RES is crucial across all energy sectors to meet the national decarbonization goals. Biomass already plays a significant role in Croatia's DH systems, while geothermal energy is frequently highlighted as a promising focus for future development. Other technologies with strong potential include solar energy, biogas, heat pumps, WH recovery, and thermal storage. The success of this transition relies on infrastructure development, with regional self-government units responsible for proposing essential measures to the ministry for implementation.

**Hungary**: The strategic goals to increase the share of RES and CHP in DH systems are outlined in the NECP, which aims for a substantial expansion of renewable energy in the DH sector. The NECP targets a 21% share of renewables in the overall energy mix by 2030. In 2019, biomass and geothermal energy combined accounted for 22.9% of the DH energy mix, rising to 26.8% by 2022[8]. Integrating RES such as biomass, geothermal, and solar thermal into DH systems is seen as vital

[7] *http://www.mvteo.gov.ba/data/Home/Dokumenti/Energetika/Nacrt_NECP_BiH_loc.pdf*

[8] *MEKH-MaTáSzSz, 2022*

for reducing GHG emissions and enhancing energy security by decreasing reliance on fossil fuels. Hungary also recognizes the importance of CHP in its DH strategy, emphasizing the efficiency of these systems. The NECP and Energy Strategy 2030 advocate for modernizing DH networks to facilitate the integration of more RES and CHP installations, which are expected to play a significant role in decarbonizing the heating sector. To drive this transition, financial incentives and support programs have been introduced, encouraging the adoption of CHP and the integration of RES into DH systems. This strategic focus not only advances national environmental objectives but also aims to enhance the overall efficiency and sustainability of its energy system.

**Romania**: According to the 2021-2030 Integrated National Energy and Climate Plan (NECP), the target share of RES in DH is set to reach 8.5% by 2030, marking a significant increase from 5.4% in 2022, which indicates the Romania's move towards more sustainable heat supply. It is expected that the use of HPs and solar thermal energy will increase significantly by 2030, making a major contribution to meet DH demand. Conversely, the share of biomass-based DH systems will gradually decline. The country plans to build 2.6 GW of CCGT power plants and 947 MW of natural gas-powered CHP plants by 2030. According to the NECP, all natural gas-powered plants are required to be 50% compatible with renewable gases, such as renewable hydrogen, by 2036.

**Serbia**: The NECP for the period up to 2030 and with a vision towards 2050, emphasizes the need to integrate renewable energy technologies into existing and planned DH networks. This integration will be supported by targeted financial assistance to cover the required investment costs. Additionally, the potential introduction of a mandatory quota for the use of RES as fuel in DH networks will be considered. The plan also aims to promote the development of modern low-temperature district heating systems, which will connect local demand with renewable and WH sources, as well as the broader electricity and gas grids, optimizing supply and demand across all energy carriers. The goal is to introduce an additional 2.65 ktoe (31 GWh) of biomass and 19.06 ktoe (220 GWh) of solar energy into DH systems by 2050.

**Slovakia**: There is a clear strategic commitment to significantly increase the share of RES and CHP systems in DH networks. The focus is on replacing coal and natural gas with more sustainable options such as biomass, geothermal, and solar thermal energy. Projections indicate a modest rise in biomass use in Slovakia, primarily for energy purposes, including in the CHP facilities. The supply of wood biomass is expected to rise from 3,160 tons in 2020 to 3,540 tons in 2030, marking a 12% growth. The NECP outlines concrete measures to support this shift, aiming to achieve 19% RES in DH by 2030. This target aligns with broader decarbonization efforts in the heating sector, which include replacing fossil fuels with low-carbon alternatives such as biomethane and potentially hydrogen. The expansion of CHP systems is central to this strategy due to their high efficiency in producing both heat and electricity. Policy incentives further promote the integration of RES-based CHP plants, contributing to overall carbon reduction targets and supporting EU climate objectives.

**Slovenia**: The total installed capacity of high-efficiency CHP production facilities has remained around 350 MWe in recent years, with units in DH systems accounting for as much as 80%. Total annual electricity production is just under 1.2 TWh, of which about 0.9 TWh is generated by CHP in DH systems. The total useful heat produced in CHP is around 3.1 TWh, with DH systems contributing roughly 1.7 TWh. The main challenge for the future of CHP in Slovenia is the replacement of currently dominant fossil fuels (coal, natural gas) with cleaner alternatives. The availability of renewable gases, such as biomethane and hydrogen, will be essential for this transition. Under the business-as-usual scenario, CHP capacity in DH systems is expected to gradually decrease, stabilizing around 200 MW by 2040. However, in the ambitious scenario, with increased support for CHP units powered by renewable gases and wood biomass, current capacity levels could be maintained. According to the ambitious NECP goals till 2050, about 70% of DH supplied heat would come from CHP by 2035, with 60% of this coming from RES. The overall share of renewable heat in DH is expected to increase from 65% in 2035 to 100% by 2050.

### 4.2.4. Future energy supply sources and technologies

The leading question: *What sources and technologies are envisaged for the future supply of DHC in the country?*

**Bosnia and Herzegovina:** The NECP outlines plans for expanding the capacity to produce thermal energy from RES by 2030. Among the technologies designated for this purpose, solid biomass is projected to contribute approximately 1,309 ktoe (15.2 TWh) for heating and hot water preparation in residential buildings, as well as for heating in public and commercial facilities. In contrast, aerothermal HPs are anticipated to be used for heating both residential and public buildings, delivering only 5.4 ktoe (52.3 GWh) in thermal energy. Currently, there are no plans to incorporate geothermal or solar energy sources for H&C.

**Bulgaria**: The future energy supply of DHC in Bulgaria is set to transition toward more sustainable and innovative sources and technologies. Increasing reliance on biomass, geothermal energy, solar thermal, and WH recovery, as outlined in the National Energy and Climate Plan (NECP) 2021-2030, will play a key role in this shift. High-efficiency CHP plants, especially those powered by biomass and other renewables, are also central to DHC strategy. The national Energy Strategy until highlights the expansion of CHP capacity to enable efficient cogeneration of heat and electricity, reducing energy losses. Incorporating smart technologies, such as advanced metering and digital management systems, will further enhance heat distribution and demand-side management, aligning with EU directives for smarter, more sustainable energy systems. Additionally, WH recovery from industrial processes and other sectors will be a crucial element of future DHC networks, helping to reduce primary energy consumption and boost overall system efficiency.

**Croatia**: By 2030, the use of solar energy is expected to increase more than four times compared to 2020, while geothermal energy is predicted to grow sixfold. The share of heat from RES in DH systems is anticipated to rise 4.5 times. While biomass remains an attractive option, geothermal power plants are gaining attention as a promising alternative due to their ability to generate electricity, operate with minimal downtime, and facilitate the cascading use of residual thermal energy from geothermal water for applications such as heating, drying, aquaculture and more, significantly enhancing cost-effectiveness. Embracing technologies like high-capacity electric boilers and heat pumps is important, alongside adopting a comprehensive approach to optimising connection and operational conditions for enabling greater integration of RES into DH systems.

**Hungary**: The National Energy Strategy 2030, looking ahead to 2040, emphasizes integrating a diverse mix of RES and advanced technologies. Biomass is a key RES, and HU plans to expand its use in DH systems due to its availability and low carbon footprint. Geothermal energy is also significant, given the country's favourable geological conditions, and is expected to increasingly contribute to a stable, low-carbon heat supply. In 2023, the Hungarian Geothermal Cluster was established to bring together stakeholders in this sector. Solar thermal energy is envisioned as part of the future DHC mix, especially when combined with seasonal thermal storage. Additionally, the integration of WH recovery from industrial processes and data centres into DHC networks is under exploration. CHP, particularly those powered by RES, will remain a cornerstone of the national energy strategy. Advanced technologies, such as HPs and smart grid systems, are expected to optimize DHC networks operations, enabling more flexible and efficient energy management. These initiatives align with NECP and Energy Strategy 2030, which prioritize the transition to a more sustainable and resilient energy system by increasing the share of RES and adopting innovative technologies within the DHC sector.

**Romania**: The future supply of DH in the country is expected to rely on the following sources and technologies: a) Expansion of biomass and biogas production through CHP and CCGT plants; b) Installation of solar thermal collectors; c) Increased use of heat pumps; d) Harnessing geothermal energy; and e) Integration of hydrogen as an energy source.

**Serbia**: For some time, the DH systems will primarily rely on natural gas, but an increase in the use of RES such as biomass, solar, and geothermal energy is expected and will be actively supported.

**Slovakia**: Future DH supply sources centre on RES such as biomass, geothermal, and solar thermal, aiming to phase out fossil fuels like coal and natural gas. WH recovery from industrial processes and the adoption of CHP systems that use RES are also pivotal in increasing EE. Additionally, plans emphasize the deployment of heat pumps and thermal storage systems to better balance supply and demand, particularly in low-temperature heating networks. The integration of smart technologies for monitoring and optimizing energy use within DHC networks further supports these goals.

**Slovenia**: The goal for 2050 is fully decarbonized DHC sector, relying on sustainably sourced wood biomass, geothermal energy, biomethane, other renewable gases (incl. hydrogen), and WH recovery from industrial, commercial, and also power generation processes. The DH supply will be powered by a mix of technologies, beginning with CHP systems that will gradually transition to 100% renewable fuels, along with large-scale heat pumps, biomass boilers and advanced thermal storage solutions. Transitioning to low-temperature DH (LTDH) and sector integration will also play a crucial role in this transformation. The entire process will be supported by digitalization, smart grid technologies, and advanced metering infrastructure, enabling greater efficiency and flexibility across the whole energy system.

## 4.2.5. Accessibility and affordability considerations

The leading questions / themes:

a) *The role of DHC in addressing energy poverty and social housing.*

b) *Accessibility of DHC services to different socio-economic groups.*

c) *Affordability of DHC compared to alternative heating and cooling solutions.*

**Bosnia and Herzegovina:** a) In 2015, the Government of the Federation of BiH established a commission to draft the "Program for the Protection of Vulnerable Consumers of Electricity in the Household Consumption Category in FBiH." However, this program has not been finalized due to the lack of a social map of the FBiH population. In the meantime, the Government has implemented measures to reduce household electricity costs and promote EE. Specific categories of pensioners and recipients of permanent financial assistance are entitled to electricity cost subsidies. This initiative aims to address energy poverty through a comprehensive approach that assesses the needs of vulnerable populations and develops targeted programs and funding mechanisms. While there are general efforts for energy renovation of buildings, none of the planned activities specifically address the role of DHC systems.[9]

b) All socio-economic groups have equal access to DHC services.

c) Government subsidies for fossil fuels, which are both high and unsustainable, have made DHC relatively more affordable compared to alternative heating solutions.

**Bulgaria**: a) DHC systems play a critical role in alleviating energy poverty in Bulgaria, particularly within urban areas and social housing sectors. By providing centralized heating, DHC reduces reliance on costly individual heating solutions, which can be a substantial financial burden for low-income households. However, outdated infrastructure and limited flexibility in DHC systems have led some households to disconnect, seeking more affordable or adaptable options.

b) DHC services are available primarily in cities, specifically in multifamily buildings, where centralized heating is most feasible. For low-income households, however, the cost of DHC services can still represent a financial strain. Despite regulatory efforts to manage tariffs and offer subsidies, many lower-income residents find heating bills difficult to afford, especially in older, less energy-efficient buildings. As a result, some households turn to alternative heating sources, such as coal or wood stoves, which are often less efficient and have adverse environmental and health impacts.

c) DHC is generally more cost-effective than individual heating options (such as electric heaters or gas boilers) due to economies of scale and centralized management. However, inefficiencies within outdated DHC networks can reduce these cost benefits, making individual heating options more competitive in certain areas.

[9] *https://fmpu.gov.ba/wp-content/uploads/2023/07/SOZFBiH_finalni-nacrt_07_02_2023_rev-28.04.2023.docx*

**Croatia**: According to Eurostat, 7% of citizens were unable to keep their homes adequately warm in 2022, up from 5.7% the previous year. DH systems can help address this issue by providing more affordable heating solutions for low-income households. Expanding the DH network from larger urban centres to smaller communities could further improve service coverage, benefiting a broader range of socio-economic groups.

**Hungary**: a) DHC systems play a crucial role in mitigating energy poverty, particularly in urban areas with high concentrations of social housing. By providing centralized and efficient heating, DH systems reduce energy costs for low-income households, which is vital in combating energy poverty. However, several challenges persist. Unpaid invoices are often redistributed among users, creating additional financial burdens. Inadequate insulation in many buildings results in uneven heating, with upper floors typically overheated while lower floors remain underheated. This discrepancy disproportionately affects elderly residents who prefer lower floors but pay for relative discomfort. Additionally, outdated systems and poorly insulated buildings lead to significant energy losses in the DH infrastructure, forcing consumers to cover these costs, further exacerbating energy poverty. Despite these issues, residential consumers benefit from favourable pricing for DH services, largely due to government subsidies. Consequently, arrears have been low in recent years, and willingness to pay remains high.

b) DHC services are primarily accessible to urban populations, as these systems are concentrated in cities and towns. However, accessibility varies among socio-economic groups, especially in less densely populated or economically disadvantaged areas, where limited network availability and slower DHC expansion can impact service access.

c) For residents in densely populated urban areas, DHC is often more affordable than alternative H&C options. These systems benefit from economies of scale and the integration of cost-effective RES, making them a competitive choice. Affordability is further supported by government subsidies and social programs aimed at reducing energy costs for vulnerable populations[10]. In Hungary, DH is provided at a fixed, official rate, allowing all households to access heating at a uniform price regardless of usage, while municipalities and businesses access DH at cost price.

**Romania**: a) The Law no. 226/2021, establishes social protection measures for vulnerable energy consumers. These financial measures aim to help low-income households meet their basic energy needs. Since the 1990s, social protection programs have been implemented during the cold season, when heating costs typically rise. The subsidies provided to vulnerable consumers cover a variety of heating systems, including centralised thermal supply (by DH), natural gas, electricity, and solid or oil fuels.

b) Local strategies focus on making heating energy accessible and affordable for all socio-economic groups. The public heating service is designed to be continuous, universal, equitable, transparent, adaptable, and sustainably managed. In line with these principles, DHC providers are committed to serving all municipal residents, regardless of social status. Subsidies play a key role in financing public heating services, supporting vulnerable residents and ensuring access to affordable energy.

*[10] According to Government Decree No. 157/2005 (VIII. 15.) on DH services, consumer costs and regulations are defined under the Heat Supply Act of 2005.*

c) The main alternative heating solutions are individual gas boilers and wood stoves. Recently, Romania has committed to promoting the use of biomass for heating as part of its National Recovery and Resilience Plan. Additionally, the ongoing conflict between Russia and Ukraine has led to significant increases and volatility in gas and electricity prices, particularly in Europe. In this context, accelerating the deployment of RES and prioritizing EE improvements in DH systems could enhance the cost-effectiveness of district heating compared to other heating options.

**Serbia**: DH is classified as a communal service and therefore considered a service of common interest. As such, it is typically provided by public utility companies, which are controlled by municipalities and subject to political influence. Although the heat prices of heat are regulated by law, they are often kept artificially low to make it more affordable for consumers, which can result in prices that do not fully cover production costs. In most cases, over 90% of DH prices are based on the area of the heated space rather than actual energy consumption, which negatively impacts the overall efficiency of heat supply. To make bills more manageable for users, the total cost is often divided into 12 monthly instalments, making payments more affordable. Currently, DH prices are higher than those of alternative heating sources, such as wood, coal, natural gas, or electricity, and in many instances, they exceed the affordability threshold based on household income.

**Slovakia**: a) DH systems are essential for reducing energy poverty in urban areas, especially for low-income households and social housing residents. Centralized heat distribution lowers costs, also through improved efficiency. For vulnerable households, DH offers protection from energy price volatility by stabilizing supply costs. By integrating RES, DH systems further enhance environmental sustainability without raising heating costs.

b) In urban centres, like Bratislava or Košice, DH serves large populations, helping lower per-unit costs for heating, especially in apartment complexes and social housing. The initial cost of connecting to DH networks is generally lower than installing individual heating units, making it more affordable for financially constrained families. In addition, municipalities and the government offer subsidies and financial aid to help vulnerable groups access DH systems, further reducing the financial burden.

c) The affordability of DH is supported by government-regulated pricing, which makes it a competitive option compared to alternative heating solutions, such as individual gas or electric systems. In addition, subsidies for connecting to DH and incentives for energy-efficient systems further lower costs for vulnerable households. Thanks to economies of scale and the integration of RES, DH provides a more stable and cost-effective heating solution compared to alternatives.

**Slovenia**: a) According to the UMAR (Institute of Macroeconomic Analysis and Development) report on green transition and energy poverty risk in Slovenia, the rate of energy poverty in Slovenia reached 12.1 % in 2022, a 0.4% increase from the previous year. Despite this gradual rise since 2020, Slovenia still has one of the three lowest energy poverty rates in the EU. Energy poverty is closely linked to factors like low household income, poor building and heating system quality, limited education, lack of awareness on EE, and weak financial literacy. Slovenia has not yet clearly indicated the role of DH in addressing energy poverty. Centralised heat production and supply through DH systems offer a reliable heating solution that requires minimal or no technical knowledge, making it accessible to users with limited technical capabilities. As a public utility of common interest, DH could be actively promoted and financially supported, especially for social housing, to help alleviate energy poverty. Currently, however, DH utility companies are not incentivised to supply low-income housing at their own economic risk, often leading them to avoid areas or buildings with higher expected rates of energy poverty. Generally, DH services are available to all connected customers, regardless of economic status.

b) The Heat Supply from Distribution Systems Act (ZOTDS) establishes guidelines for heat supply, including provisions for emergency supply and protections for socially vulnerable consumers. The goal is to reduce energy poverty and ensure affordable heating for low-income households. Households are entitled to emergency heating if, due to financial or social conditions, they cannot access an alternative heating source at an equal or lower cost. For consumers with overdue payments, the law mandates a verification process before disconnection, ensuring protection for vulnerable users. Emergency heat supply costs are initially covered by the distributor; if unrecoverable, these costs are incorporated into regulated pricing. Specific conditions are detailed in the distributor's system operating instructions (SON).

c) DH prices vary based on the provider, distribution costs, technology used, and energy sources for heat production. In the past two years (2023-2024), DH prices have remained relatively stable, generally ranging from 125 to 195 EUR/MWh across most systems, though in some cases reaching up to 280 EUR/MWh. Compared to individual heating options, DH costs are often lower than heating oil but can significantly exceed the costs of heating with wood biomass or heat pumps. However, DH offers key advantages, including relatively low initial investment (if a DH network is already available nearby), minimal maintenance requirements, and ease of use without the need for fuel storage.

### 4.2.6. Ensuring social acceptance

The leading question: *What efforts are being made to ensure social acceptance of DHC and address concerns or objections from local communities, businesses, and other stakeholders?*

**Bosnia and Herzegovina:** (Data not available.)

**Bulgaria**: DH prices in Bulgaria are regulated by the Energy and Water Regulatory Commission (EWRC) under the Energy Sector Act and the Ordinance on Heat Energy Price Regulation. To maintain transparency and fairness, DH prices are regulated ex-ante for all DH suppliers using the Capital Asset Pricing Model (CAPM) methodology. This regulatory model allows EWRC to exclude certain cost elements as needed to keep heat prices at reasonable levels, thereby supporting affordability and public acceptance. To further protect consumers, EWRC is authorized to adjust DH prices during the pricing period if there are significant fluctuations in gas or $CO_2$ prices.

**Croatia**: The REHEATEAST survey conducted for report D.1.1.5[11] revealed that while most consumers have a positive perception of DHC systems, several key improvements are necessary to maintain their trust. These include better communication and providing more transparent,

[11] *Stakeholder Survey and Analysis of Results*

accurate billing information. Addressing high heating costs, enhancing service reliability and offering tailored solutions, such as individualized billing, are seen as crucial steps to increase consumer acceptance. Overall, introducing incentive mechanisms is considered as essential for promoting the adoption and expansion of DH systems.

**Hungary**: The perception of DH among current consumers can be enhanced primarily by improving service quality and offering competitive pricing. It is worth noting that DH service fees for residential users and independently managed institutions are centrally regulated by authorities. Equally important is the need to promote the benefits of DH through targeted communication campaigns and to increase public awareness of DH services. A key driver in improving the public image of DH is ensuring that existing users are satisfied and willing to share their positive experiences with others. Service providers also play a crucial role by adopting an open, informative, and approachable attitude, not just toward their customers but within the wider community. Events like the "Night of Power Plants", featuring guided on-site tours, allow visitors to explore power plants, heating facilities, and utility operations, provide an excellent opportunity to enhance public understanding of DH. Organized annually by the Hungarian Energy and Public Utilities Regulatory Office (MEKH), the event highlights how electricity generation and DH systems operate, while also educating the public on the sustainable use of natural resources and environmental protection.

**Romania**: DHC system operators prioritize targeted marketing campaigns to a) raise awareness and ensure the public has easy access to information about the company's policies and initiatives; b) increase engagement of residential users and other customers to actively participate in decarbonization efforts, including coordinated programs and events; c) enhance accessibility through various communication channels to ensuring that information reaches the widest possible audience and is easy to understand; and d) improve the transparency of policies and operations to strengthen the company's reputation and credibility, fostering trust with stakeholders and the wider community.

**Serbia**: National legislation recognizes the category of energy-vulnerable customers and allocates national budget funds to support them. Additionally, municipalities can subsidize vulnerable groups through their social programs by covering a portion of their bills for communal services, including DH.

**Slovakia**: Achieving social acceptance for DHC systems involves engaging local communities and stakeholders through public consultations and information campaigns. Authorities and project developers hold community meetings as opportunities to address concerns, share transparent information about the benefits of DHC, and gather feedback. The planning and decision-making processes actively involve local businesses and residents to ensure that DHC projects are tailored to the community's needs. Additionally, incentive programs and subsidies are communicated to highlight the financial benefits and ease the transition to DHC systems. Partnerships with local organizations, along with educational initiatives, further help to build trust, address concerns, and emphasize the long-term environmental and economic benefits of DHC.

**Slovenia**: In recent years, especially since 2022, public perceptions of DH have grown negative, largely due to significant price hikes for heat. Concerns are emerging about the reliability of supply and the long-term stability of DH prices compared to alternatives like individual heating systems with heat pumps or modern wood biomass boilers. Although DH offers convenience and relatively low upfront costs for users, its weaker price competitiveness has led to a rise in disconnection requests, potentially jeopardizing the financial stability of DH operators. Public scepticism also extends to the environmental impact of DH, with many systems still reliant on fossil fuels or operating inefficiently. This perception undermines confidence in DH's role in improving air quality and reducing emissions. Efforts to promote DH through subsidies for connections, provided by the Eco Fund (Eko sklad), have seen limited uptake. Temporary measures like co-financing heating costs for vulnerable groups and regulating DH prices offer only short-term relief and likely fail to enhance long-term acceptance of these systems. Municipalities, as part of preparing local energy concepts (LEK) and strategies, conduct public consultations, but these participatory approaches remain underutilized as tools for actively fostering DH acceptance. A lack of effective communication and coordination among municipalities, DH operators, and current or potential users further hinders progress. Sharing successful examples of DH implementation from other municipalities or countries could help alleviate scepticism and build trust, but such activities have not yet been widely implemented.

### 4.2.7. Consumer protection regulations

The leading question: *Are there regulations in place to protect consumers, covering aspects such as pricing, profit structures, consumer participation (influence), and transparency in utility operations?*

**Bosnia and Herzegovina**: The price proposed by the DH service provider must be approved by the relevant authority, such as cantonal or municipal councils. Consumers can engage in the approval process through public consultations or via their representatives in these councils. DH companies present their annual business reports to the cantonal or municipal councils for review and formal adoption.

**Bulgaria**: There are regulations in place to protect consumers of DHC services, focusing on fair pricing, transparency, and consumer engagement. The Energy and Water Regulatory Commission (EWRC) oversees DHC pricing, setting tariffs based on actual costs to ensure fair pricing and prevent excessive profits. EWRC also reviews and approves price adjustments to accurately reflect operational costs, protecting consumers from undue financial burdens. Consumers can participate in public consultations and hearings held by EWRC to raise concerns or objections about price changes or service conditions, offering a direct platform for consumer input. Additionally, DHC utilities are legally required to maintain transparency in pricing and operations, regularly publishing information on service quality, pricing, and planned upgrades or disruptions. Established channels allow consumers to file complaints and resolve disputes with DHC providers, with EWRC serving as a mediator for unresolved conflicts to ensure consumer rights are upheld.

**Croatia**: The Act on the Heat Market protects consumers by promoting fair pricing, ensuring billing transparency, and establishing mechanisms to address consumer complaints within the DH sector.

The Croatian Energy Regulatory Agency (HERA) is tasked with developing methodologies—including tariff systems—in alignment with relevant energy laws and is responsible for approving prices, tariff components, and fees according to these guidelines. Through this oversight, HERA supports consumer interests by actively monitoring pricing structures.

**Hungary**: DHC prices are regulated to protect consumers, with profit margins for utilities capped to prevent overcharging. Residential DHC prices remained unchanged for the past decade. Utilities must operate transparently by disclosing costs and revenues and maintaining service quality standards, all subject to regular reporting. Recent legislation also mandates the installation of individual meters and remote reading systems in specific housing arrangements to enable more accurate billing.

**Romania**: In accordance with Law on Community Services of Public Utility No. 51/2006, as republished and amended, the prices and local tariffs for the public heating service in the (centralized) DH system are approved by local public administration authorities. This is done in accordance with the relevant legislation and following the methodologies established by the competent regulatory authority.

**Serbia**: The price of DH is regulated by the government, specifically by the Energy Agency of the Republic of Serbia (AERS). The prices are set through a methodology that aims to balance the need for affordability for consumers while ensuring that utility companies cover their operating costs. Mechanisms are in place to protect consumers through the Law on Consumers, as well as grievance mechanisms within public utility companies (PUCs) that provide DH services. The Law on Communal Services mandates that PUCs conduct annual surveys and research on user satisfaction to improve all aspects of the service, including efficiency and affordability.

**Slovakia**: There are several consumer protection regulations in place for DH systems. The Regulatory Office for Network Industries (ÚRSO) oversees price regulation, ensuring that tariffs are fair and transparent, based on cost-plus models to prevent excessive pricing and promote affordability. DH utilities are required to operate on a cost-recovery basis, with regulations in place to review and approve their cost structures, preventing excessive profit margins. Consumers are encouraged to participate in public consultations and provide feedback on DHC services and pricing, ensuring their concerns are considered in decision-making. Transparency is also a priority, with utilities mandated to provide clear information about service terms, pricing, and performance through annual reports. Additionally, dispute resolution mechanisms are available, including ombudsman services and regulatory reviews, to effectively address consumer grievances.

**Slovenia**: A framework for determining heat prices, designed to protect consumers from uncontrolled or unjustified price increases, is defined in the Act on the Methodology for Setting the Heat Price for District Heating[12]. This regulation ensures price stability and predictability for users, while providing transparency in the pricing process. Additionally, it safeguards consumers from sudden price fluctuations and negative economic impacts, with the Energy Agency (AGEN-RS) monitoring and approving proposed prices. Key protective mechanisms include transparency in

[12] *Akt o metodologiji za oblikovanje cene toplote za daljinsko ogrevanje*

price formation based on actual production and distribution costs, and ongoing monitoring of price changes by the Energy Agency. Prices may also be adjusted in case of extraordinary circumstances, with consumers protected from excessive cost increases. Furthermore, the social and economic conditions of consumers, especially vulnerable groups, are taken into account, helping to reduce the risk of energy poverty. Each DH provider must publicly disclose its prices and regularly adjust them to reflect changes in operational costs and energy prices. Any price changes must be approved by the Energy Agency. It is also important to note that, according to the ZOTDS[13] law, the price of district cooling (DC) is not regulated and is instead determined through a contractual agreement between the DC distributor and the end consumer, based on market conditions.

### 4.2.8. Local planning and zoning

The leading question: *What types of local planning measures are in place to ensure appropriate zoning for DHC, preventing parallel systems like gas networks or competition with individual heat supplies that could compromise sufficient connection rates?*

**Bosnia and Herzegovina:** Local planning exists at the city and municipality levels to ensure appropriate zoning for the expansion of DHC systems. However, current planning does not effectively prevent competition from alternative heating solutions, such as gas networks or individual heating systems. This lack of strategic oversight poses a risk to achieving sufficient connection rates for DHC.

**Bulgaria**: The expansion and modernization of DHC systems are primarily driven by private companies. DHC network planning and development rely on the business plans of these companies, which assess growth potential in specific areas. These plans consider factors such as demand potential, population density, and economic growth to evaluate the viability of expanding networks within target territories.

**Croatia**: Local self-government units are required to plan for the expansion of DH systems if they implement cogeneration with RES within their region. In drafting spatial planning documents, they must prioritize the development of DH distribution networks to meet the heating needs of residential, commercial, and industrial sectors. This approach aims to reduce parallel infrastructure, such as overlapping gas networks, and to ensure sufficient connection rates by avoiding competition with individual heating systems.

**Hungary**: Currently, local planning and zoning regulations do not specifically address DH. However, with the national transposition of the EU Energy Efficiency Directive, DH is expected to receive greater emphasis in future local H&C plans. Although some cities provide good examples of effective local planning, a comprehensive local development strategy is generally lacking.

**Romania**: Local planning documents such as General Urban Plans (PUGs) and Zonal Urban Plans (PUZs) play a critical role in urban infrastructure development by providing detailed information

[13] *Zakon o oskrbi s toploto iz distribucijskih sistemov (The Heat Supply from Distribution Systems Act)*

on water distribution networks, gas networks, and heating supply solutions. Priority for connection to DH systems is given to areas with high population density, public institutions, or industrial facilities. Under Law No. 325/2006, municipalities are mandated to designate specific zones where connection to DHS is mandatory, particularly in urban areas with concentrated heat demand. Within these designated zones, residents and businesses are required to connect to the DHC system, while alternative heating solutions are either restricted or prohibited.

**Serbia**: Zoning for energy planning is not yet a common practice at the local level; however, spatial plans adopted by municipalities typically include this aspect.

**Slovakia**: The country has established local planning and zoning measures to facilitate the effective integration of DHC systems while preventing conflicts with other energy supply options. Local authorities are responsible for zoning regulations that allocate specific areas for DHC development, ensuring that new residential and commercial projects are connected to existing or planned DHC networks. This approach helps avoid the creation of parallel systems, such as individual gas networks, in regions already served by DHC. Moreover, DHC infrastructure is typically incorporated into broader urban development strategies, ensuring that new construction and urban redevelopment include this infrastructure, which promotes EE and minimizes competition with other heating solutions. In high-density urban areas, local regulations may mandate that new buildings connect to DHC systems, ensuring higher connection rates and infrastructure sustainability. Local planning authorities also coordinate with DHC providers and other utilities to align development plans and avoid redundant infrastructure investments. Additionally, local policies may offer incentives, such as subsidies or reduced connection fees, to encourage the integration of DHC systems and reduce competition from alternative heating options.

**Slovenia**: Spatial planning is governed by the Spatial Planning Act (ZUreP-3), which outlines the procedures and responsibilities for preparing spatial documents, such as municipal spatial plans (OPN), national spatial plans (DPN), and others. These documents regulate the placement of infrastructure systems, such as gas pipelines and DH networks, specifying where and under what conditions they can be located. They also facilitate coordination between infrastructure and spatial needs at both local and national levels. The Energy Act (EZ-2) requires the local energy concept (LEK) as the mandatory basis for spatial planning of energy infrastructure in local communities. LEK guides the preparation of (detailed) OPN, while the regulation on the methodology for preparing LEK defines the requirement to identify areas for gas and DH supply. Despite legal requirements, zoning for these areas is rarely implemented in practice. It typically occurs when the same distribution company manages both gas and heat networks, and where there is recognition of the need for coordinated development and capacity within the municipality. Conflicts often arise when consumers seek alternative, usually cheaper, heating methods instead of connecting to the DH system. However, due to strict disconnection conditions, such cases are generally not feasible.

## 4.2.9. Responsibilities of cities/municipalities

The leading question: *What are the primary responsibilities of cities and municipalities in planning DHC systems and zoning for heat supply?*

**Bosnia and Herzegovina:** DH is regulated by laws governing communal services and is managed by public utility companies at both the cantonal and municipal levels. Cantonal and municipal authorities are responsible for preparing and adopting regulatory spatial and urban plans, which define DH zones and identify areas where new DH infrastructure is needed.

**Bulgaria**: Municipalities are responsible for spatial planning, guided by the Territorial Planning Act. Under this framework, municipalities develop master urban plans and detailed spatial plans, which define the general layout of areas within their jurisdiction, including residential, industrial, and storage zones, as well as zones for technical infrastructure and mixed-use territories. According to the Energy Act, municipal mayors are required to obtain forecasts from energy companies within their territories regarding future consumption of electricity, heat, and natural gas, along with plans for energy, heat, and gas supply. Based on these forecasts, municipalities incorporate provisions into their master and detailed spatial plans for public works essential to implementing these energy plans, as proposed by the energy utilities.

**Croatia**: Cities and municipalities are responsible for creating urban plans that designate suitable areas for DHC systems, taking into account factors like population density, building types, and energy demands. They also promote the use of RES and ensure adherence to national EE and environmental standards. By coordinating with a range of stakeholders, municipalities play a crucial role in supporting the integration and successful implementation of DHC projects.

**Hungary**: Cities and municipalities play a critical role in planning DHC systems and zoning for heat supply in alignment with national energy policies and local needs. Their responsibilities include developing urban plans that integrate DHC networks, particularly in densely populated areas where centralized heating is most effective. Municipalities are authorised to designate zones where DHC should be prioritized, ensuring these areas are properly serviced while avoiding competing infrastructure, such as gas networks. Local governments also coordinate with utility companies to plan DHC system expansion and modernization, considering future urban growth and sustainability goals. They may establish regulations mandating DHC connections for new buildings or major renovations to maintain high connection rates essential for DHC systems' economic viability. Additionally, municipalities engage in public consultations to ensure community support and safeguard consumer interests. There are successful examples[14] showing how local authority involvement can effectively leverage DHC in urban planning, achieving both environmental and economic gains while supporting national energy and climate objectives.

[14] *A leading example of effective municipal involvement in DHC planning is found in Pécs, where the city's DHS has successfully transitioned to biomass, significantly reducing its reliance on fossil fuels. The local government facilitated this shift by zoning for biomass, securing supply chains, and upgrading infrastructure to support RES.*

**Romania**: National legislation requires local authorities to develop annual heating plans and EE programs in line with the national Energy Efficiency and District Heating Laws. The DH Law also mandates local governments to create DH zones based on the "one area, one heat source" principle, with feasibility studies identifying areas suitable for exclusive DH system heating. National legislation defines "unitary heating zones" as areas where all buildings must use the same heating type. However, these zones are not applicable in existing neighbourhoods due to the absence of centralized heating infrastructure, rendering them unenforceable as legal requirements. Nevertheless, such zones can be applied when authorizing the construction of larger residential buildings, where it could be stipulated that a single heating system must be used for the building or a group of buildings in order to obtain a construction permit. To implement this regulation, local authorities must first gather detailed information on available heating sources and infrastructure in the area. In certain municipalities, local councils have already made decisions regarding the establishment of unitary heating zones.

**Serbia**: By law, DH and zoning for heat supply are the primary responsibilities of local authorities. As a result, municipalities and cities have full responsibility and the necessary mechanisms to manage these tasks.

**Slovakia**: Cities and municipalities are tasked with integrating DHC into their urban planning and zoning regulations. They are responsible for designating areas for DHC infrastructure to ensure efficient energy distribution and to prevent conflicts with other heating solutions. Municipalities collaborate with DHC providers to align development plans, optimizing infrastructure investments and reducing redundancy. Local authorities also enforce building codes and regulations that either mandate or encourage the connection of new buildings to DHC networks. Additionally, cities and municipalities may offer incentives and support programs, to promote DHC adoption and ensure high connection rates across residential and commercial properties.

**Slovenia**: Municipalities have important responsibilities and opportunities in planning and zoning heat supply, primarily through spatial planning and local energy strategies. They are required to prepare a local energy concept (LEK), which serves as the (expert) basis for planning energy infrastructure, including heat supply, and must align with national energy goals. Within the LEK and municipal spatial plans (OPN), municipalities define areas for heat supply via DH systems, gas pipelines, and other methods. They also coordinate the development of energy infrastructure with other spatial needs, such as residential and industrial construction. Additionally, municipalities are responsible for ensuring the coordinated development of energy infrastructure, including both new systems and the modernization of existing DH and gas supply networks.

### 4.2.10. Public utilities for heating

The leading question: *How prevalent is it for cities to have dedicated public utilities managing heating services?*

**Bosnia and Herzegovina:** Public utilities offering DH services are primarily established in larger urban areas.

**Bulgaria**: It is uncommon for cities to operate public utilities for heating. With the exception of the municipally-owned district heating system in Sofia, all other heating systems in the country are privately owned.

**Croatia**: DH is primarily operated by public entities under municipal, city, or state ownership. These public utilities generally oversee the heat infrastructure, from production to distribution, for residential, commercial, and industrial consumers. While private companies may contribute in areas such as construction or maintenance, public ownership remains predominant, ensuring broad accountability and consistent service provision.

**Hungary**: Many urban areas have municipally owned or controlled utilities that manage DH systems, ensuring a reliable and efficient heat supply. These public utilities are typically responsible for operating, maintaining, and expanding the heating infrastructure[15].

**Romania**: It is fairly common for cities to have established public utilities responsible for centralized heating. These utilities, often managed by local authorities or designated companies within administrative associations, provide heating and hot water to residential buildings, public institutions, cultural facilities, and businesses as part of the public service.

**Serbia**: In most cases, DH services are provided by public utility companies established by local authorities. Slightly more than a third of the 145 local governments (municipalities) in the country have their own public utility company responsible for the production and distribution of thermal energy.

**Slovakia**: It is common for cities to have public utilities, often municipal or state-owned, that manage and operate DH systems. These utilities are responsible for providing centralized heating to residential, commercial, and public buildings. They also maintain the necessary infrastructure and implement EE measures. Public utilities operate within a regulatory framework overseen by the Regulatory Office for Network Industries (ÚRSO), which monitors pricing and ensures service quality. These utilities play a vital role in supporting national efforts to integrate RES and reduce carbon emissions in urban heating systems, contributing to the country's broader sustainability goals.

**Slovenia**: In the case of DH systems, it is common for (at least larger) municipalities to establish their own public companies responsible for heat supply. These services are provided as non-profit activities, with the primary goal of offering affordable heating to residents. Heat distribution can take two forms: as an optional local public service or as market distribution, both of which must be approved by the Energy Agency. Municipalities may grant a concession to a private company to provide heat supply services. In such cases, the company assumes responsibility for service delivery for a specified period while remaining under the regulation and supervision of both the municipality and the Energy Agency. According to the Energy Law, if a distributor serves or intends

*[15] For example, in Budapest and other major cities like Pécs and Debrecen, municipal companies such as Főtáv and PÉTÁV operate the DH networks. These utilities are regulated by the Hungarian Energy and Public Utility Regulatory Authority (MEKH), which oversees pricing and service quality to protect consumers.*

to serve more than 500 household customers, the heat distribution is classified as a public service. In Slovenia, there are 61 such systems.

## 4.2.11. Criteria for DHC utilities to benefit consumers

The leading question: *Are there established criteria for DHC utilities to maximize consumer benefits by reducing heating prices and ensuring that all profits are directed toward benefiting consumers?*

**Bosnia and Herzegovina:** Most of the energy produced from both fossil fuels and biomass and distributed by DHC utilities is subsidized by the authorities. These subsidies are largely driven by political motives rather than structured policies aimed at reducing costs for consumers or improving service efficiency. Consequently, while subsidies may reduce consumer expenses in the short term, they do not ensure that DHC utilities operate with a consumer-focused approach in the long term.

**Bulgaria**: Currently, no such criteria exist to ensure that DHC utilities maximize benefits for consumers through lower heating prices or profit reinvestment.

**Croatia**: Under the Act on Heat Market, HERA establishes tariffs for heat production and distribution within central DH systems. The Act defines heat supply and customer activities as market-driven, with fees set accordingly. It also classifies heating systems into central, closed, and independent categories: in central systems, tariffs for production and distribution are regulated, while supply fees are market-based. In closed and independent systems, heat prices are entirely market-determined.

**Hungary**: Residential users currently benefit from district heating provided at a fixed price, ensuring predictable heating costs. To support this system, DH companies receive government subsidies to cover their operational expenses.

**Romania**: There are no specific criteria requiring DHC utilities to maximize consumer benefits through reduced prices or direct profit redistribution However, the National Energy Regulatory Authority (ANRE) regulates DH pricing to ensure fair practices and support affordability indirectly. Local authorities set the price of heat billed to residents, with some subsidizing costs by covering the difference between actual costs and consumer prices, especially for vulnerable populations. In such cases, the difference between the total cost and the lower, locally approved price billed to residents is subsidized from local budgets.

**Serbia**: No specific criteria exist beyond those established by the AERS Methodology for determining heat energy prices, which are based on the fixed and variable costs of heat production. The Law on Communal Services sets a pricing criterion that limits the price difference between residential and commercial users at a maximum ratio of 1:1.5.

**Slovakia**: The Regulatory Office for Network Industries (ÚRSO) sets pricing guidelines that ensure heating costs are fair and reflect the actual cost of service without allowing excessive profit margins. Utilities are required to operate on a cost-recovery basis, with their financial models subject to review to ensure that any profits are reinvested in infrastructure upgrades and service quality, rather than being used for profit maximization. Transparency requirements also mandate that utilities disclose clear information on pricing and operational costs, ensuring accountability. Additionally, consumer protection regulations, along with dispute resolution mechanisms, are in place to effectively address concerns about pricing and service quality.

**Slovenia**: These specific criteria for DH public services are primarily designed to protect the interests of consumers, meaning they focus on ensuring objectively determined and fair heating prices that reflect actual costs. The main framework for determining heating prices is the Act on the Methodology for Setting the Heat Price for District Heating. This act provides a detailed definition of how prices are set and includes a methodology for calculation based on actual production and distribution costs, ensuring transparency and fairness in price formation.

## 4.2.12. Government support and incentives

The leading question / theme: *The extent of government support for DH projects, including financial incentives, grants, and policy initiatives.*

**Bosnia and Herzegovina:** Local authorities occasionally provide subsidies for households to procure and install individual substations for connecting to the DH network. However, these incentives are sporadic and lack a coordinated national policy or broader financial support framework for DH expansion.

**Bulgaria**: Government support for the DHC sector is relatively low. The primary form of support comes through a compensation mechanism for cogeneration outlined in Chapter Eleven of the Bulgarian Energy Act.

**Croatia**: Further investments are necessary to enhance EE and modernize the heating system, with a focus on RES and essential infrastructure improvements by 2026. These initiatives aim to achieve cumulative energy savings through 2030 and beyond. The National Recovery and Resilience Plan for 2021-2026 also supports the upgrading of heating systems to reduce carbon emissions from major energy consumers and facilitate the decarbonization of individual energy use. To maximize potential savings, it is crucial to align investments in large heating infrastructure with EE measures in buildings. This alignment underscores the importance of integrated policies and practices across all stages: production, transmission, distribution, and consumption.

**Hungary**: The government provides various subsidies and funding programs to encourage the integration of RES into DH networks. For example, the KEHOP[16] offers financial support for projects aimed at improving the EE and environmental performance of DHS, including infrastructure upgrades and the incorporation of biomass and geothermal energy[17]. Additionally, the Hungarian

[16] *Environment and Energy Efficiency Operational Program*

[17] *Source: Hungarian Ministry for Innovation and Technology, 2023*

Energy and Public Utility Regulatory Authority (MEKH) oversees regulations and financial frameworks that promote DH development, including tariff structures that allow utilities to recover costs and invest in modernization while keeping prices reasonable for consumers. The NECP outlines strategic goals and provides a policy framework to support the expansion of DH systems, emphasizing RES integration and GHG emission reduction. The government also funds specific infrastructure projects through direct grants, focusing on initiatives that enhance EE and incorporate innovative technologies such as smart grids and HPs. These financial supports are often complemented by incentives for private sector participation, driving further investment in DH infrastructure. Local municipalities benefit from national support programs to upgrade and expand their district heating networks. These initiatives typically involve collaboration between national and local governments to align with broader energy and climate objectives. Overall, the combination of financial incentives, grants, and supportive policies reflects Hungary's commitment to advancing DH systems as a crucial part of its energy strategy and environmental goals.

**Romania**: Support for DH projects includes financial incentives, grants, regulatory measures, and targeted policy initiatives that promote renewable energy integration, EE, and consumer affordability. Non-reimbursable funding is available for DHC systems from various sources, including Government Ordinance No. 67 (OG 67), the National Recovery and Resilience Plan (PNRR), and the Modernisation Fund. These funds collectively exceed 1 billion euros for DHC projects across the country. Additionally, the government promotes high-efficiency cogeneration through a dedicated scheme established under Government Decision No. 219/2007.

**Serbia**: Financial incentives, grants, or policy initiatives to promote DH projects are not common. However, several phases of the KfW (bank) credit line have been implemented to support the rehabilitation of DH systems in Serbian municipalities, with funding partially covered by the state budget and partially by local authorities.

**Slovakia**: The government provides a range of financial incentives to support the development and modernization of DH systems, particularly those that integrate RES. These measures include subsidies and grants designed to reduce the upfront costs of adopting innovative sustainable technologies. The country also leverages EU funding programs, such as the Cohesion Fund and the European Regional Development Fund (ERDF), which finance large-scale DH projects and the transition to low-carbon and RES. Additional support comes from tax incentives, including tax breaks and reductions. The NECP establishes a policy framework for upgrading the sector. This is complemented by operational support, including technical assistance and guidance for planning, feasibility studies, and stakeholder engagement to further streamline project development. The Ministry of Economy oversees policy frameworks and regulations governing district heating, while the Slovak Innovation and Energy Agency (SIEA) plays a pivotal role in managing technical and financial support for H&C projects. SIEA administers initiatives such as the Green Households Program, which provides subsidies to enhance EE and the use of RES in DHC systems. It also manages grant schemes and supports strategic energy planning at municipal level.

**Slovenia**: Various forms of support are available to promote DH, including financial incentives and subsidies from the European Regional Development Fund (ERDF), the Cohesion Fund, national funds, and the Eco Fund, as well as regulatory requirements and policies. Financial incentives and loans are mainly intended for the construction and renovation of DH systems, and the replacement or installation of heat substations for connecting to the DH network. One of the most supported technologies for DH is the use of wood biomass, with solar collectors also being encouraged as a complementary measure. However, support for geothermal energy has been more limited. In the past, CHP systems received strong support through funding schemes, but the support period for operations using natural gas is now coming to an end. While the development of DH systems is generally supported by municipal local energy concepts (LEK), these often fail to include plans or zoning for DH, despite legislative requirements. Current regulatory obligations related to DH efficiency, emissions, and the share of RES and WH are insufficient to effectively drive the development of systems. The draft revision of the NECP (October 2024) introduces new measures, including a regulated return on investment for DHC utilities, legislative frameworks for advanced tariff models, and an analysis of geothermal heat potential through direct use or large heat pumps.

## 4.2.13. Technical feasibility and reliability

The leading question: *What is the technical feasibility of developing DHC, considering the availability of suitable technology and necessary expertise?*

**Bosnia and Herzegovina:** There is sufficient expertise and access to suitable technologies for providing DH in the region. However, progress is hindered by a lack of political will to acknowledge the end of the fossil fuel era and insufficient funding to support the transition to decarbonized DH.

**Bulgaria**: DH sector primarily relies on CHP plants powered by natural gas, a well-established and reliable technology in the country. These systems effectively deliver stable energy services; however, integrating renewable energy technologies into the DH sector presents several challenges. While renewable solutions like biomass and geothermal energy are technically feasible, their implementation requires significant investment and modernization of existing infrastructure. To transition toward more sustainable energy sources, DH systems would need upgrades, such as enhanced distribution networks, improved energy storage, and the integration of smart grid and decentralized heat pump technologies.

**Croatia**: The potential of RES technologies within the local grid needs to be assessed and planned at the local level. Currently, there is a lack of knowledge and skills in this area, which presents an opportunity for development to better inform participants in DHC projects.

**Hungary**: The technical feasibility of DHC in Hungary is robust, supported by a combination of advanced technologies, skilled expertise, and a strong industry presence. The ongoing modernization of DHC systems, alongside supportive policies and funding, positions Hungary well for further expansion of this infrastructure. The country has access to various traditional and advanced technologies, including smart meters and automated control systems. A well-developed workforce, supported by universities[18] ensures expertise in designing, installing, and maintaining

[18] *Such as Budapest University of Technology and Economics.*

these systems. Established companies[19] bring significant industry experience, effectively managing complex DHC projects and integrating new technologies. Furthermore, Hungary's existing urban infrastructure facilitates the adoption of new solutions and the expansion of networks, with ongoing projects enhancing these capabilities. The integration of RES is actively pursued, leveraging the country's natural resources and technological strengths.

**Romania**: The country has a solid foundation for implementing DH, supported by its established infrastructure and technical expertise. With a long history of centralized energy planning, Romania has developed large-scale DH networks to serve both residential and industrial customers. The country has a skilled workforce, including local engineering firms and contractors experienced in DH infrastructure design, installation, and operation. To successfully implement and operate new technologies, ongoing professional development is essential. This can be achieved through workshops, seminars, research collaborations, training programs, and strategic partnerships, helping to advance technologies that address the country's energy and sustainability challenges.

**Serbia**: Expertise in DH is readily available, with skilled professionals in public utility companies and experts in scientific and educational institutions.

**Slovakia**: The technical feasibility of DHC is well-supported by advanced technologies and expertise, having access to modern solutions regarding biomass boilers, geothermal heat pumps, and WH recovery systems, which are essential for upgrading and expanding DHC networks. The engineering and technical expertise in energy infrastructure further facilitate the design and implementation of efficient solutions. National and EU-funded research programs contribute to the development of new technologies and best practices, while existing DHC networks in major cities, backed by operational experience, provide a strong foundation that ensures reliability and technical capacity for future expansions and improvements.

**Slovenia**: A long-standing tradition in Slovenia, with over one hundred distribution systems operating across one-third of the country's municipalities, supports the expertise in use of diverse heat production technologies. In larger systems, CHP based on natural gas (NG) is dominant, with Celje employing waste incineration and Ljubljana, the largest DH system transitioning from coal-based CHP (CCGT) with wood biomass co-combustion to NG. Approximately 40 medium-sized and smaller systems rely on wood biomass boilers, with biomass-fired CHP being rare. Geothermal and hydrothermal energy utilization remains limited, with one system tapping hot water from a deep well and another using high-capacity heat pumps to extract heat from river water. Systems utilizing industrial WH and thermal solar remain exceedingly rare. Peak demand is typically met by NG boilers. Thermal storage units are rather uncommon, resulting in limited experience in their operation and management. Various SCADA systems are widely implemented, with some advanced setups offering real-time optimization. Most systems depend on one or two heat production technologies, restricting expertise in managing more complex, multiple-source systems. The development and operation of DH systems are supported by numerous experts, including engineering firms with extensive experience in planning, implementation, and maintenance. Collaborative efforts with research institutions also contribute to innovation and

[19] *Such as Főtáv in Budapest and PÉTÁV in Pécs.*

knowledge exchange. Despite a solid foundation, further development will require more investments in sustainable technologies and professional skills.

# 4.3. DHC legislative framework

Key legal instruments and policy mechanisms regulating the DHC sector in PP countries are explored, with a focus on providing an overview of regulatory frameworks. This includes examining the primary laws, acts, and decrees that govern the sector in each country. Supporting policies aimed at fostering DHC expansion, such as financial incentives, zoning regulations, and emissions standards, are also addressed. Additionally, the integration of DHC systems with urban infrastructure and long-term building renovation plans is discussed, along with a review of monitoring and reporting mechanisms.

## 4.3.1. Overview of regulatory framework

The leading questions: *What are the national and local regulations governing DHC in terms of regulation, planning, and incentive structures? What provisions are outlined in the Heat Law (or equivalent legislation) and other relevant national policies?*

**Bosnia and Herzegovina:** The heating sector is regulated at the entity level, with no national regulation in place. In the Federation, public utility companies manage heating under communal activity regulations at the cantonal and municipal levels. However, for a large share of consumers, metering and billing are not based on actual consumption, undermining EE and rationalization efforts. Outdated infrastructure restricts the provision of sanitary hot water through DHS, and there are currently no plans or funding for cogeneration infrastructure, leading to significant energy losses. In Republika Srpska, heating is classified as an energy activity under the Law on Energy but is delivered by communal companies per the Acts on Communal Activities and Building Maintenance. Like in the Federation, metering and billing for many users are not based on actual consumption, hindering energy-saving initiatives. The aging infrastructure also prevents the supply of sanitary hot water through DHS and contributes to substantial energy losses.

**Bulgaria**: The regulatory framework for DHC is primarily governed by the Energy Act, which outlines both national and local regulations. Chapter 10 specifies the procedures and technical conditions for heat supply and district cooling. It details the operational management of these systems, the connection protocols for producers and consumers to the heat transmission network, as well as the guidelines for distribution, termination, and shutdown of H&C services. These standards are implemented through ordinances issued by the Minister of Energy. Chapter 11 focuses on promoting cogeneration and establishes conditions that support the development and efficiency of CHP technologies, recognizing their dual capacity to generate both heat and electricity, which is essential for enhancing the sustainability of Bulgaria's energy supply.

**Croatia**: The DH sector is regulated by the following acts:

- Energy Act (Official Gazette No. 120/2012, 14/2014, 102/2015, and 68/2018)
- Act on Regulation of Energy Activities (Official Gazette No. 120/2012 and 68/2018)
- Act on the Heat Market (Official Gazette No. 80/2013, 14/2014, 102/2014, 95/2015, 76/2018, and 86/2019)
- Act on Renewable Sources of Energy and High-Efficiency Cogeneration (Official Gazette No. 138/2021)
- Act on Energy Efficiency (Official Gazette No. 27/2014, 116/2018, and 42/2021)

**Hungary**: The regulation, planning, and incentive structures for DHC are governed by a combination of national and local regulations, such as Act XVIII of 2005 on DH and a Decree 9/2023 (25.V.) of the Ministry of Construction and Transport. This decree outlines the energy characteristics of buildings, with Annex 4 being particularly relevant. It serves as the primary legislation governing heat supply, including DH, and establishes the framework for tariffs, service quality, and the obligations of heat suppliers. It prescribes that DH tariffs must be approved by MEKH[20]. In terms of incentives, Hungary offers financial support through programs such as KEHOP, which funds projects aimed at improving the EE and environmental performance of DHC systems. Additionally, national policies and the NECP (NEKT) promote the integration of RES and innovative technologies within DH networks.

**Romania**: The key documents defining the basic provisions for the operation of the DH sector are as follows:

- Law no. 51/2006 on community public utility services (including DH), with subsequent amendments.
- Law no. 325/2006 regulating the public service of the centralised heat supply, covering production, transport, distribution, and supply to ensure efficiency, quality, and environmental protection, with amendments.
- National Strategy for DH Services (2004): The first national strategy recognizing the need for coherent state action in DH, emphasizing social and environmental protection, decentralization, market mechanisms, and private financing for infrastructure rehabilitation.
- Government Decision (HG) no. 219/2007: Promotes cogeneration (influenced by EU policies as Romania prepared for EU accession).
- Energy Efficiency Law 121/2014: Transposed EU Directive 2012/27/EU, promoting energy-efficient H&C services.
- Government Emergency Ordinance (GEO) no. 53/2019: Approves multiannual financing program for modernizing and expanding DH systems and amends the Community Services Law (51/2006), including specific updates on local energy supply systems.

**Serbia**: DH, as both an energy and utility service, is governed by two primary laws:

- Energy Law (Official Gazette of the RS, no. 145/2014, 95/2018, 40/2021, 35/2023, 62/2023, and 94/2024) regulates the production, distribution, and supply of thermal energy as energy-related activities. It also addresses pricing of thermal energy services, defines the

[20] *Hungarian Energy and Public Utility Regulatory Authority*

category of "vulnerable customers" in relation to thermal energy, and includes incentive measures for renewable energy use in heat production.

- Law on Communal Services (Official Gazette of the RS, no. 88/2011, 104/2016, 95/2018, and 94/2024) defines the production and distribution of thermal energy as a communal service, describing it as the centralized production and distribution of steam and hot water for heating purposes. It outlines who can organize and provide DH services and specifies the rights and responsibilities of utility companies, municipalities, and consumers.

Since DH is considered a communal service, municipalities establish local acts that govern the production, distribution, and supply of thermal energy within their jurisdiction. Local authorities also incorporate DH infrastructure development into their spatial plans, while public utility companies (PUCs) prepare short- and medium-term business plans that include strategies for service and infrastructure development.

**Slovakia**: The regulation of DHC is primarily governed by the Heat Supply Act No. 657/2004), also known as the Heat Law. This law sets the framework for the production, distribution, and supply of heat, establishing key provisions such as:

- licensing requirements for heat producers and distributors.
- Tariff regulations managed by the Regulatory Office for Network Industries (ÚRSO), which ensures fair and affordable heat pricing.
- Obligations for improving EE within DHC networks.
- Guidelines for integrating RES into DH systems to support the national transition to a low-carbon energy system.

Additional relevant national legislation includes the Energy Efficiency Act No. 321/2014, which promotes EE in buildings and incentivizes the modernization of DHC systems, as well as the Act on Renewable Energy Sources (Act No. 309/2009), which encourages the integration of RES such as biomass and geothermal energy into DH systems.

**Slovenia**: The Heat Supply from Distribution Systems Act (ZOTDS, OG RS, No. 44/22) governs the provision of heat to users through centralized DH networks, specifically for systems with a total user connection capacity exceeding 500 kW. Key provisions include: a) conditions for the public service of heat supply, b) rights and obligations of heat distributors and users, c) technical standards for the construction, operation, and maintenance of systems, d) rules for setting heat supply prices, e) conditions and general rules for connecting to and disconnecting from the system, and f) reporting, inspection, and penalty provisions. The Energy Act (EZ-2, OG RS, No. 38/24) prioritizes the use of heat from energy-efficient DH systems. The Renewable Energy Sources Act (ZSROVE, OG RS, No. 121/21, 189/21, 121/22) governs financial support for RES in DH systems and mandates an increase in the use of renewable energy, WH, and improved efficiency. The law also requires DHC operators to prepare a sustainable development plan, inform the public about sustainability indicators, and define conditions for disconnection from the system. The Energy Efficiency Act (ZURE, OG RS, No. 158/20) mandates the installation of meters to accurately measure energy consumption for heating, cooling, and domestic hot water in DH systems, with meters and heat cost allocators required to have remote reading capabilities. The law also establishes criteria for energy-efficient DH systems and requires cost-benefit analysis for building investments and DH connections. The DH sector is further regulated and supported by several secondary legal acts:

- Regulation on the cost-benefit analysis for the use of high-efficiency cogeneration and efficient DHC;
- Regulation on the allocation and billing of heating costs in residential and other multi-unit buildings;
- Regulation on financial Incentives for EE, district heating, and the use of RES
- Legal act on the mandatory content of operational instructions for district heating systems;
- Legal act on the methodology for calculating primary energy factors, carbon dioxide emissions, and efficiency for DHC systems, and on the content and format of the consolidated overview of planned measures and related data;
- General acts of public service providers for heat distribution, published as System Operating Instructions (SON).

## 4.3.2. Supporting policies for DHC development

The leading question: *What policies support the development and expansion of DHC networks, including zoning regulations, building codes, and emissions standards?*

**Bosnia and Herzegovina:** Certain cantons in the Federation have enacted laws on public-private partnerships, establishing a framework for collaboration between private investors and local communities. These laws facilitate funding for infrastructure projects, including construction, rehabilitation, management, and maintenance of facilities, to meet public needs. Consequently, potential investments in DH infrastructure can be pursued under these regulations. Similarly, the Law on Public-Private Partnership in Republika Srpska outlines a framework for cooperation between private investors and local communities to secure financing for infrastructure projects. This includes the construction, rehabilitation, and management of facilities to satisfy public needs, thus enabling potential investments in DH infrastructure.

**Bulgaria**: Policies that support the development and expansion of DHC networks are outlined in various strategic and regulatory documents at national and local levels. These policies focus on modernizing existing networks, decarbonizing the sector, and integrating RES. Zoning laws enable the strategic placement of DHC infrastructure, while building codes encourage EE and the use of renewables in new constructions. Emissions standards ensure that DHC systems operate within environmentally acceptable limits, aligning with national and EU climate goals. However, there are currently no specific financial mechanisms to facilitate DHC project implementation, presenting a challenge to the sector's growth and modernization.

**Croatia**: The Act on the Heat Market emphasizes that the construction and development of centralized heating systems, along with high-efficiency CHP production, is in the national interest. DH systems are essential for achieving national EE goals. Furthermore, the Building Act requires that all buildings subject to EE obligations provide a detailed analysis of alternative energy supply systems. DHC, especially when based on RES, is identified as one of these alternative systems.

**Hungary**: The national building codes establish energy performance standards for new buildings and major renovations, often requiring connections to DH systems. Emission standards promote the adoption of cleaner technologies and RES in DH to support climate objectives, with government incentives facilitating this transition. Financial programs such as KEHOP provide grants and subsidies to modernize DH infrastructure and integrate renewable technologies. These initiatives fully align with NECP.

**Romania**: The state aid scheme for investments in energy infrastructure, under Key Program 5 – High-efficiency cogeneration and modernization of DH networks, provides financial support for both the construction of high-efficiency CHP plants and the modernization of DH networks. To continue modernizing Romania's centralized heating supply systems, the District Heating Programme (2019–2027) was approved by GEO No. 53/2019. The beneficiaries of this program are the Territorial-Administrative Divisions (TADs). The main objective is to ensure ongoing modernization of centralised DH systems, focusing on key components such as heating production facilities, primary heating transmission networks (hot water), thermal power stations, heating modules at building level (where economically viable), and central heating networks. Additionally, the program also finances the establishment of centralized DH systems for towns.

**Serbia**: As DH falls within their core jurisdiction, local authorities are responsible for planning and implementing public policies that support DH system development. To guide long-term strategy, local authorities adopt a Local Development Plan, the highest-ranking policy document at the local level, which shapes development priorities across their territory for a minimum of seven years. This plan serves as a foundation for more specific policy documents, including the air quality plan, Sustainable energy and climate action plan (SECAP), and local infrastructure development plan, each of which can further detail DH system development objectives.

**Slovakia**: Zoning regulations enable municipalities to designate specific areas where DHC networks are mandatory, particularly in urban centres, ensuring that new developments connect to existing systems. The national building regulations require new buildings, especially large developments, to assess their energy needs either to connect to DHC systems or install energy-efficient heating solutions that align with national EE targets. Emissions standards have also been implemented to limit the use of fossil fuels by heat producers, encouraging the transition to cleaner energy. Solutions such as biomass, WH recovery, and CHP with RES are promoted to help reduce GHG emissions.

**Slovenia**: The Energy Act (EZ-2) prioritizes the use of heat from energy-efficient DH systems over other individual systems and technologies for heat supply. The Renewable Energy Sources Act (ZSROVE) requires an annual increase in the share of heat from RES and WH in DH systems. Between 2021 and 2030, this share must grow by at least 1% annually or reach 10% if a minimum 5% increase is achieved in both five-year periods (2021–2025 and 2026–2030). If these interim targets are not met, the law mandates a total increase of at least 15% over the decade. Furthermore, ZSROVE includes RES-based heat production within DH systems as eligible for financial incentives to support investments. The regulation on preparing local energy concepts (LEK) stipulates that maps of DH areas must be included. However, this requirement is largely unimplemented in practice, with only a few municipalities having adopted ordinances to define areas served by DH systems.

## 4.3.3. Integration with urban infrastructure

The leading questions: *Is there a regulatory framework established to harmonize energy solutions for building infrastructure with DHC systems? Do the policies consider DHC integration with existing urban infrastructure, including retrofitting buildings and planning new urban developments?*

**Bosnia and Herzegovina:** Savings in final energy consumption within the housing sector are a key focus of the national Building Renewal Strategy[21]. In assessing energy use in residential buildings, it is important to quantify the shares of different energy consumption types. Heating and improving EE in buildings are paramount for developing effective renovation programs. The NECP aims to achieve final energy savings in the housing sector, with measures projected to reduce energy consumption by 150 ktoe (1.7 TWh) by 2030 compared to the baseline BAU scenario which projects total energy consumption at 1,982 ktoe (23.1 TWh) in 2030.

**Bulgaria**: The national regulatory framework supports the integration of DHC systems with existing urban infrastructure, including the retrofitting of buildings and the development of new urban areas. This integration is largely facilitated through urban planning principles established by municipalities, which guide the strategic placement and expansion of DHC infrastructure. Additionally, national regulatory bodies play a crucial role in capacity planning and development, ensuring that DHC solutions align with broader urban development goals.

**Croatia**: The integration of DHC with existing urban infrastructure primarily falls under the jurisdiction of local communities rather than being dictated by a national framework. In general, urban development plans at both the general and implementation levels outline zoning regulations and designate specific areas for various types of infrastructure, including DHC systems.

**Hungary**: The regulatory framework mandates the integration of DHC systems with building infrastructure, supporting both new developments and the retrofitting of existing buildings. Financial incentives, such as those offered through the KEHOP program, fund projects that connect buildings to DHC systems and enhance EE. Urban planning policies require that new developments incorporate DHC infrastructure, ensuring EE and sustainability from the outset. The NECP aligns DHC expansion with broader climate goals, promoting the modernization of DHC networks to reduce GHG emissions.

**Romania**: National-level policies focus on establishing a legal framework to implement the national energy strategy while granting local municipal authorities the responsibility for planning urban energy infrastructure. These policies ensure that municipal planning aligns with the broader societal interests. Local authorities are empowered to set rules and guidelines to streamline energy infrastructure planning.

[21] *https://fmpu.gov.ba/wp-content/uploads/2023/07/SOZFBiH_finalni-nacrt_07_02_2023_rev-28.04.2023.docx*

**Serbia**: This aspect of planning requires enhancement. Beyond spatial plans, there are currently no mandatory mechanisms to coordinate planning efforts. Introducing new and effective solutions in this area would support more cohesive DH system development within municipalities.

**Slovakia**: Local governments are required to integrate EE and DHC solutions into urban development plans. These plans focus on retrofitting older buildings and ensuring that new urban developments are designed to accommodate DHC infrastructure. The regulatory framework encourages the modernization of existing buildings for compatibility with DHC networks, and municipalities have the authority to mandate that large energy consumers, such as public buildings and residential complexes, connect to these systems when economically feasible. Policies also require the inclusion of DHC (as a sustainable energy solution) in the development of new urban areas, particularly in densely populated residential zones. Incentives are also provided for projects that integrate DHC with RES.

**Slovenia**: The Spatial Planning Act (ZUreP-3) outlines the fundamental principles for constructing public utility infrastructure (GJI), emphasizing the rational use of space. It prioritizes the reconstruction and expansion of existing infrastructure while ensuring alignment with both current and future municipal needs. The aim is to achieve optimal space utilization and efficient construction that is consistent with the existing infrastructure. Data on utility networks and related facilities are maintained in the public utility infrastructure register. Municipalities are responsible for planning local spatial arrangements. When preparing spatial acts (e.g., municipal spatial plans), they should use the local energy concept (LEK) as a technical foundation for planning energy use and supply, as mandated by the Energy Act (EZ-2). The Renewable Energy Sources Act (ZSROVE) further requires municipalities to collaborate with network operators in preparing the LEK, ensuring that future needs for network expansion and the integration of RES and energy communities are addressed. However, municipalities often lack the capacity to effectively prepare and implement LEKs that integrate comprehensive and coordinated planning for all types of energy infrastructure, including DHC, as well as the construction of new buildings and neighbourhoods or their renovations.

## 4.3.4. Role of DHC in long-term building renovation plans

The leading question: *How is the role of DHC defined in the long-term building renovation plans?*

**Bosnia and Herzegovina:** The long-term building renovation plans specify a role for DHC that includes the centralization and modernization of heating systems, as well as improvements in cooling and the preparation of sanitary hot water through the utilization of RES[22].

**Bulgaria**: DHC systems play a vital role in long-term building renovation strategies. They provide essential heating to a large portion of multi-family residential buildings nationwide. Modernizing these systems is critical for reducing GHG emissions and achieving nZEB standards.

[22] *https://fmpu.gov.ba/wp-content/uploads/2023/07/SOZFBiH_finalni-nacrt_07_02_2023_rev-28.04.2023.docx*

**Croatia**: The role of DHC in building renovation plans is not explicitly defined; rather, it is addressed indirectly, primarily in the context of its potential to provide renewable energy or utilize highly efficient cogeneration as an energy source.

**Hungary**: The national long-term building renovation strategy prioritizes the integration of DHC systems, while the NECP emphasizes the importance of upgrading existing buildings to improve energy performance, often by connecting them to centralized, low-emission DHC networks. EE programs offer both financial and technical support for retrofitting buildings. Regulations require that major renovations meet specific energy performance standards, promoting the use of DHC wherever feasible. The Heat Law mandates that new buildings and significant renovations buildings connect to DHC networks in designated areas. Additionally, government programs like KEHOP fund the integration of DHC in building renovations.

**Romania**: The national long-term renovation strategy by 2050 identifies several key actions to improve EE and sustainability of residential and non-residential buildings, including the integration of sustainable heating solutions like DH. The modernization of DH networks and support for high-efficiency CHP plants are emphasized in PNNR. Focus is also placed on finding innovative cooling solutions in multi-family and public buildings, particularly through DHC systems that can provide cooling in summer. This may include technologies such as absorption cooling systems, steam turbines, thermal (cold) storage for off-peak cooling, and natural ventilation. Promoting reconnections to DHC systems is a key strategy for enhancing their financial stability. The Long-Term Strategy for Romania outlines that the energy demand in the residential and commercial sectors will be partially met through the use of renewable-based (biomass, biogas and hydrogen) CHP systems.

**Serbia**: The role of DH is recognised in the NECP, and it is expected to be a central focus of the upcoming national thermal energy strategy.

**Slovakia**: The national building renovation strategy highlights the important role of DH in the decarbonization of the building sector. It encourages retrofitting buildings to improve EE and enhance compatibility with modern, lower-temperature DH systems. The strategy promotes the expansion of networks within urban areas, integrating RES and advanced heat storage solutions as part of the renovation process. Financial support is also provided for connecting buildings to DHC networks, particularly within the framework of energy-efficient renovations funded through both EU and national programs.

**Slovenia**: The Long-Term Strategy for Building Renovation until 2050 (DSEPS), published in 2021, outlines that centralized heat supply, in line with the NECP, is prioritized in areas with high heat demand density and where DHS already exist. The strategy highlights that efficient DH is the most suitable method for supplying heat to buildings in urban and densely populated areas, as long as its costs remain competitive with alternative systems. Individual heating systems are not encouraged in ways that could result in disconnections from DH systems. Among the recommended measures for the energy renovation of residential buildings, the strategy includes the installation of heat substations and connections to DH systems, including for sanitary water heating. Furthermore, DH is recognized as one of the most effective solutions for utilizing the substantial potential of lower-quality wood biomass as an energy source for heating.

### 4.3.5. Monitoring and reporting mechanisms

The leading question: *What mechanisms are in place for monitoring and reporting heat supply data, including the preparation of annual reports and compliance with regulatory requirements?*

**Bosnia and Herzegovina**: Statistical data are submitted to entity statistics institutes, and annual business reports are presented to cantonal and municipal councils for approval.

**Bulgaria**: The National Statistical Institute (NSI) collects and publishes statistical data related to energy production and consumption, including specifics about DHC systems. This information offers valuable insights into overall performance and trends in the heating sector. Additionally, DH operators are required to report their emissions annually to the National Environment Agency, and these reports are subject to certification. They must also submit an annual report on their operations to the EWRC.

**Croatia**: Monitoring and reporting of heat supply data are conducted through national statistical reports. The annual report by HERA and the "Energy in Croatia" survey provide comprehensive statistical data on DH production, fuel usage, demand, and other relevant metrics. All DH producers and operators are required to submit the necessary input data. Additionally, the production of heat from RES is subject to specific analyses and reporting requirements.

**Hungary**: DH utilities are required to submit annual reports detailing their operations, including data on heat production, distribution, consumption, energy sources, efficiency, emissions, and financial performance. The national authority (MEKH) oversees heat supply regulations and mandates periodic reporting on tariffs, service quality, and compliance with standards. It also conducts audits to ensure accurate data reporting and regulatory adherence. Utilities must also report on the quality of heat supply, including temperature stability and service disruption response times, enhancing transparency and allowing consumers to monitor the performance of heat providers. Additionally, utilities are required to report on their EE, detailing measures taken to reduce losses, which is crucial for tracking progress toward national EE targets and accessing government incentives. Environmental reporting includes emissions data from heat production facilities (GHG and other pollutants), ensuring compliance with national and EU environmental regulations. As part of national commitments under the NECP, utilities must submit data related to the performance and expansion of DH systems to support national planning and monitoring efforts.

**Romania**: The Methodology for monitoring public centralised heat supply service and urban heating and cooling systems, established by the national energy regulatory authority ANRE under Order no. 11/2021, outlines a) monitoring parameters b) reporting obligations and responsibilities of energy sector operators to regularly submit monitoring data; and c) the responsibilities of ANRE for analysing and publishing reports based on the submitted data. The monitoring results are published annually on ANRE's website, with data available by administrative-territorial units (UATs), as well as aggregated by geographical regions and at the national level.

**Serbia**: Apart from the annual business and operations reports submitted by public utility companies (PUCs) to local authorities and ministries, and the monitoring of harmful air emissions, there are no well-developed monitoring and reporting mechanisms in place.

**Slovakia**: Heat producers and distributors are required to submit annual reports to the Regulatory Office for Network Industries (ÚRSO), detailing energy consumption, pricing, efficiency improvements, and the share of RES in heat production. Large DHC systems undergo regular energy audits to assess system performance, identify energy losses, and pinpoint opportunities for efficiency improvements. As part of the Energy Efficiency Act, the country tracks progress toward EE targets, including data on DHC systems, which is used to report to the European Commission. DHC operators must also report emissions data to meet national environmental regulations and the EU's Emissions Trading System (ETS) requirements.

**Slovenia**: The Energy Act (EZ-2) establishes the fundamental requirements for data reporting by energy activity operators, including those involved in heat distribution through DH systems. The Heat Supply from Distribution Systems Act (ZOTDS) provides further details regarding the reporting process, mandatory data analysis, and the role of the Energy Agency. Reporting must adhere to standard formats defined by the Agency. DH operators are required to report annually on: a) the volume of heat produced, distributed, and supplied, broken down by customer type; b) the fuels used for heat production; c) the share of RES and CHP; d) network losses; e) production costs and end-user heat prices; f) key details about the distribution system; g) areas of operation; and h) other technical and economic performance indicators. The Energy Agency uses the collected data to prepare national analyses and reports. Publicly disclosed information on the Energy Agency's website includes: a) analyses of heat prices from DHC systems; b) a list of DHC systems where heat prices are regulated, in accordance with the Act on the Methodology for Heat Pricing for District Heating; c) annual lists of energy-efficient DH systems (as required by ZURE); and d) sustainability indicators for DHC systems, such as the primary energy factor, annual EE, and $CO_2$ emissions.

## 4.4. Action plans and available instruments in support of DHC

National and regional initiatives promoting the modernization and expansion of DHC networks in PP countries are examined. The review includes support instruments such as financial incentives, subsidies, and policy-driven mechanisms designed to stimulate investment in DHC infrastructure, as well as the role of local development plans in facilitating these efforts.

## 4.4.1. DHC in National and Regional Plans

The leading questions: *How is DHC incorporated in the NECP or other action plans on energy efficiency and renewable energy? What specific DHC measures or instruments are included in these action plans for your country?*

**Bosnia and Herzegovina:** The NECP has not yet been adopted by the authorities, resulting in the absence of actionable plans. (Note: All references to the BiH NECP in this report refer to the most recent publicly available draft.)

**Bulgaria**: The NECP emphasizes the importance of DHC systems in promoting EE and integrating RES. It supports the implementation of efficient H&C technologies, utilizing innovative solutions such as geothermal, hydrothermal, solar technologies, and WH recovery. The plan prioritizes the expansion of existing DHC networks and the development of new systems to connect public sector buildings and service facilities that are currently not linked to these networks. Enhancements in EE focus on rehabilitating heat transmission networks, particularly through the use of pre-insulated pipes to minimize heat losses. Additionally, NECP outlines plans for integrating advanced management and monitoring technologies, including sensors, smart meters, and systems for optimizing heat flow. These innovations aim to lower the temperatures of heat carriers and increase the share of RES within DHC sector.

**Croatia**: The NECP addresses DHC by outlining specific EE measures for energy infrastructure. Key initiatives include:

- Production side: Modernizing thermal production facilities by diversifying heat sources, with a focus on high-efficiency CHP, WH recovery, and RES wherever feasible.
- Distribution and consumption: Implementing pipeline reconstruction using pre-insulated pipes in areas lacking proper infrastructure; transitioning to the 4$^{th}$ generation of DH; and introducing advanced metering systems to enhance overall EE.

**Hungary**: The NECP outlines strategic actions for expanding and modernizing DHC systems over the next 10, 20, and 30 years, with a focus on increasing renewable energy use, enhancing efficiency, and integrating advanced technologies. This plan emphasizes thermal storage to improve DHC flexibility, supported by funding programs like KEHOP for large-scale heat storage projects. Initiatives to lower DH supply and return temperatures by promoting low-temperature DH technologies aim to boost EE, while smart metering and control systems are encouraged to optimize operations, better align heat supply with demand and even further reduce energy losses. To promote wider adoption of DHC, awareness campaigns and educational initiatives aim to improve stakeholder understanding of its benefits. The government provides financial incentives for developing low-temperature DHC systems and is working to simplify permitting procedures for renewable energy projects. New participation models, such as cooperatives and energy communities, are being promoted to help finance and manage DHC projects. Efforts to enhance the bankability of DHC projects include financial guarantees and risk mitigation tools to attract investment. Technical guidance and best practices for integrating RES are being developed, along with initiatives to promote solar thermal and geothermal solutions through financial incentives, research, and pilot projects.

**Romania**: Several key policies and measures aimed at advancing the energy sector, directly or indirectly related to DHC, are outlined in the NECP:

- P&M2 - Introduction of renewable hydrogen into the energy system, targeting 100% renewable hydrogen in CCGT and CHP plants by 2036.
- P&M4 - Promotion of high-efficiency cogeneration capacities.
- M&M26 - Installation of solar thermal collectors in the residential sector, with provisions for integration with DH systems.
- P&M27 - Expansion of energy production from biomass and biogas by building new power plants and CHP facilities.

The energy strategy of Romania 2025-2035, with a perspective towards 2050, further outlines specific measures for the DH sector:

- P3.1.1 - Implementation of new integrated investments in centralized heat supply systems, focusing on:
    - updating legislation for DH to ensure a transparent, stable, and predictable legal framework, with an emphasis on EE;
    - supporting investments in infrastructure modernization to make the sector more attractive and financially viable, which will reduce losses and improve service performance;
    - addressing insolvency issues within some operators to protect creditors and restore confidence, facilitating future investments.
- P3.1.2 - Support for high-efficiency cogeneration through financial incentives such as bonus support and co-funding for investments in CHP systems, thermal energy storage and modernizing DH networks. A state aid scheme is also in place to support the development of flexible gas production capacities for electricity and heat generation through highly efficient cogeneration in the DH sector.

**Serbia**: The Energy Development Strategy for the Republic of Serbia until 2025 with projections to 2030 recognizes DH as a key energy sector (though DC is not mentioned). The strategy outlines several priorities: 1) Modernizing existing heating systems; 2) Implementing a unified tariff system for thermal energy; 3) Enhancing institutional coordination (DH is regulated under two separate laws by different ministries); 4) Expanding DH networks; 5) Promoting energy source diversification and efficiency; 6) Reducing reliance on liquid fuels and coal; 7) Increasing biomass usage, including co-combustion in coal-fired plants; 8) Utilizing communal waste; 9) Expanding the use of sanitary hot water; 10) Supporting CHP production; and 11) Strengthening local self-government capacity for market regulation. The Integrated NECP (INECP) outlines considerations for the development of DHC systems, including the need to build new infrastructure using RES. It emphasizes supporting the integration of renewable technologies into existing and planned DHS through financial assistance for necessary investment costs. The plan also explores the potential introduction of mandatory quotas for using renewable energy in DHC systems. Additionally, it proposes launching modern low-temperature DHS, which would connect local demands with renewable and waste energy sources, as well as the broader electricity and gas networks, optimizing energy supply and demand. The Law on Amendments and Changes to the Energy Law, adopted by the Serbian Parliament in November 2024, mandates the development of a National Thermal Energy Strategy. Although Serbia has yet to set specific goals for DHC, as a member of the Energy Community, it must align with EU targets, which include a 55% reduction in emissions by 2030, and is expected to harmonize its obligations with those of EU member states in the coming years.

**Slovakia**: DHC is in focus of the NECP as well as regional action plans with efforts centred on modernizing systems to reduce energy consumption, improve efficiency, and integrate RES. The NECP outlines specific measures to boost the share of RES in DH, particularly through the adoption of biomass, geothermal energy, and WH. Complementing this, the national Low-Carbon Development Strategy sets long-term decarbonization targets for the heating sector, including improving EE in buildings connected to DHC systems and expanding RES usage. A major optimization highlighted in the National Action Plan involves integrating CHP units into DHC systems. Priority is given to optimizing existing CHP systems and gradually transitioning them to efficient RES-compatible solutions. This transformation accounts for decreasing heat demand driven by improvements in thermal insulation. To streamline decision-making and permitting processes, it is crucial to coordinate policies on the ETS, pricing, taxation, and regulations while addressing environmental concerns. Aligning these policies with investment plans presents an ongoing challenge but is essential for achieving more effective regulation and sustainable development.

**Slovenia**: DHC systems are recognized in the NECP as crucial for achieving EE goals and increasing the share of RES. There are no regional plans for the development of DHC systems, and they are rarely included in local energy concepts (LEK). The NECP highlights the need to transition towards 4$^{th}$ generation DHC systems while improving the efficiency of buildings and distribution networks. The final proposal of the revised NECP from August 2024 includes several measures related to DHC, such as: a) updating the Renewable Energy Sources and Energy Efficiency Act (ZSROVE) to align with the revised energy efficiency and renewable energy directives (EED and RED), setting higher mandatory shares of RES and WH in DH systems; b) creating a supportive environment for DHC project development, supported by digitalization; and c) ensuring stable financial incentives and regularly conducting calls for the development of efficient DHC systems. Additional new measures include: a) supporting local energy planning and the preparation of LEK; b) establishing legislative frameworks for advanced tariff models and regulated returns on investments for DHC operators; c) preparing expert foundations for using geothermal energy in DHC systems; d) setting criteria for promoting centralized heat and cooling supply to public buildings; and e) ensuring transparent data to end users to encourage their active role in DHC. Spatial planning measures include preparing expertise as a foundation for placing heat and cooling supply devices, including DHC systems. Cross-sectoral measures also promote DHC, such as encouraging the use of WH across all sectors and connecting it to DHC systems, and strengthening the capabilities of the s.c. "Contact Point" to support EE in buildings, industry, and DHC. Building-focused measures include developing a program to phase out fossil fuel use in buildings, which encourages connections to DHC systems. However, the renovation of DHC systems, aside from heat substation upgrades, is not explicitly mentioned in the measures.

### 4.4.2. Support instruments

The leading question: *What are the key support instruments affecting DHC, such as subsidies for connecting existing buildings to DH, biomass phase-out initiatives, and incentives for CHP?*

**Bosnia and Herzegovina:** Co-financing consumer connections by municipal authorities plays a significant role in increasing the number of connected buildings, with Tuzla serving as a positive example. Conversely, a negative example is the forced disconnection of consumers within multi-apartment buildings, mandated by the Competition Council of Bosnia and Herzegovina. This has led to a chain reaction in some municipalities where, despite the heating quality meeting prescribed standards, users disconnect from the system due to its lower perceived quality. There are, however, initiatives to connect existing multi-apartment buildings to the DH system. For instance, in Tuzla, the process of connecting all old multi-apartment buildings within DH zones to the DH system was completed in 2016.

**Bulgaria**: In the last three years, Bulgaria has implemented a program to facilitate the free connection of households that rely on solid fuels to existing heating networks in cities with poor air quality. Despite this initiative, uptake has been limited, with only a small number of households benefiting from the program. The primary support instruments focus on promoting CHP production.

**Croatia**: While there are no specific instruments exclusively dedicated to DHC, certain subsidies may be available through programs aimed at developing DH networks that integrate existing renewable heat plants, such as biomass and biogas. Additionally, there are expectations for incentives to promote the use of geothermal energy within DH networks, and feasibility studies are currently underway to assess this potential. In line with the transposition of the 2012/27/EU directive (on energy efficiency), obligations related to energy savings for mandatory parties have been relaxed for energy supplied by producers, distributors, or providers of DH. Furthermore, measures ENU-3 and ENU-4 offer financial incentives, including grants for the reconstruction of residential buildings that achieve a heat demand reduction of at least 50%.

**Hungary**: The country advances DHC system development through financial and regulatory measures, primarily under the Environment and Energy Efficiency Operational Program (KEHOP). KEHOP provides financial assistance to connect existing buildings to DHC networks, expanding system reach and efficiency. Both residential and commercial property owners can access funding options to upgrade heating systems and connect to DHC, lowering the financial barriers to these energy improvements. To promote cleaner energy, Hungary supports the shift from high-emission fuels to sustainable alternatives, including biomass. The government has established programs to improve the efficiency and reduce emissions of biomass-fired DH plants, focusing on modernizing these facilities and reducing fossil fuel dependency. Incentives also support adopting CHP systems, which increase EE and reduce GHG emissions. The Hungarian Energy and Public Utility Regulatory Authority (HEPURA) oversees regulations and offers both financial and technical assistance to make CHP projects more affordable and accessible. National strategies further promote the integration of RES into DHC systems through financial incentives, grants, and technical support.

The regulatory framework sets clear targets for renewable energy use and offers guidelines for integrating renewables into DHC. KEHOP funding aids in modernizing DH infrastructure and incorporating smart technologies to enhance system performance and reliability.

**Romania**: Several support instruments are designed to impact DH, in particular: a) supporting high-efficiency cogeneration installations (connected to DH networks) through bonus schemes and investment co-funding (under Recovery and Resilience Facility); and b) facilitating investments in the modernization and rehabilitation of smart heating networks

**Serbia**: There are several local initiatives aimed at improving DH systems. For instance, with the support of a KfW (bank) loan, five smaller heating plants in the City of Novi Pazar and the municipalities of Priboj, Mali Zvornik, Kladovo, and Majdanpek transitioned from using fossil fuels, primarily heavy oil and coal, to biomass. The USAID-funded Better Energy project is enhancing the efficiency of DH systems by incorporating solar energy and optimizing billing practices. The EBRD's Renewable District Energy Serbia project is investing in renewable and WH-based generation across several DH companies in ten small and medium cities, including Pančevo, Vršac, Kraljevo, Niš, Bogatić, Bečej, Kruševac, Novi Pazar, Paraćin, and Kragujevac.

**Slovakia**: A few financial and policy-based support instruments are available to advance DHC systems: a) subsidies for connecting existing homes to DH that aim to encourage households to switch from individual fossil-fuel-based heating systems to cleaner DHC solutions, especially in urban areas; b) biomass phase-out initiatives for replacing the coal and non-renewable biomass in DH with locally sourced renewable biomass, supported by funding from both the EU Cohesion Fund and national sources; c) incentives for CHP plants that integrate with DHC systems, which are energy-efficient and can utilize biomass or WH (subsidies are offered through the Operational Programme Quality of Environment); d) tax reductions and incentives for low-temperature DH (tax breaks and subsidies are available for installation and infrastructure upgrades).

**Slovenia**: In April 2024, the "Regulation on the Allocation of Financial Incentives for Promoting the Use of Renewable Energy Sources and High-Efficiency Cogeneration, and Energy-Efficient District Heating and Cooling[23]" (OG RS, No. 32/2024) was revised. It governs the allocation of incentives as state aid in accordance with the last update of Commission Regulation (EU) No 651/2014, published in July 2023. The national regulation defines procedures for granting incentives, eligibility criteria, monitoring, record-keeping, and reporting, as well as technical requirements for eligible systems such as biomass boilers, heat pumps, and efficient DHC. The most recent public call for co-financing the restructuring of DH systems to RES for the 2023–2025 period was published by the Ministry of the Environment and Spatial Planning (MOPE) as part of the Recovery and Resilience Plan, but was closed prematurely in March 2024 due to reallocation of funds, with just under EUR 3 million used out of the available EUR 20 million. The Eco Fund (Eko sklad) provides subsidies for connecting existing buildings to DH as part of a program to promote RES investments and increase EE. DH operators can also allocate support to end-users through the Energy Savings Program. In recent years, some municipalities have allocated funds from their budgets to subsidize DH costs

[23] *Pravilnik o dodeljevanju finančnih spodbud za spodbujanje energije iz obnovljivih virov in soproizvodnje z visokim izkoristkom ter energijsko učinkovito daljinsko ogrevanje oziroma hlajenje*

for financially vulnerable groups. In 2022, the legislation governing support schemes for electricity production from RES and high-efficiency cogeneration was last amended, allowing production plants to enter the support scheme through a public call, though it has had limited impact on DH systems to invest in RES-based CHP projects.

## 4.4.3. Local development plans

The leading question: *What are the primary activities regarding DHC development outlined in local (municipal) development plans?*

**Bosnia and Herzegovina**: The expansion of the network, modernization of substations, and implementation of EE measures for buildings connected to the DH network.

**Bulgaria**: A) Develop scenarios for DHC systems over the next 10, 20, and 30 years within local energy and climate plans, taking into account the ownership structures of existing heating systems. B) Increase awareness among users and stakeholders to encourage a transition to DHC solutions. C) Develop new business models and participation frameworks such as cooperatives, crowdfunding, collective ownership, and energy communities to enhance stakeholder involvement. D) Advocate for the integration of solar thermal and geothermal technologies within DHC systems.

**Croatia**: A) Create long-term scenarios for DHC over the next 10, 20, and 30 years to guide planning and investment. B) Increase the capacity for thermal (heat) storage by developing and designing innovative storage solutions and projects. C) Formulate DHC plans for the gradual transformation of systems to primarily rely on locally available RES and heat storage solutions. D) Encourage the use of solar thermal and geothermal solutions within DHC systems. E) Advocate for the deployment of HP in coastal areas, utilizing the heat of seawater for DHC supply.

**Hungary**: Municipalities are running awareness campaigns to educate residents and stakeholders about the benefits of DHC, promoting wider adoption. To foster growth, they are increasing financial and tax incentives for low-temperature DH and simplifying permitting to accelerate the development of renewable DHC projects. New business models, including cooperatives and energy communities, are being explored to provide alternative financing, with efforts to improve the bankability of these projects through financial support and risk mitigation. Municipal plans also focus on integrating local RES and heat storage into DHC systems, supporting sustainability goals. Training platforms and knowledge-sharing initiatives are being developed to spread best practices. Solar thermal and geothermal solutions are being promoted within DHC networks, backed by financial incentives and pilot projects. Retrofit programs are improving EE in existing buildings and connecting them to DHC systems. Additionally, efforts are focused on integrating smart grid technologies to improve DHC network efficiency.

**Romania**: The development and expansion of DH networks are often integral parts of municipal development plans, particularly in urban areas. Key activities include:

- Implement technical strategies, promotional activities, and marketing approaches to rebrand existing customers and attract new ones.
- Upgrade distribution networks to reduce losses and ensure reliable heat supply.
- Assess the potential of local RES and industrial WH for integration into DH system.
- Introduce smart metering and digital solutions to optimize system performance.
- Collaboration with national initiatives to secure EU funding for DH projects.
- Conduct studies on establishing unitary heating zones in compliance with Law 325/2006 on the public heat supply service.
- Promote solar thermal solutions in DHC.

**Serbia**: The key DHC-related initiatives in the municipal development plans focus on improving efficiency, sustainability, and the integration of RES, including:

- Developing long-term plans for infrastructure growth and upgrades, with a focus on expanding the DH network, increasing coverage, and phasing out fossil fuel-based boilers. A gradual transitioning to RES for heat production, alongside the expansion of thermal (heat) storage, are also key priorities. Efforts will be needed to design and implement innovative storage solutions that balance supply and demand, as well as optimize system performance by reducing supply and return temperatures.
- Reducing losses in thermal energy production and distribution while increasing EE among end users.
- Introducing individual measurement and regulation of heat consumption, enabling more accurate billing (based on actual use) and improved energy management.
- Raising awareness among users and stakeholders about the benefits of transitioning to DHC and promoting connections to networks.
- Improving the financial viability or bankability of DHC projects to attract investment and ensure long-term sustainability

**Slovakia**: A number of municipalities have committed to enhance DHC and have defined measures in their municipal development plans, generally as follows:

- Setting long-term DHC scenarios: Municipalities like Košice and Zvolen have developed extensive DHC plans with decarbonization milestones over the next 20 years, focusing on increasing the RES share and reducing emissions from heat production. Košice, in particular, is prioritizing the integration of biomass and WH from industrial sources.
- Thermal storage development: Cities such as Bratislava are investing in heat storage technologies to better balance supply and demand, especially when incorporating solar thermal.
- Supply and return temperature reduction: the city of Zvolen is actively pursuing the reduction of supply and return temperatures, a key measure for minimizing energy losses, enhancing the efficiency of existing DHC and connecting new buildings to the network.
- Awareness and stakeholder engagement: The Slovak Association of District Heating (SZVT) leads efforts to raise awareness and engage stakeholders in the transition to RES-based DHC, using educational campaigns, workshops, and policy discussions.
- New participation models: small towns like Banská Bystrica are exploring innovative participation models, involving citizens through energy communities and collective

ownership of DHC systems. These approaches foster new business models and financing methods, such as cooperatives and crowdfunding.

- Enhancing DHC project bankability: To improve the bankability of DHC projects, efforts are underway to increase access to EU funds, streamline permitting processes, and establish risk-mitigation tools for investors. Additional work is focused on standardizing technical and regulatory frameworks to attract private investment.
- Providing training and networking platforms: The Slovak Innovation and Energy Agency (SIEA) offers platforms for knowledge exchange, technical guidance, and best practices on integrating RES into DHC systems, including training for local governments and energy providers.

**Slovenia**: The development of DHC systems in municipal development plans and local energy concepts (LEK) is often poorly defined or entirely absent. Municipalities generally lack specific strategies for H&C, and only a small proportion of operators have developed sustainable development plans for district heating systems. Additionally, there is a shortage of technical foundations, such as heat maps or assessments of RES potential. Strategic planning processes for energy supply, including heating, are not established, and there is a lack of knowledge and resources for strategic development. Plans typically include the following DHC-related elements: a) general support for transitioning to RES, where existing DH systems are primarily shifting toward biomass, with occasional consideration for geothermal energy or WH; b) promotion of building and energy system upgrades, which may include connecting existing buildings to DH; and c) awareness campaigns that aim to encourage investments in RES and EE in buildings, though they only occasionally promote the benefits of DHC systems. However, the development of DHC systems within municipal development plans is primarily constrained by:

- Lack of technical foundations, including no clear identification of areas or potential for heat supply from DHC systems.
- Limited knowledge, expertise, and experience for preparing heat supply scenarios that incorporate DHC.
- Weak awareness and understanding about the benefits of DHC within local communities and among end-users.
- Unattractive existing business models for heat supply that fail to attract investors.
- Insufficient collaboration and inadequate coordination among stakeholders, including municipalities, end-users, investors, DHC operators, industry, sources of WH, and energy distribution network managers.
- Poor identification and utilization of local energy resources, such as geothermal energy, which hinders the increase of RES shares in DHC systems.

# 5. Barriers and gaps in DHC development across the REHEATEAST region

Development of DHC systems is often hindered by various challenges. Key barriers that slow down the adoption and expansion of DHC networks are examined, focusing on technical, economic, regulatory, and organizational constraints.

## 5.1. Challenges in developing future-proof district heating systems

Technical, social, financial, and political complexities create multifaceted challenges in transitioning from traditional high-temperature, fossil-fuel-based district heating (DH) systems to modern, low-temperature solutions that integrate RES and WH.

Many existing DH systems, constructed decades ago, were originally designed for high-temperature operations (above or around 100°C) with centralized heat production primarily reliant on (fossil) fuel combustion. These legacy systems pose significant barriers to the integration of modern technologies, particularly the efficient utilization of RES such as geothermal and solar energy, and low-grade WH. Transitioning to low-temperature systems, which are more energy-efficient and compatible with renewable energy integration, is constrained by outdated infrastructure, making modernization a complex challenge.

The systemic transition to future-proof district heating systems involves complex challenges that extend far beyond technological considerations. Stakeholders often have differing perspectives on the best direction of development. Technologists and researchers advocate for smart, resilient systems with the lowest possible distribution temperatures to efficiently integrate diverse heat sources and technologies, including various renewable sources, heat pumps, and thermal storage. However, successful development requires addressing additional, often underestimated factors, such as the timing and phasing of transitions, social dynamics, institutional collaboration, financial constraints, and the political context and policy environment. Focusing solely on technical or economic solutions risks undermining long-term sustainability.

Successful implementation hinges on understanding the roles and motivations of all actors, particularly key decision-makers. Aligning the interests of diverse stakeholders is a major challenge, as each plays a critical role in the development and modernization of DH systems:

- Municipalities: As central actors in DH projects, municipalities are often (or at least should be) the most motivated to drive change due to their responsibility for reducing $CO_2$ emissions and improving local energy security. They must act as impartial mediators, resolving conflicts and balancing interests among stakeholders, while maintaining the willpower to pursue long-term projects that may have relatively low financial returns.

- Utilities and operators: These entities must modernize infrastructure and integrate new technologies while ensuring economic viability, often in a context of regulatory constraints and limited funding.
- Building owners and property managers: These actors are responsible for maintaining building-level heat distribution systems, which significantly impact overall DH system efficiency. Transitioning to low-temperature systems often necessitates upgrades to building substations, internal distribution networks, and heating devices, raising questions about cost allocation and benefit-sharing among stakeholders.
- End-users and public: Public acceptance is critical, and other stakeholders must address consumer concerns regarding costs, transparency, and service quality to build trust and foster engagement in the modernization process.

The transition to sustainable DH often requires comprehensive upgrades, from production and distribution facilities, to building substations, internal heat distribution systems, and heating devices, this raising the challenge of fairly distributing and balancing the associated costs and benefits among stakeholders. The transition to future-proof DH could be particularly challenging process from the financial perspective, as it requires substantial financial investment in infrastructure modernization and technology upgrades, with the long-term investment span and strong stakeholder support. Securing funding is a significant barrier, particularly in regions with limited public or private financial resources. Additionally, the policy environment must provide clear incentives and regulatory support to foster innovation and encourage collaboration among stakeholders. Without robust policies, efforts to transition to sustainable and efficient systems may falter.

Despite these challenges, the strengths of DH systems remain unparalleled, especially as modern DH systems can a) achieve higher EE than individual systems; b) facilitate the use of renewable energy and reutilize WH; c) lower operational costs through economies of scale; d) enhance energy security by diversifying energy sources; and e) foster sector coupling and reduce air pollution – a benefit often underappreciated in local energy planning.

To fully realize the societal benefits of DH systems, public involvement and collaboration are essential. Stakeholders must work together to co-create policies and participate in local energy planning. A holistic approach is crucial, incorporating the following elements:

- Integrated planning: Long-term strategies that align technological innovation with social, financial, and political considerations;
- Stakeholder collaboration: Mechanisms to facilitate dialogue and cooperation among municipalities, building owners, utilities, and consumers;
- Fair cost allocation: Transparent methods to balance the costs and benefits of infrastructure upgrades and modernization;
- Capacity building: Training and knowledge-sharing to equip stakeholders with the expertise needed to manage transitions effectively;
- Strong governance: Municipalities must lead with clear, impartial leadership to navigate conflicts and drive progress.

## 5.2. Key barriers to the acceptance, planning, development and operation of DHC

Key obstacles arise from the need to mobilize potential users, address financial and technical uncertainties, ensure efficient implementation, and navigate complex policy environments. Mobilizing communities and stakeholders requires tackling issues such as public mistrust, limited awareness, and concerns over costs and service quality. From a financial perspective, high upfront capital costs, long payback periods, and economic risks make DHC investments less attractive. On the technical side, integrating modern DHC infrastructure with existing urban systems and maintaining operational efficiency, presents significant obstacles. Furthermore, inconsistent regulations and policy uncertainties further hinder progress. The key barriers to the acceptance, planning, development, and operation of DHC systems, have been grouped into four main areas: user mobilization, financial and technical challenges, implementation difficulties, and regulatory constraints. Addressing these barriers is essential to unlocking the full potential of DHC systems, enabling them to deliver substantial environmental, economic, and societal benefits.

### 5.2.1. Mobilisation of potential users

Mobilizing potential users is crucial for the successful acceptance, planning, development, and operation of DHC systems. However, several barriers can impede this process:

- Identifying internal resources to initiate the scheme and overcome the lack of knowledge.
- Persuading building occupants to accept communal heat as (eventually) mandated by the planning authority.
- Overcoming customer lack of trust and scepticism of the technology with many believing they are paying more compared to other heat supply options.
- Lack of interest and low awareness of district heating.
- Perceived lack of service quality.
- Concerns about the cost of connecting and using a heat network.
- Negative public image of DHS due to low transparency toward customers.
- Unclear responsibilities and coordination among stakeholders.
- Discrepancy between the value of DHS offering and customer needs: while DHS focuses on sustainability, comfort, and convenience, customers often prioritize energy costs over environmental, climate related or societal benefits.
- Decisions to connect to a DHC network are made by housing companies or building developers, often in collaboration with the municipality, not by DHC users.
- The development of a DHS requires cooperation among many stakeholders, leading to complicated agreements, increased costs and higher risks.
- Long and difficult negotiations among stakeholders.

- The “chicken and egg” problem: heat consumers or housing developers hesitate to commit to connecting until a heat network is established, while suppliers and DHS operators hesitate to commit without guaranteed customers. Support and risk mitigation measures to overcome this impasse are often unavailable.
- Monopolistic position of DHS operator: since the network owner is also responsible for heat delivery, there is no room for competition, and the effectiveness of legislation to protect DHS customers from the monopolistic position of DHS operators is often questionable in practice.

### 5.2.2. Financial viability and technical feasibility

Financing is one of the most significant challenges to DHC development, largely due to the substantial reinvestments needed and the long payback periods typical of infrastructure projects. The barriers are extensive and multifaceted, including the following:

- High capital costs and long payback periods (20-30 years) overall make DHS a less attractive business case, offering low returns on investment (typically below 6-8%).
- Economic uncertainties, such as fluctuating future demand and DH prices, compounded by potential crises that could stall real estate projects, may negatively impact financial returns. This makes DHS a particularly risky investment, especially for private companies.
- Challenges in securing funding for feasibility and viability studies.
- Limited knowledge and expertise in the development of DHS.
- Difficulty in identifying and selecting appropriately qualified consultants for project planning and execution.
- Challenges in correctly interpreting reports provided by consultants.
- Uncertainty regarding the longevity and reliability of heat demand, especially in new or extensively renovated buildings. The high fixed costs of DHS exacerbate investor concerns about demand fluctuations, as the economic viability of DHS is highly dependent on economies of scale, making it particularly sensitive to the level of secured demand.[24]
- EE improvements in buildings reduce heating demand, which can negatively impact DHS revenue streams and undermine future economic feasibility.
- Inadequate heat planning, often lacking proper modelling of future heat demand, hinders effective decision-making.
- Small decentralized DHS projects are poorly suited for energy-efficient housing stock, as demand levels may not justify the investment.
- Uncertainty surrounding the reliability of heat sources, including WH, raises concerns for long-term operational stability.
- New technologies, such as hybrid 5th generation DH networks, are perceived as too risky and costly for private investors, discouraging adoption of innovative solutions.

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[24] *Established solutions mainly include implementing DH "mandating zones" (as seen in Denmark), leveraging the urban planning process (practiced in Sweden and Germany), or securing "anchor" tenants to ensure system viability.*

- Commercial building owners are hesitant to commit to long-term contracts, and effective process management to foster trust, support, and collaboration among stakeholders is often lacking.
- The absence of tax incentives for using WH or renewable energy in DH systems makes alternative heating solutions more financially attractive.

### 5.2.3. Implementation and operation

The evolving energy landscape, marked by reduced heat demand in energy-efficient buildings, demands for innovative and future-proof designs that traditional systems often fail to meet. The implementation and operation of DHC systems encounter a range of complex challenges. Below are some of the most significant and pressing barriers.

- High upfront capital costs.
- Limited access to funding for independent legal advice for local authorities (LAs).
- Absence of widely accepted standardized contract mechanisms.
- Inconsistent heat pricing, lack of transparency in pricing structures, and billing practices not based on metering.
- Challenges in securing agreements with energy service providers, including obtaining contributions toward capital costs.
- Need for capacity-building and enhancing the skills of LAs procurement teams to effectively manage DH projects.
- Concerns regarding the performance of heat networks and the level of service provided by suppliers.
- Heat losses and defects within the network due to insufficient measures such as reducing network temperatures or improving insulation.
- Suboptimal network designs that fail to balance cost efficiency with operational flexibility.
- Difficulties and high costs associated with connecting existing residential areas to a DHS.
- Complexity and significant installation expenses involved in integrating heat infrastructure into existing cities or urban areas.
- The lower heat demand of new dwellings necessitates the use of different technologies and lower design temperatures compared to traditional DHSs. This creates a risk that DHS designs may not be "future-proof," failing to accommodate the reduced energy requirements of new or retrofitted buildings.
- Decreased heating demand resulting from EE measures at the building level, which reduces DHS revenue streams.
- Unsuitable business models or organizational frameworks, such as municipally-run DHS companies, can create instability and uncertainty due to political changes and the requirement for municipal approval for investments.
- Delays in housing development anticipated to be served by DH systems negatively impact the return on investment.

- Outsourcing operations without sufficient internal expertise often leads to poor performance and subpar customer service.
- A lack of a dedicated initiative or project leader to mediate between stakeholders and drive the project forward hampers progress.
- Dependence on multiple stakeholders for the development of DHC systems necessitates business models that create win-win scenarios to ensure cooperation. One of the key challenges is designing business models that capture economic value while delivering social and environmental benefits to the region.
- Unclear roles for LAs pose a significant risk of hindering DHC development. The absence of a universally accepted framework defining their responsibilities – such as setting strategic direction, initiating schemes for public (LA-owned) and private buildings, or promoting new projects through planning processes, particularly for new developments – creates uncertainty and obstructs progress.
- Securing access to land presents significant challenges, especially for greenfield projects. Identifying suitable locations for central heating plants, distribution networks, and other necessary infrastructure can be complex. Fragmented land ownership further complicates the process, as property owners may be unwilling to sell or lease their land for DHS purposes. Moreover, integrating DHS infrastructure with existing urban infrastructure adds another layer of difficulty.

## 5.2.4. Regulation and policy as a barrier

Regulatory and policy frameworks are vital for fostering the successful development of DHC systems, but they can sometimes act as barriers instead of enablers. Addressing these policy-related obstacles is essential to establishing a supportive environment where policy objectives align with the practicalities of implementing sustainable H&C solutions. Several policy challenges can impede progress[25], including the following:

- The absence of long-term, credible policy commitments creates a volatile and unpredictable environment for DHC investments, which are typically capital-intensive with extended asset lifespans. Fluctuating policies and shifting regulatory landscapes heighten the risk for investors, deterring long-term commitments. Possible solutions include establishing robust frameworks that protect operators from government-induced risks, implementing supportive planning laws, and promoting integrated planning approaches to encourage consistency and investor confidence.
- Inconsistencies between different policy objectives can create significant roadblocks for DHC development. For example, policies designed to promote renewable heating may not align with existing DHC regulations, resulting in contradictions that complicate project implementation. A lack of coordination between local, regional, and national policies

[25] *Useful further reading: Research on district heating and local approaches to heat decarbonisation - Annex 1: Overcoming barriers to district heating; Frontier Economics Ltd, London, November 2015*

further exacerbates this issue, leading to inefficiencies and missed opportunities for system integration.

- Restrictive planning policies and complex permitting processes can create substantial challenges for new entrants in the DHC sector or hinder the expansion of existing systems. These regulatory hurdles delay projects, escalate costs, and discourage innovation.

# 6. Selected best practices in DHC

The transformation of DHC systems is being shaped by innovative technologies, sustainable energy practices, and evolving regulatory frameworks. This section showcases selected best practices in DHC development across the REHEATEAST region and EU, providing insights of several successful projects that demonstrate technical, environmental, cooperative and economic advancements.

## 6.1. Lighthouse DHC related projects in the REHEATEAST region

The following DHC projects from the REHEATEAST region[26] highlight successful and practical approaches to enhancing EE, integrating RES, and modernizing infrastructure. These cases demonstrate strategies addressing location-specific challenges while delivering environmental, economic, and operational benefits. Each initiative underscores the potential of DHC to enhance urban sustainability, reduce carbon footprints, or improve service quality for end-users. These examples aim to inspire replication and foster further innovation across the region, driving progress toward a more energy-efficient and renewable-powered future.

**Bulgaria**

- *Integrating solar-thermal panels into the DHC and domestic hot-water supply system in Burgas*

In late 2015, the Bulgarian government announced the launch of the National programme for energy renovation of multi-family residential buildings, offering measures fully funded by a 100% grant. Measures included window replacement, thermal insulation on facades and roofs, and the options to integrate RES. Before this initiative, large-scale renovation of multi-family buildings were uncommon nationwide. To test its feasibility, a pilot project was launched in Burgas, focussing on installing solar thermal panels on selected building roofs. These panels were connected to the DHS via the DH company's subscriber stations and integrated into the energy renovation program. Installations required the subscriber station to be in the same building block, and adequate technical space for additional boilers. The pilot project was well-received, significantly reducing energy needed for hot water production in summer and delivering noticeable cost savings. Its success provided strong evidence for scaling and replicating the model in other cities nationwide.

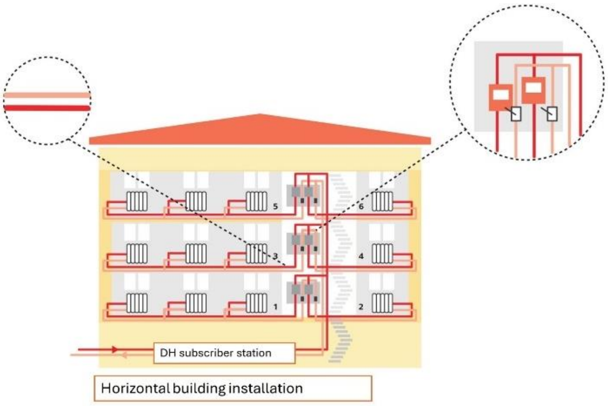
- *Conversion of multi-apartment building heat distribution systems from a vertical to a horizontal configuration*

Retrofitting internal vertical heating installations is a practical solution for buildings that currently use central (district) heating as well as those where the central heating supply was discontinued in the past. This upgrade allows residents to once again enjoy the convenience of central heating, but with a modern horizontal installation that provides individualized service. In 2015, EVN Toplofikatsiya successfully reconstructed the vertical heating system of a seven-story building in

[26] *The cases from BiH were not provided by AC-BIH, the project partner representing the region.*

Plovdiv, originally built in 1975. As part of the project, individual heat meters were installed at the entrance of each dwelling. The retrofit delivered several key benefits: a) Reduced energy consumption in the building by over 89%; b) A new installation featuring high-quality insulation materials; c) Individual heat meters and contracts for each dwelling, offering personalized billing; d) Improved capabilities for monitoring and control of individual consumption; and e) Better management and greater control over energy use for residents. In addition to its energy and economic advantages, this solution addresses a critical customer retention challenge in the heating sector by enhancing service quality and convenience. The model has demonstrated success and is currently being implemented in the city of Varna.

Source: thermal.bg




Source: EVN Toplofikatsiya

*Figure 1: Bulgarian best practices - Integration of solar-thermal panels in Burgas DHC (left); Scheme of horizontal heat supply configuration for multi-apartment buildings (right)*

**Croatia**

- *Sustainable transformation of Rijeka's heating energy infrastructure*

The project, funded by the European Regional Development Fund, aims to modernize the heating energy infrastructure in Rijeka. Managed by Energo d.o.o. (energotoplinarstvo.com), a company that is majority-owned by the City of Rijeka, the initiative addresses the challenges of a 50-year-old heating network that currently serves nearly 10,000 users. The focus is on enhancing EE and the reliability of heat supply through the modernization of plants and pipelines while transitioning to RES. Key elements of the project include integrating individual heating systems in both the eastern and western parts of the city into a unified network, utilizing CHP and renewable resources to minimize energy losses and emissions. This project exemplifies a commitment to sustainable urban energy solutions, aiming to modernize infrastructure, improve environmental outcomes, and enhance EE in Rijeka's DHS.

The project's objectives are as follows:

- Reduction of $CO_2$ emissions and elimination of $SO_2$ from production processes.
- Enhanced efficiency through production optimization and decreased distribution losses.
- Facilities that primarily use fuel oil for heat production transition to natural gas as their main heating fuel.

- Generation of over 50% of heating energy from CHP and RES.
- Preparation of the system for increased integration of RES.
- Continuous 24-hour operation of all heating plants.
- Complete renovation without increasing costs for users or the city's budget.

- *Revitalizing Zagreb's centralised heating system*[27]

The ongoing project aims to enhance the efficiency and reliability of DHS in Zagreb. Launched in 2021 under the Integrated Territorial Investments (ITI) mechanism, the initiative focuses on replacing nearly one-third of the existing hot water network to modernize and optimize the system. This revitalization will utilize advanced ductless technology for installing pre-insulated pipes, significantly improving the reliability of central heating system. This modern approach addresses the challenges of outdated infrastructure, which is prone to corrosion, high heat losses, and disruptions in thermal energy supply. In the first two years, 40 km of the hot water network have been upgraded, resulting in a total of 80 km due to the two-way nature of the pipeline. An additional 28.5 km are scheduled for replacement between 2024 and 2026. By modernising the infrastructure, the initiative aims to boost system efficiency and provide end customers with a stable and reliable heat supply.

Source: Energo d.o.o.

Source: HEP toplinarstvo

*Figure 2: Croatian best practices - Modernisation of the Gornja Vežica heating plant in Rijeka (left); Revitalisation of the DH network in Zagreb (right)*

**Hungary**

- *Modification of heat substation connections Pécs DHS*

The original design and control of "separating supplier substations" (also known as "block substations"), which linked the primary and the secondary DH network, were marked by high heat losses, substantial space requirements, and inefficiency in meeting individual heat demand. This system has been replaced with a modernised approach that eliminates separating supplier

[27] https://www.hep.hr/projekti/projekti-iz-eu-fondova/revitalizacija-vrelovodne-mreze-na-podrucju-grada-zagreba/3601

substations and instead installs individual building substations directly connected to the primary DH network, with controls tailored to the specific requirements of each building. Furthermore, the outdated four-pipe secondary network has been replaced by a pair of modern pre-insulated pipes laid directly in the ground. This upgrade has streamlined the infrastructure, significantly reducing heat losses and electricity consumption for pumps and auxiliary systems, while enhancing the overall efficiency and reliability of the DHS operated by PÉTÁV.

- *Transforming the Kaposvár DHS – a model for sustainability and efficiency*

$CO_2$ emissions from the Kaposvár DHS have been reduced to just 10% of their original level, driven by a 50% reduction in both specific heat and electricity consumption through EE improvements, while maintaining the existing customer base. The transition from NG to biomass boilers has further cut emissions by approximately 80%, and geothermal heat is now used for household hot water preparation. A four-level heat regulation system has been implemented to enhance efficiency further. These efforts, coupled with the inclusion of major institutional users like hospitals and schools, have helped restore heat sales to original levels. The company’s specific heat generation costs and client consumption are now among the top 10% lowest in Hungary's DH sector. Collaboration with private sector partners and local transportation initiatives has led to the use of biomethane and electric transport solutions. With over EUR 25 million invested, involving also EU grants, the DHC complies with the efficiency rules according to EED.


Source: PÉTÁV

Source: https://kaposvarmost.hu/hirek/kaposvari-hirek/2023/10/04/zold-futomu.html

*Figure 3: Hungarian best practices - Improved heat substation connection concept in the Pécs DHS (left); Kaposvár Green Heating Plant at the October 2023 inauguration (right)*

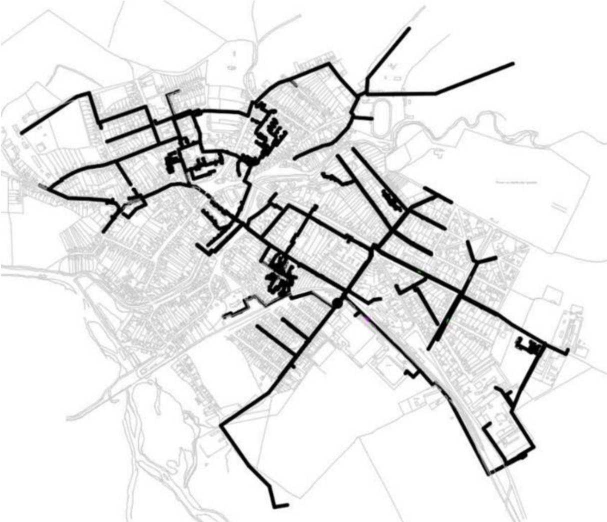
**Romania**:

- *A fully renewable DHC in Beius*

The Beiuș DH system is entirely powered by renewable geothermal energy, sourced from two geothermal wells with temperatures of 83°C and 73°C. This system generates 88 GWh ot thermal energy annually, providing heat to 75% of the town’s population. It offers the most affordable heating rates in Romania, at 179 lei/Gcal with VAT (appr. 31 EUR/MWh) and 4 lei/$m^3$ of geothermal water (appr. 0.8 EUR/$m^3$). The geothermal water exploitation and distribution system is relatively modern, built about 20 years ago with high-quality materials. It ensures reliable 24/7 operation, providing heating and hot water with minimal interruptions or maintenance needs. In the absence of gas infrastructure, consumers have no alternative option that offers similar affordability, efficiency, and comfort, making the Beiuș geothermal system a highly advantageous solution.

- *A sustainable approach toward modernising the DHS in Oradea*

The DH system in Oradea municipality provides heat to approximately 88% of its residents. Recent initiatives have focused on investing in cogeneration capacities to comply with environmental regulations and enhance EE. The integration of geothermal energy with heat pumps and the modernization and rehabilitation of heat distribution networks have further improved the system's performance. These advancements have led to a growing number of homes being connected to the DH system. The high efficiency of Oradea's DH system has also encouraged real estate developers to integrate it into new building projects.



Source: gogn.orkustofnun.is/Skyrslur/OS-2017/OS-2017-05.pdf

Source: eeagrants.org/news/utilising-geothermal-potential-romania

*Figure 4: Romanian best practices - Geothermal DH network map in Beius (left); Geothermal project in Oradea (right)*

**Serbia**:

- *Advancing energy efficiency and environmental sustainability in Kragujevac with support from the DH utility*

Energy efficiency, closely integrated with environmental protection measures, has become a priority for the City of Kragujevac. Working alongside national ministries, the city has established clear guidelines to enhance EE in both production and end-user sectors and has since launched several impactful projects. The DH utility, Energetika d.o.o., supports this initiative by switching to natural gas as its primary energy source, while schools and kindergartens are equipped with solar panels, allowing them to become energy "prosumers". The city promotes heating system upgrades through RES, co-finances building facade and carpentry renovations, and installs calorimeters in new apartments, helping residents conserve heat energy and better control their heating costs.

- *Sustainable transformation strategy of public DH utility Toplana Priboj*

The Municipality of Priboj exemplifies long-term planning in local energy management, demonstrating a structured, step-by-step approach to transitioning the DH utility, Toplana Priboj, towards more sustainable and efficient operations. The transition began in 2016 with the installation of a pellet boiler that provides heat to a school, a preschool, a cultural centre, and the municipal administration building. In 2019, a biomass boiler plant with a capacity of 1.8 MW was commissioned to supply heating for primary and secondary schools and a children's dispensary. These projects were financed through a combination of the local budget, the Serbian Government's Office for Public Investments, and German development aid (GIZ). In 2021, a new biomass heating plant with a capacity of 8 MW was constructed and became operational, supported by reserve oil-fired boilers with a total installed capacity of 23 MW. This project was financed through a loan from the German Development Bank (KfW) in partnership with the Ministry of Mining and Energy and the Ministry of Finance. The final phase of this initiative, currently underway, focuses on replacing fuel oil with wood chips at Priboj Hospital and Health Centre, aiming to fully eliminate fossil fuels from heating in public buildings and the DH system. This transition has not only resulted in significant economic savings by utilizing more cost-effective energy sources and substantially reducing air pollution, but has also created over 50 "green" jobs in Priboj, primarily related to the biomass supply chain for the DH system.

Source: Energetika d.o.o., Kragujevac

Source:

*Figure 5: Serbian best practices - Energetika Kragujevac (left); Biomass DH Plant in Priboj (right)*

**Slovakia**:

- *Transition to renewable biomass in Košice DHS*

Košice, one of Slovakian largest cities, is modernizing its DH system by transitioning from coal to renewable biomass. The local utility company, MH Teplárenský Holding, a.s., is leading this initiative as part of its broader strategy to meet EU climate goals. This shift not only reduces carbon emissions but also strengthens energy security by utilizing locally sourced biomass. The transition model developed by Košice can serve as an example for other cities in Slovakia (and abroad) aiming to adopt sustainable, renewable energy solutions.

- *Geothermal DH in Galanta - a model for sustainable energy solutions*

The city of Galanta in western Slovakia has implemented geothermal heating to supply its residential and public buildings. It is currently the only project in the country where geothermal heat is delivered through a DH system. By utilizing local geothermal wells, the project provides a sustainable heat supply to multiple buildings within the city. The system features multiple heating loops with different temperature levels and gradients, interconnected in a cascade design. Such configuration maximizes geothermal energy utilization, enhances the efficiency of the geothermal reservoir, and consequently extends its operational lifespan. This geothermal heating system has demonstrated cost-effectiveness, providing a replicable model for other Slovak towns with suitable geothermal resources. In 2007, a thermal spa was constructed and commissioned in Galanta, utilizing heat pumps to recover the remaining low-temperature heat from the water discharged from the station. The initiative is supported by local authorities and demonstrates how municipalities can successfully transition to renewable energy solutions for heating.


Source: remak.eu


Source: geodh.eu

*Figure 6: Slovak best practices – Central facility of the Košice DHS (left); Geothermal installation at the Galanta DHS (right)*

**Slovenia**:

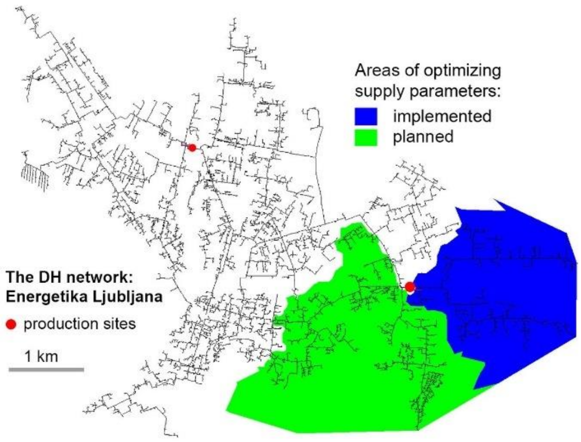
- *Harnessing hydrothermal energy for DHS in Maribor*

The project in the Municipality of Maribor aimed to enhance the use of local RES and diversify heat supply for the city's largest DHS. Two large heat pumps (HP), each with a thermal capacity of 1 MW, extract hydrothermal energy from the Drava River. Operational since October 2023, this innovative installation is expected to generate 12 GWh of heat annually. The facility is powered by electricity from an on-site CHP plant and rooftop solar panels installed on the building housing the HPs.

- *Optimizing the DH network in Ljubljana*

The DH network in the Municipality of Ljubljana is by far the largest in Slovenia. It is operated by the utility company Energetika Ljubljana, which continuously strives to lower the production and distribution costs of heat through resource optimization, including temperature regulation and hydraulic balancing of the distribution network. The optimization initiative began with dividing the heat distribution network into two interconnected sections, enabling independent management of each. In one section, serving approximately 10% of consumers, supply temperature and pressure were deliberately reduced to minimize heat losses, reduce water leakage, and improve the overall operating conditions of the network. This approach also aimed to lower the frequency of interventions and repairs. Specifically, the maximum supply temperature was decreased from 118°C to 95°C, and inlet pressure was reduced from 10 bars to 5 bars. These modifications yielded significant results: annual heat losses decreased by approximately 1.5 GWh, hot water losses dropped by over 16,500 m³, and electricity consumption for operating the hot water pumps dropped by 27 MWh. Encouraged by these outcomes, the utility expanded the optimization strategy to additional sections where similar improvements could be implemented without compromising the service quality or comfort of residential clients. While technical conditions, including network configuration, building stock conditions, and internal heating systems, impose limitations, the utility aims to extend these measures to approximately 30% of consumers - a key target for further efficiency gains.

Source: energetika-mb.si




Source: Energetika Ljubljana

*Figure 7: Slovene best practices - Large heat pump in the DH of Energetika Maribor (left); Areas of optimizing supply parameters in the DH network of Energetika Ljubljana (right)*

## 6.2. Get acquainted with more DHC best practices

District heating (DH) systems are not relics of the past; they are essential for the responsible and sustainable use of energy resources in the future. The remarkable progress in transforming DHC systems into sustainable and modern solutions is evident in numerous examples, particularly across the EU and also globally. These cases highlight that innovation and development are continuous processes, driven by emerging technologies, evolving needs, and shifting socio-economic and geopolitical landscapes. Utilities are compelled to adapt and enhance their solutions to meet the demands of consumers and society more effectively.

Envisioning the future of DH systems is challenging, but they will likely need to be resilient, accommodating diverse energy sources and integrating multiple technologies. Future developments must focus on minimizing the risk of DH becoming prohibitively expensive while enhancing its competitiveness compared to individual heating solutions.

These few examples demonstrate that the strong and stable market position of DHC systems results from strategic rethinking of local energy supply, informed by historical developments and guided by a vision that balances the interests of all stakeholders while ultimately serving the community. The cases also suggest that future systems will embrace decentralized heat production concepts, featuring greater integration with electricity systems than currently seen. They will also harness WH from various sources, such as industrial processes, data centres, and Power-to-X technologies, paving the way for a more efficient and sustainable energy ecosystem.

***Recommended publications and websites offering insights into advanced best practice solutions in DHC***

- The publication District Energy - Energy Efficiency for Urban Areas highlights DH and DC solutions from various locations, including Silkeborg (Denmark), Hamburg-HafenCity (Germany), London-Islington (UK), Shangri-La (China), Dronninglund (Denmark), Copenhagen (Denmark), and more.

- The Strategic plan of the future DH in the Greater Copenhagen area (Denmark) by 2050

https://varmeplanhovedstaden.dk/
https://dbdh.dk/district-heating-in-greater-copenhagen-2050
DH in Greater Copenhagen 2050

- The largest interconnected solar thermal DH system with long-term storage in Crailsheim (Germany)

https://www.stw-crailsheim.de/wp-content/uploads/2021/02/210204-Solar-Broschuere-EN.pdf

- The *Low-Temperature District Heating Implementation Guidebook* developed as part of the IEA DHC project Annex TS2, presents 15 successful examples of LTDH system implementation. These examples encompass systems of varying sizes and include locations such as Gleisdorf (Austria), Darmstadt (Germany), Lund (Sweden), Braunschweig (Germany), Viborg (Denmark), and others.

https://www.iea-dhc.org/fileadmin/documents/Annex_TS2/IEA_DHC_Annex_TS2_Transition_to_low_temperature_DH.pdf

- The European Geothermal Energy Council (EGEC) has launched a dedicated webpage to showcase best practices from the geothermal industry, highlighting a range of geothermal DH and DC systems. This platform presents various operational systems, such as those in Munich-Freiham (Germany), Cachan (France), Torun (Poland), Vélizy-Villacoublay (France), Ventspils (Latvia), and London-Enfield (UK). It also features innovative systems currently under construction or development, including projects in Litoměřice (Czech Republic), The Hague (Netherlands), Roosna-Alliku (Estonia), and others. A standout examples include initiatives that repurpose abandoned coal mines into geothermal plants, such as the Pozo Barredo geothermal project in Mieres-Asturias (Spain) and Mijnwater Heerlen (Netherlands). The webpage also highlights significant projects listed under REHEATEAST best practice cases like Romania's DHs in Beius and Oradea, as well as a case in Košice, Slovakia.

https://www.geothermalstories.org