Interreg Danube Region

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REHEATEAST

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Building local partnerships for reducing the fossil energy demand of district heating systems in the Eastern Danube Region

Deliverable 1.1.5 District heating and cooling stakeholder survey and analysis of results

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Content

Executive summary

In this report, the REHEATEAST project analyses the feedback and opinions gathered from stakeholders throughout the Eastern Danube region. The gathered surveys are analysed to understand district heating and cooling systems better. This will support pilot actions, communications and other subsequent stages of the REHEATEAST project.

The target groups have been identified in the deliverable D1.1.1 Stakeholder identification and communication plan: heat producers and utilities, authorities and regulators, financiers and investors, technology suppliers and contractors, media, and consumers. That document was followed by D.1.1.2, Joint stakeholder survey and analysis methodology, which identified specific institutions and organisations that ultimately completed the surveys.

As a result, the REHEATEAST consortium has obtained and evaluated feedback from the stakeholders, facilitating constructive enhancements in district heating and cooling systems during further steps of the project (including both supply-side and demand-side activities). This deliverable will influence decision-making processes, helping to shape targeted interventions that address identified challenges and capitalise on opportunities within the REHEATEAST project.

The insights gained from this analysis will guide the following project stages, supporting the development of effective strategies and solutions for the district heating and cooling sector. The findings presented in this document are crucial for informing the following steps and ensuring the project's success in enhancing the sustainability and efficiency of district heating and cooling systems.

Abbreviations and acronyms

AC BIH	Aarhus Center in Bosnia and Herzegovina
AI	Artificial intelligence
ASP	Associated Strategic Partner
BiH	Bosnia and Herzegovina
BREEAM	Building Research Establishment Environmental Assessment Methodology
DH	District heating
DHC	District heating and cooling
DHS	District heating system
EIHP	Energy Institute Hrvoje Požar
EU	European Union
ENEFFECT	Center for Energy Efficiency Eneffect
EWRC	Energy and Water Regulatory Commission
GDPR	General Data Protection Regulation
GHG	Greenhouse gas
HOA	House Owners Associations
IDEFA	International Fund Development and Coordination Agency
IFI	International financial institution
ITU	Integrated Territorial Investments (hrv. Integrirana teritorijalna ulaganja)
JSI	Jožef Stefan Institute
LP	Lead partner
LEAPOM	Local Energy Agency Pomurje
LEED	Leadership in Energy and Environmental Design
LSG	Local self-government
N/A	Not available
PANNON	Pannon European Grouping Of Territorial Cooperation

PP	Project partner
PPP	Public-private partnerships
ReDE	Renewable District Energy
RES	Renewable energy sources
SCADA	Supervisory Control and Data Acquisition
SCTM	Standing Conference of Towns and Municipalities
SMP	Stakeholder Management Plan
SO	Specific Objective
UTCLUJ	Technical University of Cluj-Napoca
VIACARP	European Grouping of Territorial Cooperation Via Carpatia
WB	Western Balkans

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1. Introduction

The REHEATEAST project aims to **reduce district heating and cooling (hereinafter: DHC) systems' fossil energy demand by decreasing energy waste (in buildings and DHC networks) and integrating renewable energy (with a particular emphasis on geothermal) and waste heat**. It encourages multi-stakeholder, cross-sectoral, and public-private cooperation. It develops, tests, promotes and distributes applicable (process, technical and nature-based) solutions catalysing and supporting the implementation of large-scale building and systems rehabilitation programs and climate adaptation measures.

REHEATEAST aims to promote catalytic measures and adaptable solutions to reduce fossil energy demand via knowledge-sharing, awareness raising and enhanced stakeholder cooperation. The project intends to promote a holistic approach instead of silo thinking (addressing closely linked issues separately) and facilitate steps for subsequent transformative investments linked to efficiency, waste heat, heat storage, geothermal energy, billing practices, etc. REHEATEAST also plans to raise awareness to tackle sectoral issues, e.g. financing/regulatory concerns/information dissemination, etc.

Its communications slogan and campaign title: 'Over 10 under 100', summarises its demand-side ambitions and sets the long-term ambition for buildings with at least ten apartments within cities with over 10,000 DHC consumers to decrease the specific average annual heat consumption below 100 kWh/m^2. The Energy Efficiency Directive (hereinafter: EED) establishes 'energy efficiency first' as a fundamental principle. Energy efficiency must be considered in all relevant policy and significant investment decisions. Target indicators for minimum energy performance requirements for buildings (MEPRs - EU EPDB Directive on the energy performance of buildings) cannot be reached with low-efficiency DHC.

The supply-side ambition is to facilitate meeting the EU Energy Efficiency Directive (EED, EU/2023/1791) criteria for 'Efficient district heating and cooling' (defined in Article 2(41) of the EED): a DHC system using at least 50% renewable energy, 50% waste heat, 75% of cogenerated heat or 50% of a combination of such energy and heat. It should be achieved with basic energy planning and management principles, designing capacities for sufficient (not wasteful) demand.

Specific Objective 1 (hereinafter: SO1) of the REHEATEAST project aims to gain a detailed picture of the **technical, regulatory, social and financial conditions of DHC systems** with a **particular focus** on **common challenges and existing good practices** in the REHEATEAST region. The objective is intertwined with the ambition to **strengthen stakeholder engagement**. The main ambition of the project is to overcome the financial and environmental sustainability challenges of DHC systems. The regional status quo and particular challenges are explored via **intensive stakeholder involvement,** enabling a better understanding of their interests and, at the same time, raising their awareness.

Engaging a wide range of stakeholders is essential to understanding the status quo of DHC systems. In the first deliverable, D. 1.1.1 Stakeholder identification and communication plan, the REHEATEAST consortium identified the relevant stakeholders in their regions and listed possible

communication methods. The second deliverable, D.1.1.2 Joint stakeholder survey and analysis methodology, prepared a joint methodology and approach to identified stakeholder groups. It included templates which considered different types of knowledge and perspectives of target groups and developed stakeholder group-specific survey concepts.

This analysis, D1.1.5 DHC stakeholder survey and analysis of results builds upon the previously established methodology and survey templates. The primary objective of this comprehensive analysis is to provide insights that will guide the subsequent steps of the REHEATEAST project. The first immediate application of these findings will be in activity A.1.2. It focuses on identifying challenges, barriers, and potentials for energy-efficient, economically and environmentally sustainable DHC systems based on gaps, good practices, trends, and benchmarking analysis.

However, the significance of this analysis extends beyond activity A.1.2. The insights presented in this document will be instrumental across all aspects of the REHEATEAST project. They will inform strategic decision-making, support the design of targeted interventions, and help shape ideas for enhancing the sustainability and efficiency of DHC systems. This analysis is a foundation for **supporting the project's broader goals**, ensuring that reliable data and comprehensive stakeholder perspectives support each subsequent step.

2. Methodology and approach overview

The methodology outlined in deliverable D.1.1.2, Joint Stakeholder Survey and Analysis Methodology, was meticulously developed to ensure a comprehensive and harmonised approach to surveying stakeholders. This document served as the foundation for the surveying process and defined the questions each partner should pose to different regional stakeholder groups. The purpose was to establish a harmonised understanding of the survey process and facilitate its implementation.

The questionnaires were designed to address specific objectives related to DHC systems, such as current challenges and barriers, anticipated advancements, use of renewable energy sources (hereinafter: RES), application of new technologies, critical changes needed for improvement, insights on future trends and opportunities, and more. Standardised questionnaires were developed to maintain consistency. A diverse range of relevant stakeholders was identified to ensure a comprehensive understanding of the DHC landscape. Each partner was responsible for effectively engaging their targeted stakeholder audience, coordinating communication efforts, and clarifying the survey instructions.

Surveys were developed and tailored to each of the following stakeholder groups, resulting in five different surveys for the following groups:

1) The '**energy stakeholders**', including Heat producers and utilities
2) The '**policymakers**', including Authorities and regulators
3) **Technology suppliers and contractors**
4) **Financiers and investors**
5) **Consumers and media**

These tailored surveys were designed to capture relevant data while allowing for regional customisation where necessary. By customising surveys to suit the characteristics and needs of each stakeholder group, the project ensured that all voices were heard and considered, providing transparency and encompassing diverse needs, priorities, and perspectives. Still, partners used the same questions for the respective stakeholder group as defined in Annexes 2 to 6 of deliverable D.1.1.2 to ensure consistency and enable this analysis across the entire region.

The surveying process began in May and continued throughout June and July. This report thoroughly examines all the feedback collected.

The initial survey process step involved translating the surveys into national languages to eliminate language barriers and motivate stakeholders to participate actively, thereby maximising the representativeness and reliability of the survey data. Once the translations were completed, the data collection process commenced. Although the specific steps and order varied slightly from

partner to partner, all partners incorporated a set of standard procedures to ensure consistency and thoroughness.

Participants were asked to confirm their compliance with rules stipulated in the General Data Protection Regulation (GDPR) Statement, shown in Annex 1 of D.1.1.2, in written or verbal form. This step was crucial for adequately handling received data and demonstrating a commitment to responsible data processing. By prioritising privacy and data protection, the survey fostered trust and encouraged more stakeholders to participate.

Following GDPR compliance, the surveys were distributed to the identified stakeholders. Partners used various methods to engage stakeholders and facilitate the survey process. This multimodal approach ensured higher response rates and better quality of data. Of course, not all project partners used all the approaches; instead, the choice of method depended on the partners' preferences and availability, as well as their experiences and regional contexts. The techniques used at the consortium level are shown in the following figure.

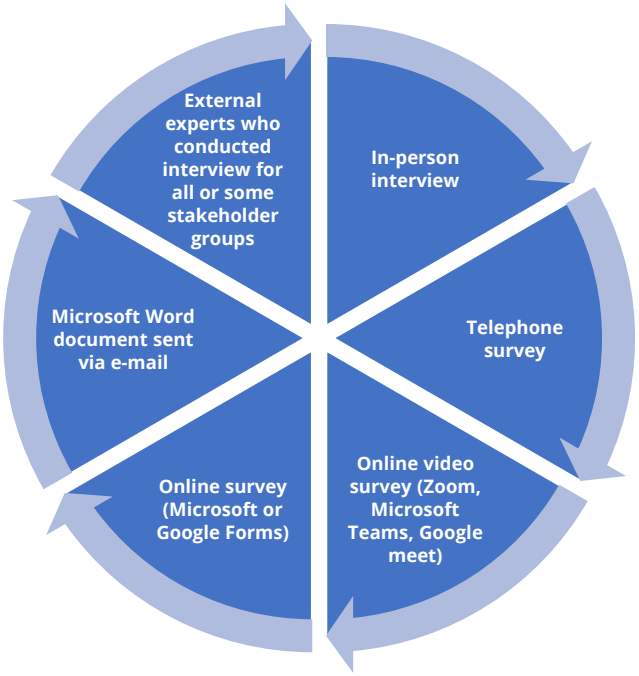

Figure 1 Communication methods utilised during the survey process

The consortium identified various opinion leaders within each stakeholder group. The list was updated as partners conducted the surveys, resulting in many contacted entities. The graph below highlights the response rates across the eight REHEATEAST countries, illustrating each region's stakeholder engagement level. Overall, response rates are relatively consistent, ranging between 33% to 64%. Bosnia and Herzegovina, Bulgaria[1], Romania and Serbia had the highest engagement levels. Respondents from Croatia[1], Hungary, Slovakia and Slovenia showed more moderate response rates, with most of them having participation levels of around 50%.

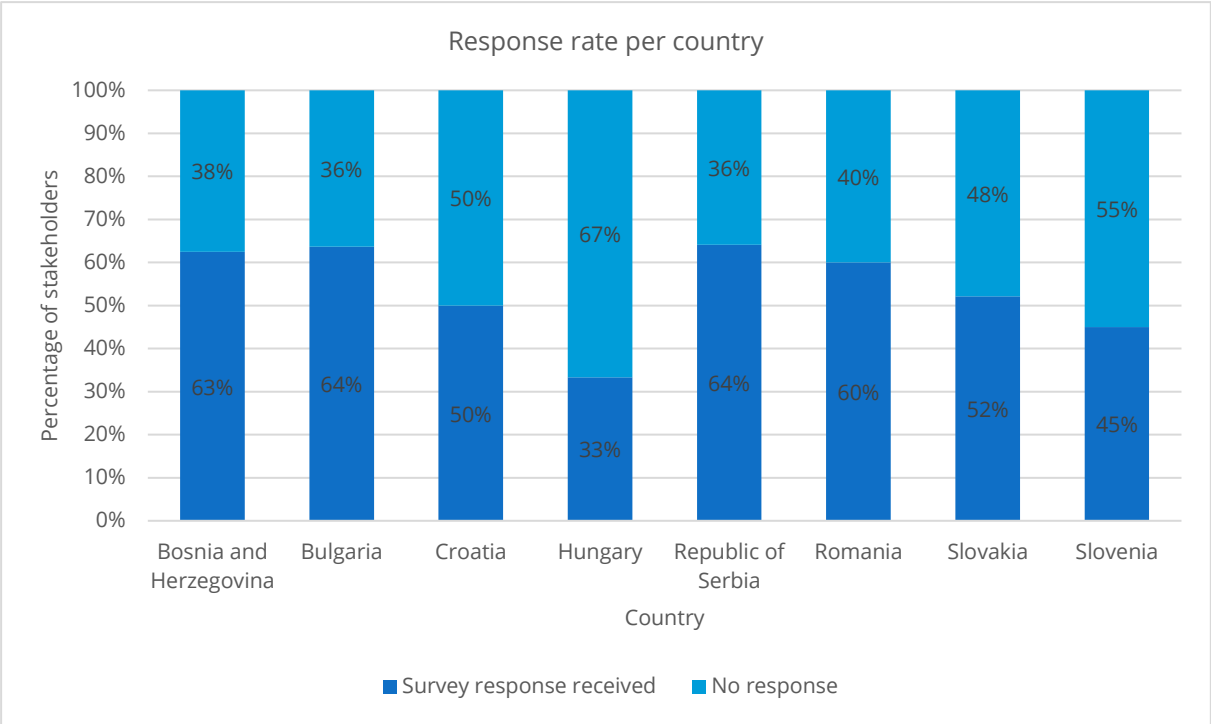

Figure 2 Response rates per country

The following chapters will outline the results of the surveys and better prepare the project partners to make informed decisions and develop strategies for subsequent project stages.

[1] *Consumers and media group has been excluded from this statistic, as responses were managed by an external agency.*

3. Country-specific analyses

This chapter provides a comprehensive analysis and detailed examination of the responses received from each participating country. It is organised into subchapters dedicated to each country, focusing on the responses from different stakeholder groups. This approach highlights the perspectives and feedback from various categories of stakeholders, providing a nuanced understanding of the data collected.

3.1. Bosnia and Herzegovina

In Bosnia and Herzegovina (hereinafter: BiH), the Aarhus Center in BiH (hereinafter: AC BiH) utilised prepared questionnaire templates to conduct surveys in main stakeholder groups. An external expert was hired to conduct interviews and deliver the survey questionnaires. In BiH, the survey focused on key stakeholder groups. Namely, we identified a representative sample of Heat producers and utilities, Authorities and regulators, and Financiers and investors (IFIs), whose feedback allowed us to understand better the current situation of DHC systems and the most appropriate steps for improvement in the future.

We invited nine Heat producers and utilities to participate in the stakeholder survey; six submitted their answers. In the category of Authorities and regulators, AC BiH invited five municipalities and one cantonal ministry to participate, with three municipal authorities providing their answers. A bank active in the DHC sector provided its answers as part of the Financiers and investors group.

Considering the diversity of DHC systems (supply side) in BiH and the limited time for resource-intensive research, a comprehensive survey of the consumer's stakeholder group was not executed since it would not result in a realistic overview of the situation. We have also considered engaging an external company to conduct sampled surveys. Still, due to the diverse nature of this stakeholder group and the time and resources available that consequently limit the number of interviews, most of them would not bring very tangible and relevant results. Furthermore, as outlined in D.1.1.2, BiH shares similar Technology suppliers and contractors with Croatia, making their responses applicable to both countries.

The report on the survey data for BiH provides an overview of the current and future perspectives of DHC systems. It covers several issues, including heat production, the assumed potential of RES, and perceived challenges in developing DH systems. The survey provided insight into how stakeholders perceive DH systems and identified several challenges, including regulatory barriers, funding gaps, and infrastructure limitations.

Our initial conclusion is that the biggest challenge for developing plans for sustainable DHC systems in BiH is that the key stakeholders still see fossil fuels as the primary energy source in the coming period. Decarbonisation is a topic being discussed but presented as something that may happen in 2050. Therefore, the general feeling among most stakeholders is that ‘we still have time’.

3.1.1. Heat producers and utilities

There were six respondents from BiH in the heat producers and utilities category. They rated the following four topics as very important from a technical perspective:

- Decreasing heat losses in heat generation
- Decreasing heat losses in network operation
- Replacing DH pipes to decrease heat losses
- Installing digital technologies to decrease heat losses and operational costs of DH networks (utilities)

In addition, they rated the following two topics as very important from a funding strategic perspective:

- Utilising EU funding for energy efficiency projects in DH
- Utilising EU funding for projects aimed at integrating RES into DH (all except one that rated this topic as important)

The fact that most of the identified 'very important' topics are related to energy efficiency measures indicates that the strategic focus should be on financial support for energy efficiency projects, which will reduce energy use/waste and improve the sustainability of the DH systems.

All respondents agreed that EU funds for energy efficiency projects should be the top priority. It highlights the crucial need to identify stakeholders, such as fund operators and investment banks.

Other topics/activities considered very important by utility respondents were the installation of digital technologies to reduce heat losses and operational costs of DH, activities to prevent DH consumers from leaving DH and using other types of heating and improvement of the image of DH and consumer satisfaction.

As mentioned, there were six respondents in the Heat producers and utilities category. In Figure 3, their responses reflect the diverse scale of DH systems in BiH. Two respondents are utilities that utilise/distribute heat purchased from third parties, two utilities that are producers and distributors, and two are heat producers. Only one respondent indicated they had incorporated RES (biomass) into their systems.

The table below summarizes the essential data related to heat profiles for 2023 from each district heating provider/producer. It includes information on critical items, including heat sales volumes, the proportion of RES in the primary energy mix, heat sales during the heating season, installed capacities, and energy purchased from third parties.

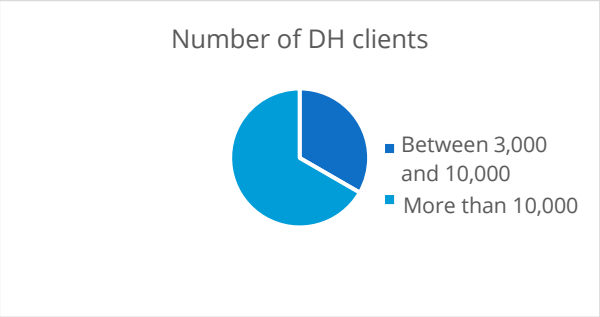

Figure 3 Number of DH clients per DH system in Bosnia and Herzegovina

Table 1 Heat profiles of heat energy providers/producers in BiH

General data for 2023	Respond.[2] 1	Respond. 2	Respond. 3	Respond. 4	Respond. 5 (heat produc.)	Respond. 6 (heat produc.)
Total heat supply in 2023 (GWh_t)	248	170	431,938	42,915	374,771	58,180
Share of RES in the primary energy mix	0%	97 – 99% (biomass)	0%	0%	0%	0%
Heat sales outside of the heating season (GWh_t)	0	0	0.366	0	N/A	N/A
Heat sales in the heating season [GWh_t]						
Total heat sales in the heating season	248	170	431,572	42,915	374,771	58,180
Residential	168	N/A	362,345	33,045	N/A	N/A
Public institutions	27	N/A	35,829	9,87	N/A	N/A
Other non-residential	53	N/A	33,398	0	N/A	N/A
Total installed DH generation capacity (MW_t)	N/A	123	523.4	N/A	220	48
Heat customers volume and breakdown:						
Total number of clients	27,003	20,363	53,769	3,736	2	1
Total number of Residential clients	24,525	19,455	52,043	3,447	0	0
Total number of Public and services clients	173	908	1,726	16	2	1
Total number of Industry and other non-residential clients	2,303	0	0	272	0	0
Total heated floor area (m^2)	2,049,197	1,443,000	3,561,103	272,684	N/A	N/A
Total heated floor area (m^2) - Residential clients	1,388,985	1,043,000	2,990,356	211,945	N/A	N/A
Total heated floor area (m^2) - Public and services clients	225,109	400,000	570,747	26,434	N/A	N/A
Total heated floor area (m^2) - Industry and other non-residential clients	435,103	0	0	34,305	N/A	N/A
Total number of buildings with building-level heat consumption measured	8	0	0	22	N/A	N/A
Total number of buildings with building-level heat consumption measured - Residential clients	0	0	0	12	N/A	N/A
Total number of buildings with building-level heat consumption measured - Public and services clients	0	0	0	6	N/A	N/A
Total number of buildings with building-level heat consumption measured - Industry and other non-residential clients	8	0	0	4	N/A	N/A

[2] *Respondent*

General data for 2023	Respond.[2] 1	Respond. 2	Respond. 3	Respond. 4	Respond. 5 (heat produc.)	Respond. 6 (heat produc.)
Total number of buildings with consumption-based billing	158	7,395	0	22	N/A	N/A
Total number of buildings with consumption-based billing - Residential clients	98	6,657	0	12	N/A	N/A
Total number of buildings with consumption-based billing - Public and services clients	16	738	0	6	N/A	N/A
Total number of buildings with consumption-based billing - Industry and other non-residential clients	44	0	0	4	N/A	N/A
Total number of flats billed based on cost allocation (within residential buildings)	6,134	0	0	0	N/A	N/A
Total number of flats billed based on cost allocation (within residential buildings) - Residential clients	4,972	0	0	0	N/A	N/A
Total number of flats billed based on cost allocation (within residential buildings) - Public and services clients	0	0	0	0	N/A	N/A
Total number of flats billed based on cost allocation (within residential buildings) - Industry and other non-residential clients	1,162	0	0	0	N/A	N/A
Key district heating capacities (assets) statistics:						
Total installed DH generation capacity (in MW_t)	260.0	123.0	523.4	30.4	220.0	48.0
Length for transport and distribution network – hot water system (one way in km)	203	180	83	84	N/A	125
Typical supply/return temperature levels (in °C) – hot water systems	Primary 130/60 Second. 75/55	85/55	70/90	Primary 130/70 Second. 65/55	130/60	90/70
Number of compact substations	1.802	100	0	55	N/A	9
Number of indirect substations	20	300	5	55	N/A	0
Number of direct substations	0	0	190	0	N/A	17
Heat sold to customer group - Residential (in MWh_t)	168,000	N/A	362,711	33,045	N/A	N/A
Heat sold to customer group - Municipal institutions (in MWh_t)	27,000	N/A	35,829	9,870	N/A	N/A
Heat sold to customer group - Other non-residential (in MWh_t)	57,000	N/A	33,398	N/A	N/A	N/A
Additional information						
Annual number of supply outages	10	N/A	60	260	6 months	6 months

General data for 2023	Respond.[2] 1	Respond. 2	Respond. 3	Respond. 4	Respond. 5 (heat produc.)	Respond. 6 (heat produc.)
Typical duration of outage	Up to 5 hours	1 day	1/6 days	1 day		
Carbon footprint (CO_2 equivalent) (tCO_2/year)	N/A	1,500 – 1,600	cca. 90,000	N/A	N/A	N/A
Share of heat purchased from third parties	100%	0%	0%	100%	0%	0%
The average energy rating/status of district-heated buildings	D	C	90% C&D 10%B	D	N/A	N/A

The respondents pointed out several ongoing and planned initiatives to reduce heat losses and improve system efficiency. These address the issues both on the side of delivery and on the side of consumption. Below are some of the examples of the ongoing and planned initiatives:

- Replacing the old pipeline with new pre-insulated steel pipes
- Reconstruction of substations and replacement of hot water distribution pipes
- Monitoring and regular maintenance of the system and introducing new technologies through reconstructing existing facilities (pumps with frequency regulation, etc.)
- Measurement at the level of each substation and consumption analysis
- Transition to invoicing by energy consumption (especially for business premises)
- Replacement of windows and thermal insulation in public buildings and private houses connected to the DH system
- The transition to a lower temperature level and the introduction of specific tools for temperature optimisation and automation of the heating system as steps for the transition to the 4th generation of the DH system

About the question of heat consumption measuring and monitoring transparency of the billing process for customers, below are the answers provided by the respondents:

- Heat energy consumption is monitored through digitised heat substations with measurements and individual heat energy meters. The billing process is completely transparent, as each user has insight into the state of their meter. This utility is initiating a switch to automatic reading of heat energy meters.
- Thermal energy is measured at the level of each substation. Everyone can switch to the calculation by measurement if the prescribed conditions are met. There is a big trend of moving to calculation by measurement for the tariff group of industry and other non-residential clients. Measurement is a mandatory calculation method for new collective and individual residential buildings, the industry and other non-residential clients.
- Heat energy consumption is measured at the heat energy supplier, in all heat substations and at 21% of end consumers.

- The reading of the heat energy meter is done monthly. All measures of thermal energy are verified within the legal term - verification of heat energy meters is carried out periodically under the Law on Metrology. There is an Agreement on cooperation on the implementation of the project 'Co-financing the costs of installing individual heat energy meters in buildings on the district heating system' as one of the measures to increase the number of meters through which to perform calculations for users.

The respondents' answers to the question 'How are digital technologies utilised for system monitoring, control, and optimisation?' are the following:

- SCADA systems for controlling and managing production facilities. SW for monitoring automated heat substations. SW for optimisation and thermohydraulic modelling. SW for temperature optimisation.
- Data acquisition and monitoring of one part of the substation (permanent SCADA) around 150 substations and chambers at the key points of the hot water pipeline. An optimisation program is in implementation.
- Out of a total of 55 substations, 15 are remotely monitored and managed on the DH system.
- A SCADA system is used to monitor and control the system.

The respondents were also asked about perceptions of DH among existing consumers, the general public and policy creators. All of the Utility respondents[3] think that the existing consumers' perspective is positive, and three out of four replied that the perception of the general public and policy creators is also positive. One Utility respondent believes that the perception of the general public is neutral and, for policy creators, negative. One Utility respondent, besides expressing a positive opinion about perceptions of DH among existing consumers, the general public and policy creators, also indicated neutral/negative opinions among the same groups.

The explanations for neutral/negative opinions are:

- The reasons for negative and neutral perceptions are mostly dissatisfaction with the price, lack of information and ignorance regarding energy, energy efficiency, and ecology. Also, there is the unrealistic price of electricity, which is a social category that represents a kind of competition with DH. Also, announcements in the media are mostly not made by reality and scientific principles but are mainly made under the influence of interest groups.
- These are steps that can be taken to resolve and improve the situation: investment in the DH system, which includes reconstruction of the pipe network, the introduction of remote monitoring in all substations, measurement of thermal energy consumption by all consumers, and thermal insulation of consumers' facilities that are connected to the DH system.

The explanations for the positive perspectives are:

[3] *For the remainder of this subchapter, 'Utility respondents' refer to energy distributors (the first four respondents) who provided the answers to most of the following questions.*

- A positive opinion is based on the quality of the heat energy delivery, the relationship with the users and a realistic understanding of what constitutes better comfort considering all aspects of the system (timely distribution of energy, safety aspect due to possible breakdowns, etc.).
- Stability in delivery, acceptable price, contribution to the reduction of air pollution and increased comfort of life.
- Continuous delivery of thermal energy.

Concerning the question of whether there is sufficient knowledge and capacities for the successful development of DH, the respondents' answers are:

- Knowledge does not exist at the local government or entity levels. Unfortunately, there is no initiative to improve knowledge. It is necessary to develop knowledge in energy efficiency, renewable energy sources, and DH as one of the ways of heating buildings, etc. Our company has knowledge, and through participation in certain events in the region and beyond, as well as constant learning and training of staff, we constantly increase this knowledge and the competencies of employees.
- There is knowledge, but not enough. It can always be better. Skills should be increased at all levels and tasks, from operational to planning and investment.
- There is enough knowledge that, of course, needs to be expanded upon, and cooperation with DH systems in developed countries in the surrounding area and Europe should be developed.

There is a consensus among the Utility respondents on the need to improve energy efficiency, increase the use of RES and enhance digitalization related to advancements anticipated in DH systems within utility companies' operations.

Once again, there is a consensus among the Utility respondents about the question 'What fundamental changes are needed: technical, organisational, or financial, to improve existing DH systems?'. They all identified technical upgrades (i.e. reconstruction of the distribution network, digitisation, new energy sources of modern technology, efficiency in distribution and consumption, pipeline reconstruction, substation automation and remote monitoring and measurement) and financial investments (i.e. involvement of the local administration and possibly the entity administration in the restoration of the system owned by them, availability of funds, try to use EU funds and domestic sources of co-financing) as essential to achieving fundamental changes.

The Utility respondents identified heat pumps, photovoltaics and biomass as more appealing heating solutions/technologies for individual households.

The primary drawbacks of DH systems compared to individual heating solutions identified by the Utility respondents are:

- Looking at the systems in Europe and developed countries, the DH system is one of the most efficient ways of heating buildings. The disadvantage can be a high cost when that system is raised 'from zero'. The only reason for disconnecting or not connecting to the DH system in BiH is the low, i.e. unrealistic, price of electricity. It potentially poses a great

danger to the power system due to a completely unregulated market. There is no control, nor does any user need the consent of the electricity distribution company for electric heating.

- The possibility of using thermal energy in periods when the central heating system is not in operation (outside the heating season)
- The large and inert nature of DH systems, despite consumers' willingness to connect due to the favourable price of heating.

Transitioning from fossil fuels to RES and persuasion of policymakers, followed by establishing appropriate regulatory frameworks and transition/change of technologies, are identified as the most significant challenges, as shown in the figure below.

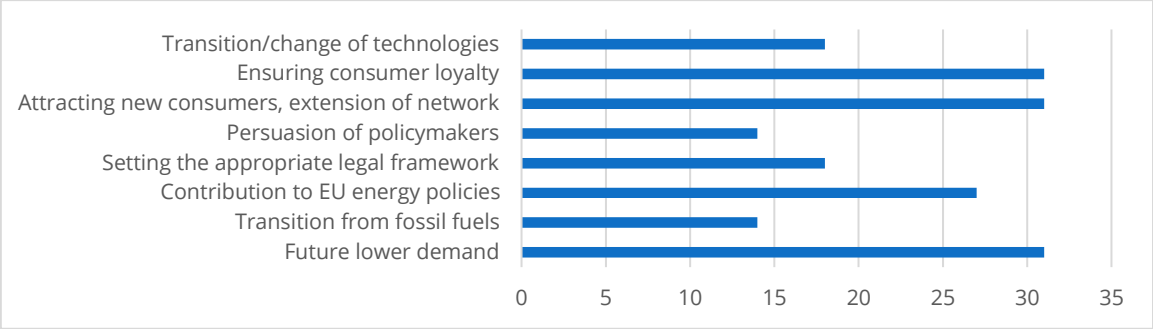

Figure 4 The biggest challenges for the DH sector in Bosnia and Herzegovina based on responses from Heat producers and utilities

Geothermal energy is the most frequently mentioned renewable source for DH, and other recommended sources include solar energy, heat pumps, and biomass.

Regarding 2030/2050 development expectations, respondents expect a slight increase in thermal energy sales in a few cases. Significant improvements in energy efficiency are anticipated, with operating temperatures expected to drop, in some cases, to as low as 55°C/45°C. Some other responses suggested that adherence to European directives and decisions should be expected; however, the situation in BiH remains uncertain and will likely be influenced by Europe's impact.

The respondents pointed out the biggest obstacles to adopting new technologies in DH systems: local administration, ministries, legal framework, transfer of technologies, and, most importantly, finances.

Responses to the need for regulatory or legislative support and additional incentive mechanisms for DHC emphasized their crucial role. Respondents highlighted the necessity of strong and consistent legislation on all levels of authority. Regarding incentives, the support for co-financing building renovations and integration of RES is visible. Overall, closer collaboration between national, entity and local governments is needed to set common strategies and provide comprehensive support for the sector's expansion.

Only a few examples of good DH initiatives were shared. In one case, a positive example of good cooperation between a local authority and DH utility company, and the second one, the introduction of RES and use of local potentials. The most indicative answer that reflects the situation in BiH was: 'Unfortunately, we have to look for examples of good practice far from us, namely the Nordic countries Denmark and Finland, as well as Germany. We should adopt their positive examples'.

3.1.2. Authorities and regulators

In the Authorities and regulators stakeholder category from BiH, we have invited five municipalities and one cantonal ministry to participate in the stakeholder survey. Unfortunately, there were only three respondents, and one municipality forwarded the questionnaire to the public utility company that provided answers on their behalf. It, in a way, indicates the lack of interest/knowledge of this stakeholder group in this topic. The respondents rated the following five topics as very important from a technical perspective:

- Decreasing heat losses in network operation
- Replace DH pipes to decrease heat losses
- Installing digital technologies to decrease heat losses and operational costs of DH networks
- Installing or improving consumption heat metering of buildings supplied with DH
- Assisting consumers in improved heat regulation and control, (building) heat cost allocation within apartment buildings supplied

In addition, they rated the following five topics as very important from a funding strategic perspective:

- Utilising EU funding for energy efficiency projects in DH
- Engaging consumers in energy-saving activities
- Billing consumers based on the actual metered heat consumption of their building
- Improving the image of DH and consumer satisfaction
- Advocating for more favourable regulations financing conditions on the national level

Like in the Heat Producers and Utilities category, the fact that most of the identified 'very important' topics are related to energy efficiency measures indicates that the strategic focus should be on financial support for energy efficiency projects that will consequently reduce energy use/waste and improve the sustainability of the DH systems. All respondents agreed that EU funds for energy efficiency projects should be the top priority.

The policies and incentives at the local authority level that promote the expansion and improvement of DH systems exist, but significant modernisation is required before these systems can effectively expand.

Regarding regulatory challenges, outdated public procurement legislation and the lack of financial/political support from higher levels of authority were identified as major issues.

Financial investments were identified as fundamental for the improvement of existing DH systems.

On the question of the need for regulatory or legislative support to accommodate the future expansion of the DHC sector, the respondents' answers are:

- The problems are the decisions of the Council of Competition, given that the heating system is a complex issue and several aspects need to be considered when making important decisions. It is also necessary to make a strategic determination not only of the municipality but also of other levels of government for a joint action and strategy for the development of the DH system.
- The question of ownership of the land where the routes of infrastructure systems (primary heating lines) pass. A frequent case is land in 'State property' that we cannot use, so alternative solutions must be sought.
- There is no law on thermal energy.

Additional incentive mechanisms are considered essential for DH systems. These could include subsidies for end-users to connect to DH systems, energy efficiency measures, and grant funds that municipalities can use in addition to their own, to implement projects on time.

Technological advancements expected to impact the sector include digitization of the entire system, remote monitoring and management, fourth-generation technology, heat pumps using wastewater, and large thermal storage. Solar energy is also highly represented in the answers for high-temperature solar thermal collectors and photovoltaic systems for powering heat pumps.

The respondents were also asked about perceptions of DH among existing consumers, the general public, and policy creators. Two out of three respondents believe that the perspective of the listed stakeholder groups is either very positive or positive, and the third respondent replied that the perception is neutral (not providing any explanation).

The explanations for very positive/positive perspectives are:

- Existing consumers are satisfied with the current state of heating in the city. The general public also benefits from reducing emissions of harmful gases, which are especially pronounced in the winter period; namely, the air quality is better. The policymakers also have a positive attitude, but there is a lack of funds to expand the network following the capacities.
- Reduction of pollution, better environmental image, savings on energy bills, reliable heating.

Transitioning from fossil fuels to RES, persuasion of policymakers and establishing appropriate regulatory frameworks are identified as the most significant challenges by this stakeholder group, as seen in the figure below.

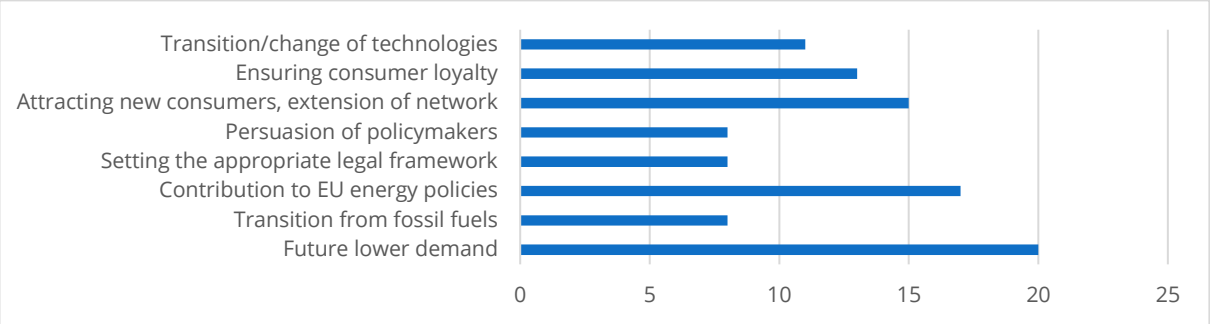

Figure 5 The biggest challenges for the DH sector in Bosnia and Herzegovina based on responses from Authorities and regulators

The most mentioned renewable source for DH is geothermal energy; other recommended sources include heat pumps.

Regarding 2030/2050 development expectations, in a few cases, respondents expect a slight increase in thermal energy sales (5%), the introduction of RES (10 – 20%), and significant improvements in energy efficiency. Operating temperatures are expected to drop to 55°C/45°C.

All of the respondents stated that the DH systems are financed and sustained from income, subsidies from the budget, loans, and applications on public calls for projects.

The financial challenges and constraints impacting the operation and maintenance of the system identified by the respondents are related to the expansion and development of the DH network and energy efficiency, which are done mainly with credit funds from commercial banks. In addition, due to the system's age, work is constantly being done on reconstructing the existing DH network.

Only one example of a good DH initiative was shared. One stakeholder is currently in the implementation phase of the reconstruction project (construction) of the primary heat pipe, which will enable the improvement of the existing and expansion of the city's DH system, which will directly affect the improvement of quality and protection of the environment (water, soil, air). Projects related to energy efficiency will continue in the future to the extent that the financial capabilities of the city administration allow.

3.1.3. Financiers and investors

In the Financiers and investors stakeholder category from BiH, we have invited one international financial institution (hereinafter: IFI) to participate in the stakeholder survey. This IFI is active in the Western Balkan (hereinafter: WB) region, so the provided answers are relevant to the entire WB area.

The perception of the DHC sector as a financial market for this stakeholder is one of their priority areas since they are committed to supporting sustainable energy infrastructure that aligns with broader goals of decarbonisation and green energy transition in WB. DH systems are typically financed through public or private funding, including loans, equity investments, and grants. This stakeholder finances these systems mostly by providing long-term loans and facilitating securing grants, equity investments, and technical assistance to enhance operational efficiency and sustainability. The financial sustainability of DH systems is achieved through revenue generation from end-users, government subsidies, and cost-efficient operation.

The respondent considers financing a range of DHC projects, including new facility construction, particularly those incorporating RES or waste heat recovery, reconstruction or modernisation of existing DHC infrastructure, projects with significant decarbonisation benefits, large-scale infrastructure projects that support regional or national energy strategies and investments that improve energy efficiency and reduce carbon emissions.

Eligible projects typically require a mix of securities, including sovereign or municipal guarantees for public sector projects and corporate or project-level guarantees.

The financial challenges and constraints impacting the system's operation and maintenance include fluctuations in energy prices affecting operational margins, difficulty securing long-term financing due to perceived risks, regulatory and policy uncertainties and limited access to affordable financing for smaller-scale projects.

Regarding regulations that govern the DH sector in WB, the respondent answered that local/municipal levels predominantly govern it.

The respondent stated that the specific policies or incentives aimed at promoting the expansion or improvement of DH systems include the development of decarbonisation roadmaps for DHC sectors and companies, structuring of the process of extension of DH systems and facilitating connecting new consumers, shutting down of polluting boiler houses by connecting to DH systems, subsidies for renewable heating and cooling energy integration, tax incentives for energy-efficient technologies, grants or soft loans for infrastructure upgrades, feed-in tariffs or guaranteed prices for heat generated from renewable sources.

The regulatory barriers or challenges that hinder the development of DH infrastructure include lengthy and complex permitting processes, inconsistent regulation application across cities and regions, lack of clear long-term policies or support for DH projects, and insufficient coordination between national and local authorities.

The respondent identified the following fundamental technical, organisational and financial changes that are needed to improve existing DH systems: modernization of equipment,

quantitative/qualitative regulation and metering, integration of smart grid technologies and adoption of RES, the introduction of consumption-based billing, streamlining operations, enhancing management efficiency, improving stakeholder collaboration and access to affordable financing and development of innovative financial instruments.

On the question of the need for regulatory or legislative support to accommodate the future expansion of the DHC sector, the respondent's answers are:

- Support House Owners Associations (hereinafter: HOAs) in financing and installing internal heating systems for DHS connections and incentivize local governments to connect new buildings to DHS and shut down polluting inefficient boiler houses.
- Develop programs for DH, close boiler rooms, reconnect disconnected users (especially in multi-apartment buildings), and support residents already connected to DHS in financing energy efficiency upgrades, using proven models like EBRD VIPA and public ESCO.
- Create strategies and incentives for renewable energy, boiler room closures, and DHC connections, and tailor solutions for each city's DHC, considering local specifics.
- Promote private sector involvement where public investment is lacking and utilise public-private partnerships (hereinafter: PPP) models.
- Enhance the renewable energy market within DHS, improve energy efficiency, upgrade markets, and standardise city regulations and procedures.
- Optimise the use of existing mechanisms like environmental funds, streamline permitting and approval processes and regulations that promote the use of renewable energy and waste heat.
- Support for PPPs to mobilise investments.

Additional incentive mechanisms are considered essential for DH systems. These could include direct capital expenditures (hereinafter: CAPEX), subsidies for introducing Renewable District Energy (hereinafter: ReDE) technologies, and tax breaks for companies investing in ReDE and energy-efficient technologies.

Concerning emerging technologies that will have the most significant impact on the DH sector, the respondent identified the following: heat pumps and geothermal energy systems, seasonal thermal storages, waste heat recovery technologies (with or without heat pumps), low thermal networks and substations and smart grid and digitalization technologies.

The most significant identified challenges stated by the responder are listed in the following figure.

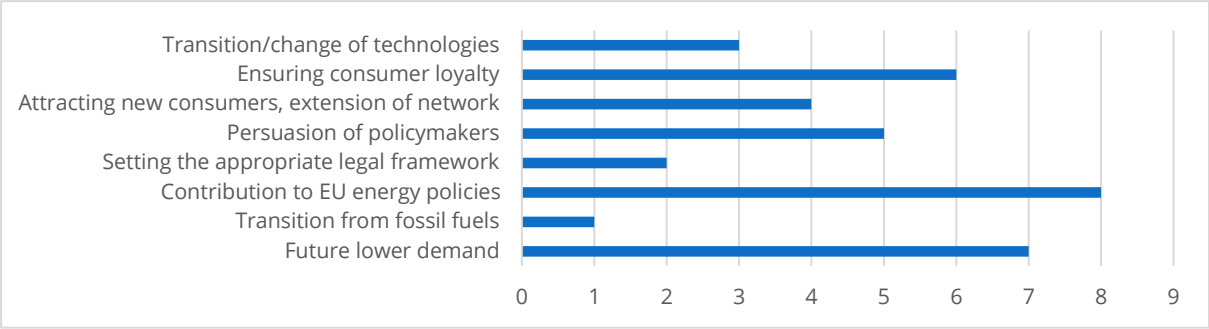

Figure 6 The biggest challenges for the DH sector in Bosnia and Herzegovina based on responses from Financiers and investors

An example of good practice in WB is the Novi Sad DH system and the joint project 'Introduction of Seasonal Heat Storage with Solar Thermal,' which the respondent is preparing in collaboration with Novi Sad DH Company, the Ministry of Mining and Energy, with support from the EU-WBIF[4] and the Austrian ReDEWeB[5] Fund.

[4] *Western Balkans Investment Framework*

[5] *Renewable District Energy in the Western Balkans*

3.2. Bulgaria

In Bulgaria, the Energy Efficiency Centre EnEffect conducted the survey mainly through Google Forms and direct interviews with the different target groups.

Given the structure of the questionnaires, the chart below presents the interests and views of the first three groups: Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors. Their responses reveal different perspectives in two main areas - technical and financial.

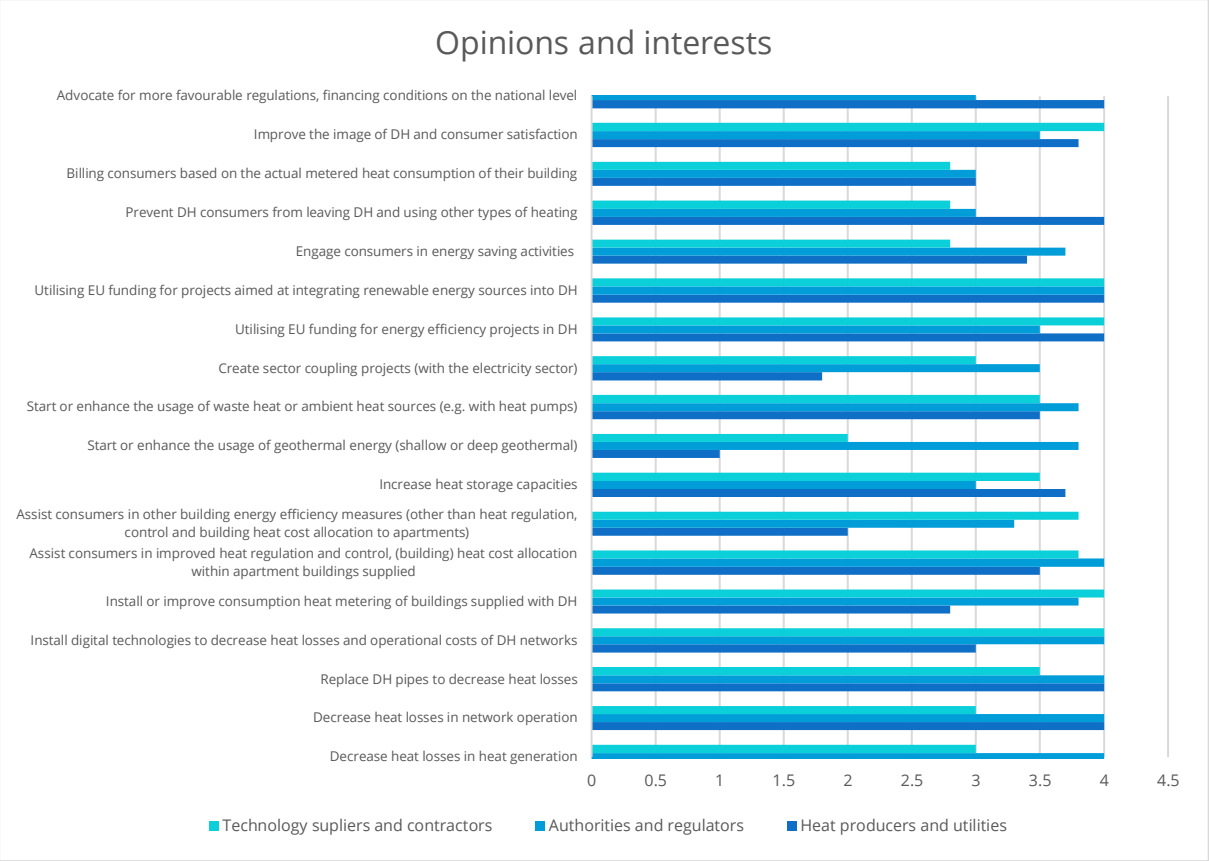

Figure 7 Comparative analysis of interests and opinions among Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors in Bulgaria

In their responses, Heat producers and utilities demonstrated a balanced approach, addressing both technical activities related to reducing losses, increasing thermal storage capacity, and integrating RES, as well as the necessity of utilising EU funds to foster innovation and advanced technologies. This group places a high value on the interaction with consumers.

Authorities and regulators have emphasised loss reduction, and the integration of RES and digital technologies. Concurrently, they have identified a need to develop sector coupling projects, a perspective that the aforementioned group has not recognised.

The Technology suppliers and contractors focus primarily on technical measures and the necessity of securing European funding. However, consumer retention is not a direct concern for them, although they perceive improvements in the image of the DH sector and consumer satisfaction as important.

All three groups concur that enhancements are necessary, but financial resources are also essential to support network investment, particularly in terms of integrating renewables and enhancing service provision.

In the following subchapters, we will present the insights and main findings gained from the answers provided by each stakeholder group.

3.2.1. Heat producers and utilities

In Bulgaria, the DH companies are privately owned, except for Toplofikatsiya - Sofia, which is 100% municipally owned and the largest DH company in the country, serving over 440,000 consumers. These circumstances made the survey somewhat challenging. However, three of the larger companies (15,000 – 32,000 consumers) provided information that is relevant for the majority of companies in the sector.

Natural gas (more than 95%) is the primary energy source utilised for heating purposes, and it is sometimes combined with energy derived from waste. Few coal plants remain, making heat generation a relatively clean process compared to oil and coal plants, which gas plants have gradually replaced.

In Bulgaria, DH is mainly applied in multi-family residential buildings, which account for over 98% of service users. Unfortunately, a significant part of the residential building stock has not been renovated, and energy efficiency levels are relatively low. It also applies to some extent to building systems, which are not always optimally maintained. It, combined with the primary sources of thermal energy, makes the definition of a zero-consumption building practically inapplicable to buildings that are connected to DH. In this regard, the modernisation of the sector and the introduction of more renewable energy are key to the competitiveness of DH in the coming years, especially after 2030.

In terms of ongoing initiatives to reduce heat loss and improve systems efficiency, all of the companies participating in the survey responded that they budget for and carry out ongoing work each year, primarily concerning networks - replacing existing thermal insulation with more efficient insulation and replacing pre-insulated pipes with low thermal transmittance insulation.

Currently, all three companies confirm that all metering devices allow remote metering, and the monthly bills contain detailed information on the heat consumed monthly, with a reconciliation once a year. At the same time, however, digital technologies are used in a relatively limited aspect- mainly for monitoring, which is an opportunity for future interventions with great potential to increase the efficiency of DH companies.

The graph shows the perception of DH by different major groups - current consumers, the general public and politicians. According to the DH companies that took part in the survey, overall attitudes are positive to varying degrees, with none of the groups indicated to have a negative perception.

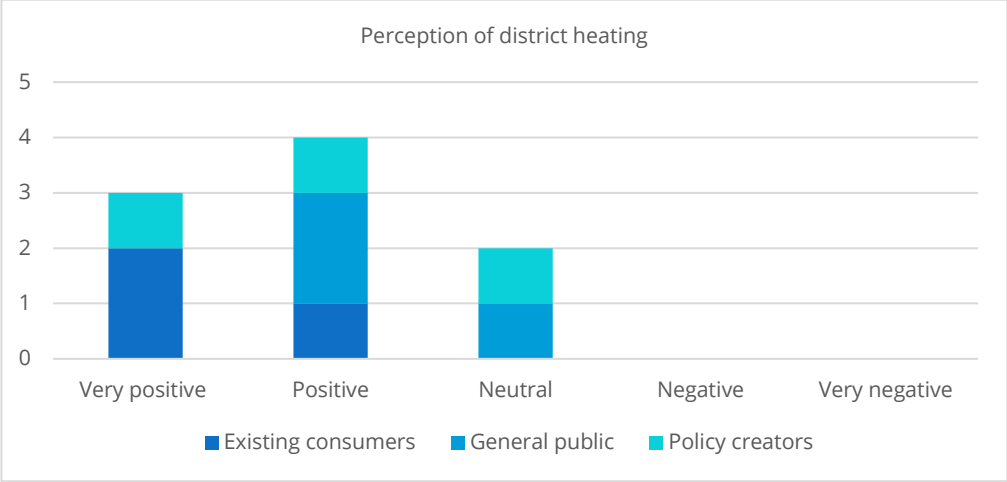

Figure 8 Perceptions of different groups on DH based on responses from Heat producers and utilities in Bulgaria

Compared to the answers received, an opinion is formed that the companies have the necessary knowledge and capacity for developing DH (mainly human capacity). Still, there are various barriers to this happening, and they are primarily financial and regulatory.

Respondents are unanimous in their anticipation of an increase in efficiency; however, some state that this is only possible in combination with enhanced digitalisation and increased use of RES.

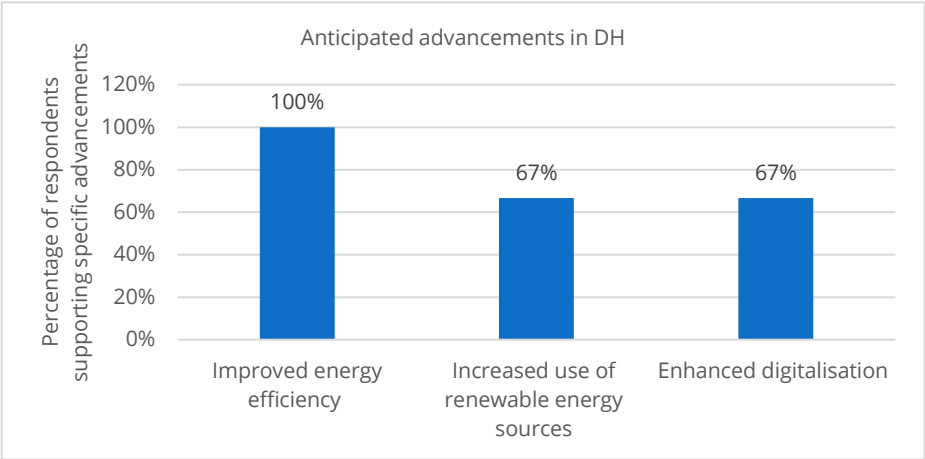

Figure 9 Anticipated advancements in DH based on responses from Heat producers and utilities in Bulgaria

Respondents rated almost all of the challenges listed as highly significant, but the main concerns were declining demand for services and the transition to new technologies and energy sources. The mean scores for each of the challenges are presented below.

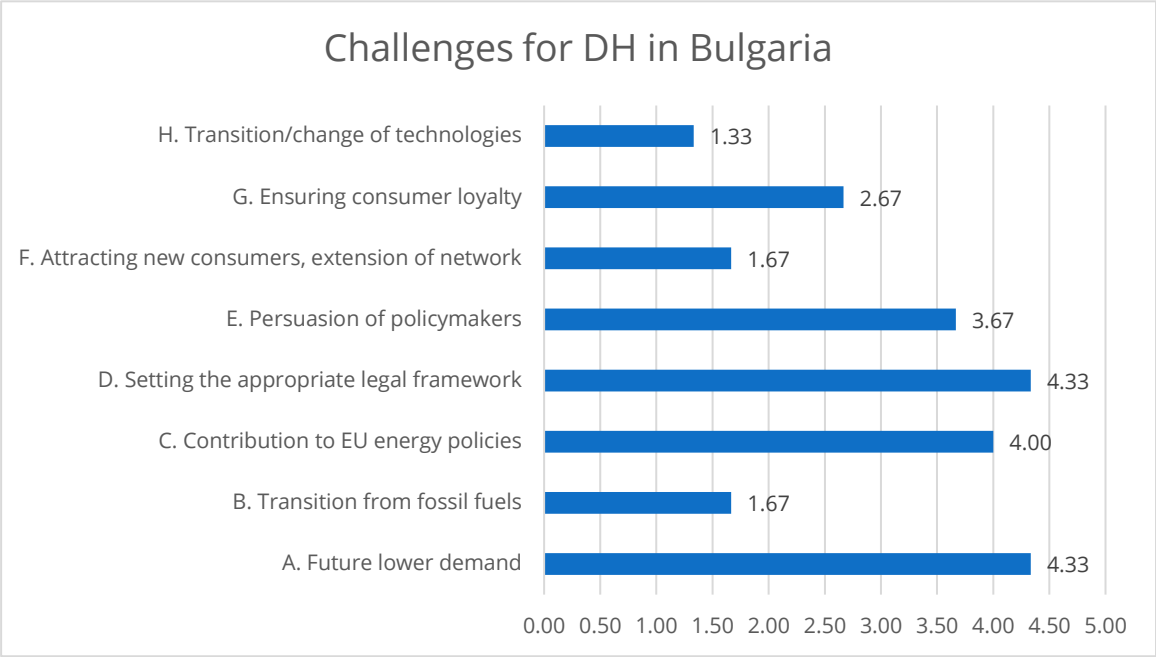

Figure 10 Challenges for DH in Bulgaria based on responses from Heat producers and utilities

All respondents indicated that they anticipate a significant increase in the proportion of renewable sources employed in heat generation, exceeding 50% by the year 2050. Furthermore, they posited that biomass is optimal for the specific local context.

According to the responses received, the most significant barrier to the introduction of new technologies in the DH sector is financial, as there is a lack of support at the national level. Each company finances its initiatives to introduce new technologies and modernisation in a regulated market in which prices are controlled at the state level. In all cases, however, financial incentives are needed to change the model when implementing measures to transform existing systems or build new systems that meet the 'Efficient district heating network' defined in Article 2(41) of the Energy Efficiency Directive.

In conclusion, the DH sector in Bulgaria faces several significant challenges and opportunities as it moves toward modernisation and increased efficiency. While the primary energy source, natural gas, has made the heating process relatively clean compared to coal and oil, it also presents a critical issue due to Bulgaria's dependency on gas imports. This dependency creates vulnerabilities in energy security and exposes the sector to price fluctuations and supply disruptions, making the transition to more sustainable energy sources imperative.

The sector's reliance on natural gas, outdated building infrastructure, and low energy efficiency presents substantial barriers to achieving zero-consumption buildings. The introduction of RES,

particularly biomass, is considered essential for the sector's future, with the expectation that renewables will account for over 50% of heat generation by 2050.

However, financial and regulatory obstacles hinder the transition to new technologies and energy sources. The DH companies have the necessary knowledge and capacity to drive these changes. Still, they face significant barriers due to a lack of national support and the financial burden of self-funding modernisation initiatives in a regulated market.

3.2.2. Authorities and regulators

As stated in the previous section, Bulgaria's DH companies are private, except for Sofia DH. However, as a key element of the country's energy system, their activities are regulated, and each service is subject to state licensing.

The Energy and Water Regulatory Commission (hereinafter: EWRC) is the main regulatory body overseeing the energy sector in Bulgaria, including DH. It is responsible for issuing licenses, setting tariffs, and ensuring compliance with regulations. On the other hand, the Ministry of Energy plays a key role in developing and implementing energy policies, including those related to DH.

Some of the key requirements for DH companies include:

- Licensing: companies involved in producing, distributing, or supplying heat must obtain a license from the EWRC.
- Tariff regulation: heat prices are regulated by the EWRC to ensure they are fair and reflect production and distribution costs.
- Consumer protection: regulations include provisions to protect consumers' rights, ensuring they have access to reliable heat supply and transparent billing.
- Energy efficiency: DH companies are required to implement measures to improve energy efficiency and integrate RES into their systems.
- Reporting and compliance: companies must regularly report to the EWRC and comply with national and EU regulations regarding energy efficiency, emissions, and renewable energy integration.

Regarding regulatory barriers or challenges hindering the development of DH infrastructure, the survey respondents pointed out that the compensation mechanism for cogeneration under the Energy Act in Bulgaria, particularly through Chapter Eleven, indeed presents significant challenges for integrating RES in the DH sector. The key issue is that the current system incentivizes the use of high-efficiency cogeneration with a premium, which primarily benefits fossil fuel-based generation, thereby creating barriers to the adoption of renewable energy.

Regarding the changes needed to improve existing DH systems, respondents indicated that the connection between renewable and waste heat sources should be encouraged. Introducing a commitment to draw up a decarbonisation roadmap by all heat producers with an installed capacity above 1 MW would also be a step forward. Some respondents indicated that the

introduction of 'guarantees of origin' for heat power would accelerate the pace of modernisation but would not be feasible without appropriate regulatory changes to tariffs.

Among the necessary technical improvements are a switch from natural gas to cleaner energy sources, decentralisation of sources, and a reduction in the grid water temperature. Electrification with heat pumps, heat accumulators, and RES should also be introduced.

It is anticipated that emerging technologies will significantly impact the DH sector in the coming years. The most significant of them, according to the respondents, are outlined below:

- Heat pumps
- Waste heat recovery
- Thermal energy storage
- Decentralised energy production (micro-CHP and renewable energy integration).
- Fourth and fifth-generation DH systems
- Artificial intelligence and machine learning for consumption forecasting - The high inertia of DH networks allows for greater freedom and relative error in dispatch. AI data centres will be a major factor in the future of DHC, but energy from them falls more in the 'Waste heat recovery' column
- Smart grid
- RES (biomass, solar power, geothermal energy)

From the regulators' perspective, the sector's main challenges are primarily driven by the significant impact of the transition to cleaner fuels and technological advancements. In this context, consumers are not seen as the primary factor, as the focus is on managing the complexities and costs associated with adopting new energy sources and technologies.

When it comes to good examples, according to some of the respondents, two DH companies in Bulgaria are promoting the possibility of 'Individual consumption' services and the conversion of vertical installations into horizontal ones. It allows better accountability of individual customers, reduces network losses and improves comfort. In addition, implementing such projects increases trust and loyalty to the DH company, and the established contacts can be used for future initiatives. Such projects should be part of the plans when renovating old buildings, and the benefits should be communicated to the owners.

3.2.3. Technology suppliers and contractors

According to the Technology Suppliers and Contractors group, there are no ongoing or planned major technological innovations in the DH sector at the moment. The primary interventions are related to maintenance and emergency repairs of the network and facilities. However, there has been interest from major consulting companies who, through various lines of interaction, are developing or have recently developed feasibility studies and modernisation strategies for some

of the country's largest installations. Due to the large amount of investment required and the lack of support mechanisms, these plans have not been implemented.

According to the respondent group, digital technologies have great potential for economic and energy benefits for utilities and heat consumers but are generally underutilised. Consumers primarily use these technologies in certain public buildings. However, respondents reported that the switch to remote metering in most companies and the use of energy management systems such as SCADA was a positive change.

According to the respondents, there are technical opportunities for developing the sector and its decarbonisation. Still, the main barriers are the lack of financing (in combination with regulated prices). At the same time, this problem is exacerbated by the cogeneration support scheme, which is one of the mechanisms that compensates for the lower supply prices and high gas prices of recent years. This vicious circle is difficult to break without a clear vision and a common strategy.

DH installations need a change in the model and structure of operation, seeking flexibility, new services, the ability to quickly connect to smaller capacities in newly developing urban areas and the mandatory integration of RES to be competitive.

As the most appropriate renewable fuel for DH supply, besides the mentioned biomass and heat pumps, waste use is recognised, and solar energy is also used in smaller amounts.

Considering the development of DH systems in Bulgaria with a vision to 2050, the increase in the share of RES and integration of district cooling services are among the anticipations.

In the shorter term, by 2030, Bulgaria's DH sector will need to overcome challenges related to declining demand, transitioning from fossil fuels, attracting new consumers, expanding the network, and adopting new technologies. Addressing these challenges will require strategic investment, regulatory support, and innovative thinking to ensure that DH remains a vital and sustainable part of the country's energy system.

3.2.4. Financiers and investors

The feedback from Financiers and investors regarding the DHC sector in Bulgaria has been notably limited. The responses received primarily came from financial institutions with elements of national-level government. It highlights a broader issue: the perception of the DHC sector as a viable financial market, particularly among private investors and commercial banks. It can be partially attributed to the considerable indebtedness of certain companies to natural gas suppliers, with some outstanding balances exceeding 500,000 euros. It has led to the necessity for sporadic state subsidies to repay or partially repay the debts of some companies that provide vital public services. However, such subsidies do not extend to modernisation and efficiency improvements.

As a result, the DH systems in Bulgaria rely heavily on financing from the DH operators. While interest in co-financing through grants can alleviate some of the financial burden, this approach is not yet widespread. Therefore, the financial sustainability of these systems hinges on DH operators' ability to secure and manage their own funds effectively, often with limited external financial support.

Regarding financing opportunities, the types of DHC projects that might attract investment involve significant energy savings. These could include the construction of new plants, the reconstruction of existing facilities, or the refurbishment of infrastructure to improve efficiency. Despite the theoretical appeal of these projects, there has been a lack of active consideration or uptake by financiers to date. It could be due to several factors, including perceived risks, the complexity of these projects, or a lack of familiarity with the DHC sector's potential for returns.

Despite the above, some possible financing options are mentioned in principle, often not used by the DH companies. These are, for example, financial instruments for phasing out solid fuel heating in municipalities with poor air quality. In this case, financial support is provided for households to connect or reconnect to DH, but the companies are rarely proactive. Other possible opportunities mentioned include the RePower EU and modernisation funds, ESCO, etc.

3.2.5. Consumers and media

To obtain a qualitative sample of DH service users' attitudes and considering the segmentation of this group, a sociological agency was engaged. This allowed the study to include over 400 consumers from Sofia, Plovdiv, Varna, and Burgas. The sample consists of representatives of the following groups: households, commercial enterprises, industrial heat consumers, municipal institutions and media.

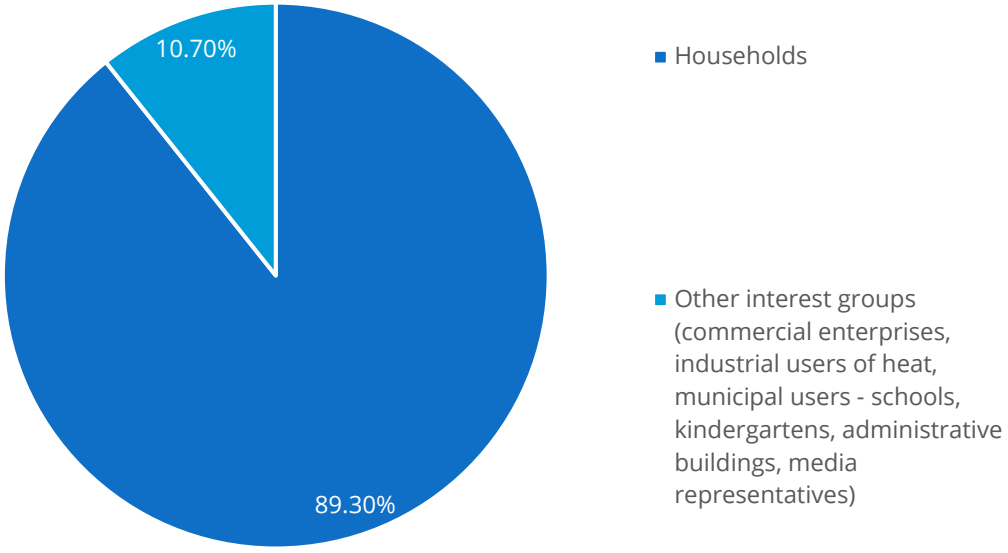

Figure 11 Respondent structure in the Consumers and media category in Bulgaria

Consumers declare high interest in DH services. Nearly 92% of the respondents want to learn more about this system.

Nearly 63% of individuals are interested in participating in interactive educational sessions, with webinars being the most popular (78%).

A significant proportion of respondents (77.8%) want to be informed about ongoing initiatives and upgrades to DH systems. Websites (60%) and social media (51.5%) are the preferred channels for receiving this information.

Over 64% of respondents believe there is a need for additional mechanisms to incentivise DH, with the most preferred measures including more information (23.8%) and financial incentives (19.5%). The most desired technology is solar energy (75.8%), followed by waste heat (42.5%) and heat pumps (40.8%).

Consumers highly value DH services - 70.1% have a positive attitude. The main spontaneous reasons given for liking the DH system are:

- Convenience and ease
- Efficiency
- Environmental friendliness

Those who have a negative attitude point out that the main reason is that the service is expensive - nearly 54% share this opinion.

When we talk about concerns, 36.8% of the people say they have none. For the remaining users, the main concern is the direction in which the service will become more expensive.

Nearly 63% of individuals have experienced service interruptions or disruptions. The main way they reported the problem was by calling, and the cause of the interruption was breakdown/repair.

Almost 47% of individuals gave a positive rating to the accessibility and transparency of the information provided by their heat supplier.

Negative assessment is given by 20.3% of consumers. The main problems that individuals highlight are opaque and unclear bills as well as a lack of understandable information.

For every second heat consumer, the significance of energy sources is very important.

In conclusion, consumer interest in DH services is strong, with a significant majority expressing a desire to learn more and participate in educational initiatives, mainly through webinars. While most consumers view DH positively, citing convenience, efficiency, and environmental benefits, there are concerns about cost and occasional service interruptions. Consumers also emphasize the need for greater transparency and information, particularly about ongoing system upgrades and energy sources. Financial incentives and the integration of renewable technologies, such as solar energy, are also highly desired to enhance the appeal and effectiveness of DH.

3.3. Croatia

In Croatia, the Energy Institute Hrvoje Požar (hereinafter. EIHP) primarily utilised Microsoft Forms to conduct surveys from stakeholders. An external agency was hired for the consumer group to conduct interviews and deliver the data in Microsoft Excel format. In the following subchapters, we will present the insights gained from the answers provided.

Before delving into more detailed responses of each group, we begin by analysing the interests and opinions of the first three groups: Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors. Their responses, illustrated in Figure 12, reveal distinct yet overlapping perspectives on various topics. Heat producers and utilities showed a balanced focus on operational activities like decreasing heat losses, installing digital technologies, sector coupling and utilising EU funds for energy efficiency and RES projects. They also showed high motivation for consumer-related activities to improve satisfaction and prevent loss. Authorities and regulators identified similar interests but with even higher ratings. They put less emphasis on utilising geothermal energy and some consumer-related challenges but highlighted technical improvements and advocated for policy-driven advancements. Technology suppliers and contractors rated technical enhancements, such as decreasing heat losses in heat generation and network and installing RES technologies, as particularly important while placing slightly less emphasis on consumer-related issues. Despite these differences, all groups have a clear consensus on the significance of improving system performance and leveraging EU funding, underscoring a collective commitment to advancing DH systems through technological and policy initiatives.

When asked about the opportunity to talk to and learn from peers through the REHEATEAST and cooperate in EU projects, the preferences of Heat producers and utilities varied widely. Still, higher emphasis on the technical side included digital technologies, thermal storage, geothermal energy, waste heat, and coupling with the electricity sector. On the financing side, they frequently mentioned joint work on utilising EU funding for energy efficiency and renewable energy projects. Three representatives of Authorities and regulators emphasised that all questions are essential and expressed openness to any knowledge exchange and cooperation to improve the sector. Two representatives of Technology suppliers and contractors showed interest in cooperation with REHEATEAST, one indicating interest in utilising waste and ambient heat. In contrast, the other respondent indicated an interest in cooperating on decreasing heat losses, improving heat metering and consumer assistance, increasing heat storage, utilising geothermal energy and waste heat, sector coupling, engaging consumers in energy-saving activities, and using EU funding for efficiency and renewable energy projects as points of interest in cooperation.

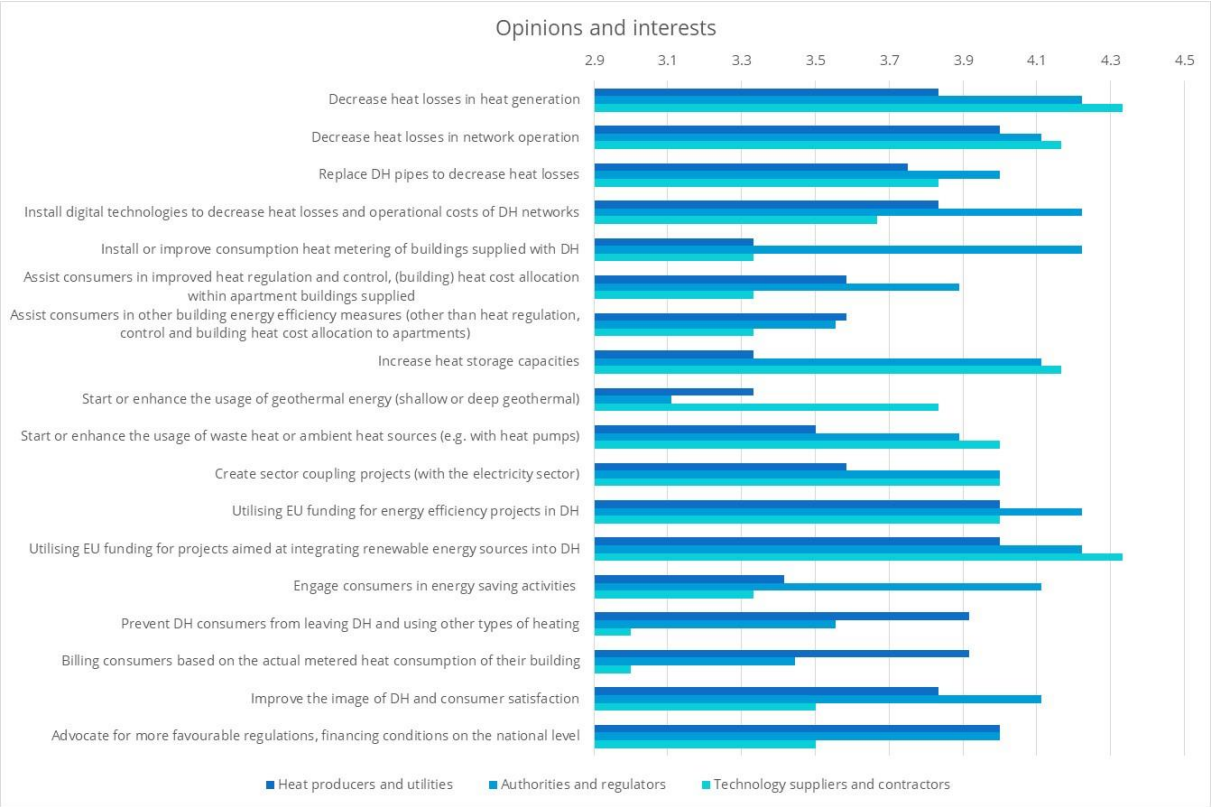

Figure 12 Comparative analysis of interests and opinions among Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors in Croatia

3.3.1. Heat producers and utilities

There were 12 respondents in the category of Heat producers and utilities. As seen in Figure 13, the respondents represent companies that supply varying number of DH clients, offering insights from a broad spectrum of perspectives and experiences within Croatia's DH systems. Half of the respondents indicated that they hadn't incorporated renewable energy, including waste heat, into their systems, indicating significant potential for growth and improvement. Most systems do not utilise heat purchased from third parties, with only one respondent reporting a reliance on externally sourced heat exceeding 75%.

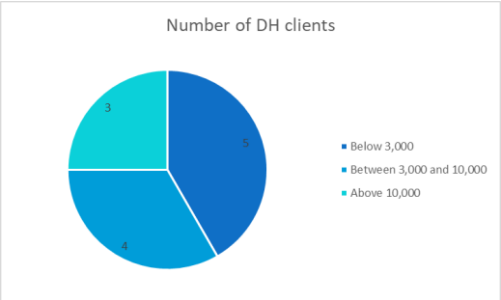

Figure 13 Number of DH clients per DH system in Croatia

General numbers for 2023

The data were gathered for the three largest heat providers in Croatia. In the following paragraphs, we describe the main observations from that data.

The data on heat sales shows DH System A as the largest distributor among the three systems, with a total annual sale of 1,335,226 MWh_{th}. The other two systems, DH System B and DH System C, recorded annual sales of 182,899 MWh_{th} and 56,915 MWh_{th}, respectively. In all three DH systems, most heat sales occur during the winter, accounting for 87% to 93% of total sales. The distribution by building type varies: DH System A and DH System C primarily serve residential buildings, with a similar distribution during winter. However, in summer, DH System A sells 55% of its heat to residential buildings and 45% to non-residential ones, while DH System C sells 75% to residential and 25% to non-residential buildings. DH System B shows a balanced distribution in winter, but the split shifts significantly to 20% residential and 80% non-residential in summer.

Regarding heat supply, DH System A provides an annual supply of 1,335,226 MWh_{th} from fossil fuels. While much smaller in supply, DH System B and DH System C demonstrate a more diversified energy mix. In all three cases, DH companies produce significantly more hot water than process steam, which accounts for 80% to 83% of the total energy supplied. In DH System B, 21% of this hot water and 18% of the process steam is derived from renewable sources. DH System C shows an even greater reliance on renewables for hot water production, with 65% derived from these sources, while all process steam is produced from fossil fuels.

DH System A serves over 100,000 buildings with a total heated area of 5.5 million m^2. In contrast, DH System B and DH System C cater to much smaller customer bases, with significantly less heated areas - 604,079 m^2 and 226,162 m^2, respectively. Residential buildings account for 89% to 96% of consumers across all three systems, with the remaining percentages attributed to public buildings, industry, and other non-residential structures. Additionally, nearly 15,000 buildings in DH System A measure heat consumption on a building level, compared to approximately 1,000 in DH System B and 265 in DH System C.

When talking about the data provided on key DH capacity statistics, DH System A has an installed capacity for heat production of 1,487 MW_{th}, DH System B 267 MW_{th} and DH System C 110 MW_{th}. This difference is reflected in the length of their transport and distribution networks. DH System A's hot water network spans 240.7 km, far exceeding the networks in System B (50.2 km) and System C (21.8 km). Similarly, System A has a steam network of 45.3 km, while System B and System C have smaller steam networks of 5.5 km and 4.6 km, respectively. None of the systems currently have heat pumps installed. Still, DH System A leads in thermal storage capacity, with 45.3 MW_{th} available, compared to 5.5 MW_{th} in System B and 3.6 MW_{th} in System C. Temperature parameters also vary, with System A's hot water systems operating at 120/70°C, System B's at 135/70°C, and System C's at 110/60°C. The number of substations is much higher in DH System A, with 2,780 units, compared to 733 in DH System B and 175 in DH System C. DH System A has the most diverse setup regarding substation types, with 1,421 compact, 1,050 indirect, and 309 direct substations. In contrast, DH System B primarily has direct substations, while DH System C only has compact substations.

The frequency of maintenance, repairs, and upgrades on the DH network varies across the systems. DH System A experiences 140 annual supply outages, typically lasting two to three days. DH System B has three outages per year, each lasting about one day, while DH System C has seven annual outages, typically two days. Regarding the primary energy mix, DH System A relies entirely on natural gas. In contrast, DH System B and DH System C use a combination of natural gas and biomass, with DH System B having an 81%:19% and DH System C having a 44%:56% ratio between

these sources. The carbon footprint for total heat production shows that DH System A has an overall CO_2 equivalent of 0.235 tCO_2/MWh and slightly higher in cogeneration at 0.252 tCO_2/MWh. DH System B's footprint is lower at 0.18 tCO_2/MWh, while the data for DH System C shows slightly different CO_2 equivalents, 0.111 tCO_2/MWh overall and 0.169 tCO_2/MWh in cogeneration.

With these data, we conclude the general numbers for the three selected DH systems in Croatia and continue with generalised questions for the Heat producers and utilities stakeholder group.

Several ongoing and planned initiatives aim to reduce heat losses and improve system efficiency. These include replacing old pipes with pre-insulated ones, installing more energy-efficient boilers, implementing central monitoring and control systems, and upgrading heat exchangers in heating substations. Other activities mentioned include the construction of a new combined heat and power plant, thermal solar collector fields, and installing economisers on boilers.

The accuracy of heat measurement varies, with some respondents ensuring maximal accuracy through calorimeters and regular calibration. In other cases, ongoing initiatives are to replace old measuring devices to improve accuracy. Some systems rely on building-level calorimeters, while others measure at each thermal substation or in the boiler rooms.

Digital technologies are employed to varying degrees for monitoring, optimising and controlling DH systems. Most systems have implemented or are in the process of implementing SCADA (hereinafter: Supervisory Control and Data Acquisition) for centralised monitoring and control. Advanced systems utilise TERMIS for network optimisation and Nordic leak control systems for pipeline maintenance. This variation in digital technology adoption reflects differing levels of technological advancement of different DH systems.

The respondents were asked about perceptions of DH among existing consumers, the general public and policy creators. As can be seen in the figure below, their opinions vary significantly. According to Heat producers and utilities, consumers tend to have a negative perception, primarily due to perceived high costs and lack of transparency, as well as a lack of understanding and desire for independent heating systems. They highlight that consumers should also take responsibility by, for example, installing thermostatic valves and renovating their buildings. The general public's view is mixed, with negative perceptions dominating but positive views emerging. Policymakers' perceptions are also mixed but on a more positive side. In general, positive perceptions are attributed to the lower cost of thermal energy compared to other sources, as well as convenience and reliability. Suggested improvements involve education, transparency, and regulatory adjustments.

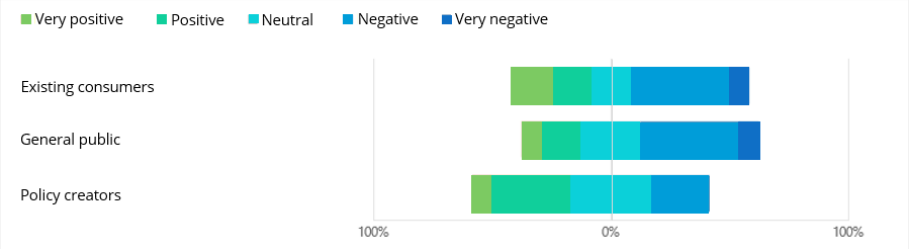

Figure 14 Assessment of perceptions of different groups on DH based on responses from Heat producers and utilities in Croatia

There is a consensus on the lack of public knowledge and skills necessary for expanding DH. Improvements can be made by promoting its benefits, better informing consumers, investors and designers, and encouraging the adoption of centralised heating systems over individual solutions. Developing strategic plans, both on local and state levels, and financial incentives are also recommended to foster acceptance and investment in DH.

Transitioning from fossil fuels to renewable sources, establishing appropriate regulatory frameworks, convincing policymakers of the benefits of DH and attracting new consumers are identified as the most significant challenges, as seen in the figure below. Contributing to European energy policy targets and adapting to future reductions in heat demand are also important issues.

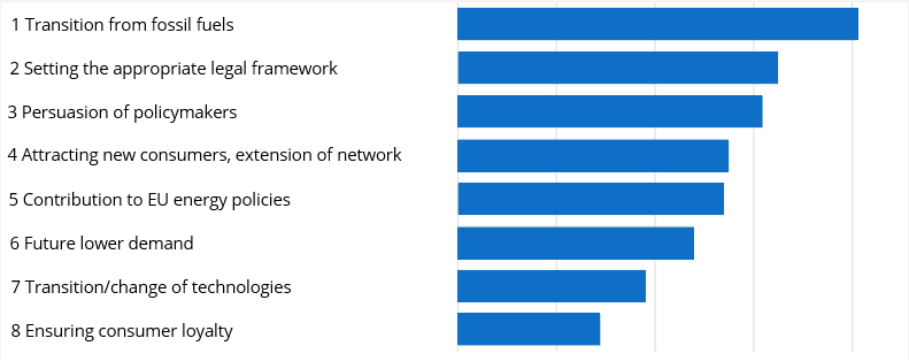

Figure 15 Biggest expected challenges for DH in Croatia based on responses from Heat producers and utilities

Geothermal energy is the most mentioned renewable source for DH due to its consistent availability. Other recommended sources include solar energy, heat pumps, and biomass. The choice of energy sources largely depends on local availability and conditions, underscoring the need for tailored solutions that leverage regional strengths and resources.

Respondents generally expect a decline in thermal energy sales, with an increased reliance on RES. Significant improvements in energy efficiency are anticipated, with operating temperatures expected to drop, in some cases, to as low as 70°C/40°C. While some predict stable consumption

levels, others foresee a gradual decline driven by these efficiency improvements and the impacts of climate change.

Responses to the need for regulatory or legislative support and additional incentive mechanisms for DHC emphasised their crucial role. Respondents highlighted the necessity of strong and consistent legislation, revising tariff methodologies, price reductions of connecting RES, and integrating DH into urban plans with support during the transitional periods. Regarding incentives, there was strong support for consumer education, financial subsidies for modernizing systems, co-financing building renovations, and integration of RES and pipeline restorations. Furthermore, securing European funds for projects through programmes such as ITU (Integrated Territorial Investments) or LIFE is also recognised. More collaboration between national and local governments is needed to set common strategies and provide comprehensive support for the sector's expansion.

Several successful DH initiatives were shared, highlighting best practices in the sector. Examples include a renovated boiler room with condensing boilers, solar panels for domestic hot water, individual heat programming, and a heat pump system. One project saw a 60% reduction in heating costs following a strategic DH renovation and a new energy calculation method. Ongoing exploration of geothermal energy and testing of the boreholes is also notable. Significant upgrades to one city's DH infrastructure, including replacing hot water pipes, installing remote monitoring systems, and automating chemical preparation of water and new distribution pumps, demonstrate substantial progress. One respondent highlighted using EU funds for a project enabling 85% of heat energy to come from RES. Additionally, they initiated a study on integrating RES into their heating system to drive investments and ensure a safe, affordable, clean heat supply for existing and future DH users. Lastly, one city utilised the funds from ITU, showcasing an example of effective DH renovation.

3.3.2. Authorities and regulators

The nine responses from Authorities and regulators highlight several key insights and perspectives on DH systems' current state and future.

Firstly, there is a recognition that while policies and incentives exist to promote the expansion and improvement of DH systems, significant modernisation is required before these systems can effectively expand. It is emphasised that it is counterproductive to expand the network if the system is inefficient and lacks renewable energy integration. A strategic collaboration between DH systems and the public sector is suggested as a measure to incentivise expansion, where public buildings can be grouped and connected to the system. It would allow DHC to plan network expansion strategically.

Regarding regulatory challenges, outdated legislation is a significant issue. The current laws have not been significantly updated since 2013. The regulated and uncompetitive thermal energy price, the high cost of connecting new users, and subsidised gas prices create an unfavourable comparison between DH and individual heating solutions. Expanding the network is expensive and lacks coordination with other municipal utilities such as gasworks and water supply companies,

which increases costs. Nationally, the decarbonisation of the building sector, which heavily relies on fossil fuels for heating, is crucial. The slow process of obtaining permits for renewable energy projects further complicates efforts. Therefore, there is a clear need for legislative reform, with a particular focus on revising the Building Act and the Thermal Energy Act.

Incentive mechanisms are considered essential for promoting DH. These could include subsidies for end-users to connect to the DH system or for the DH system to integrate renewable energy and digitise their networks. The European Structural and Investment Funds should facilitate investments in DH systems in the coming years. Local energy planning should mandate new buildings' connection to central heating systems where possible, with incentives like reduced municipal fees for those that connect to DH.

Nationally, the decarbonisation of the building sector, which heavily relies on fossil fuels for heating, is crucial. The slow process of obtaining permits for renewable energy projects further complicates efforts. Therefore, there is a clear need for revising the legislation.

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Technological advancements expected to impact the sector include demand-side response, heat pumps using wastewater, large thermal storage, biomass, biogas, and waste heat. The most widely recognised for its potential is geothermal energy. Solar energy is also highly represented in the answers for high-temperature solar thermal collectors and photovoltaic systems for powering heat pumps.

In the opinion of Authorities and regulators who filled out the survey, existing consumers and the general public predominantly hold negative or neutral views of DH, mainly due to higher costs than individual gas boilers subsidised by the government. Consumers also desire transparent billing that reflects their actual usage. Policymakers exhibit a more balanced perception, though with notable neutrality. To address the opposing views, improving the technical efficiency and increasing the share of RES in DH systems through subsidies is essential. DH is noted to be more financially attractive in other countries, suggesting that making DH more cost-effective could improve its perception in Croatia.

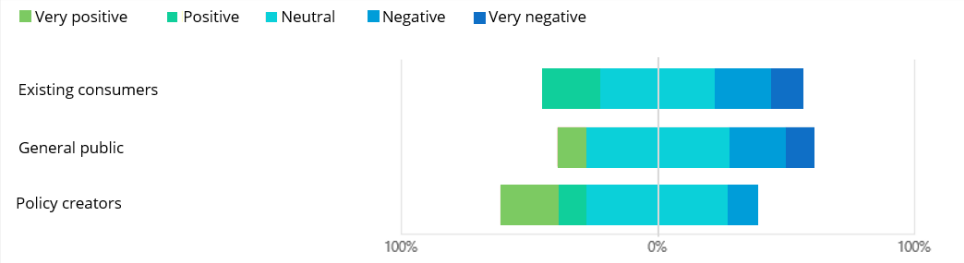

Figure 16 Assessment of perceptions of different groups on DH based on responses from Authorities and regulators in Croatia

Looking ahead, the most significant challenges for DH in Croatia, according to Authorities and regulators, in descending order, are transitioning from fossil fuels, adopting new technologies, establishing an appropriate legislative framework, attracting new consumers and expanding the network, contributing to European energy policies, convincing policymakers, addressing the future reduced demand for thermal energy and ensuring consumer loyalty.

Respondents predict an increase in renewable energy integration, improvements in efficiency and significant modernisation efforts. Generally, the respondents indicate that the demand for heating will decrease due to building energy renovations and global warming. Lowering the starting and return temperatures in heating systems is anticipated, but this will depend on the modernisation of building heating substations and renovations.

Survey responses highlighted several successful DH initiatives. The D2Heat project in Croatia aims to invest 40 million euros in renewable energy by 2026, while the KeepWarm project focused on accelerating cost-effective investments in the modernisation of DH systems. Examples of network renovations in Rijeka, Karlovac, Zagreb, and Vukovar were also highlighted, along with the META BUILD project in Velika Gorica, which focuses on electrifying the heating sector, integrating RES, and implementing smart energy management systems. Notably, Rijeka's DH system is undergoing a 14.9 million euro upgrade, co-financed by the EU, to enhance sustainability and reduce emissions without increasing costs for users.

3.3.3. Technology suppliers and contractors

There were six responses from Technology suppliers and contractors. They included equipment suppliers, providers and project designers. Regarding technological innovations and their use, the attitude is mostly positive.

The graphical presentation of responses to more straightforward technical questions is shown in Figure 17. Developed software tools are used for their purposes and commercial services using digital technologies.

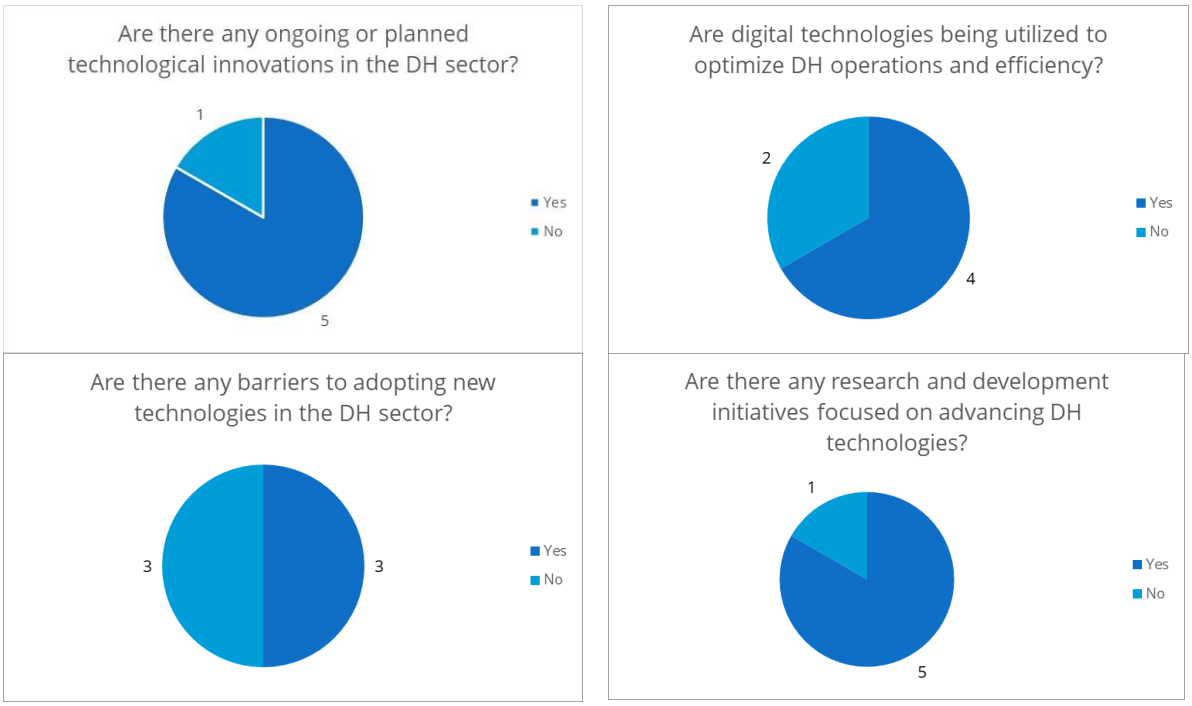

Figure 17 Responses from Technology suppliers and contractors in Croatia – Technical issues

Regulatory barriers and challenges to DH infrastructure development are shown in Figure 18. The undefined legislative framework is recognized, followed by the undeveloped market of supporting services and lagging in improving the state of existing network systems. Structural deficiencies were stipulated, pointing to insufficient spatial planning and a lack of communication among administrative stakeholders. High network losses and inadequate measures are consistently among the remarks.

The need for more effective regulatory and legislative support is strongly felt, considering fair tariffing issues and facilitating system access to potential customers.

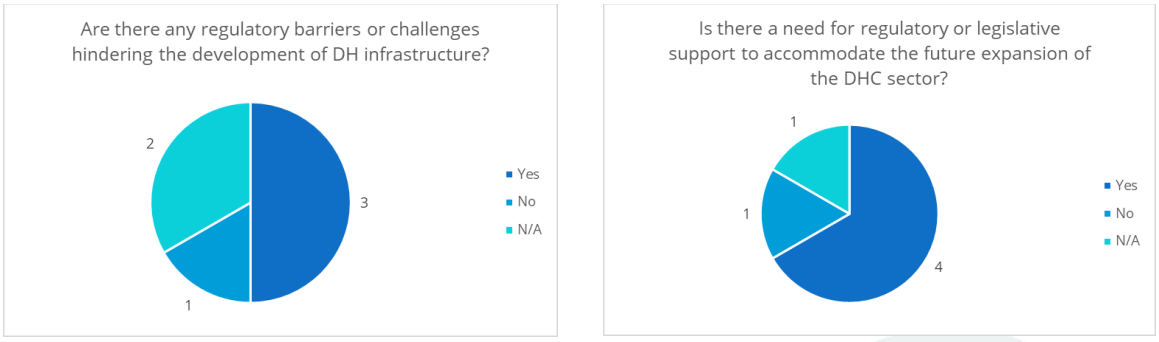

Figure 18 Responses from Technology suppliers and contractors in Croatia – Regulatory issues

Regarding the more specific questions, for the strategies appropriate for DH adoption to advanced technologies, the high-efficiency cogeneration is considered, combined with clean fuels, advanced heat pumps, and system refurbishments – state-of-the-art pipelines, automatisation, and integration with renewables. Further, as new technologies are promising, geothermal energy is mainly anticipated as software packages for optimisation and control and integrating new, alternative heat sources into the network supply.

Regarding the fundamental changes needed to improve existing DH systems, technical, organisational, and financial actions were considered significant, mostly stipulating the financing issues and investments. A higher rate of IT introduction is also desired.

The need for additional incentive mechanisms for DHC is clearly expressed. For this, the subsidizing and incentives to final DH users and network operators are stated, as well as incentives for investments in renewable heat sources to mitigate the unfavourable market position, generally co-financing the capital expenditures.

The perceptions of different groups based on the answers from Technology suppliers and contractors are shown in Figure 19. The reasons for negative perception were the inability to influence the consumption and final costs, lack of marketing strategies, security of supply with losses and other technical issues, and lack of understanding of the advantages of DH. When the perception is positive, the regarded success elements are the relatively lower cost of heating, cost/quality service ratio, and comfort regarding other supply options.

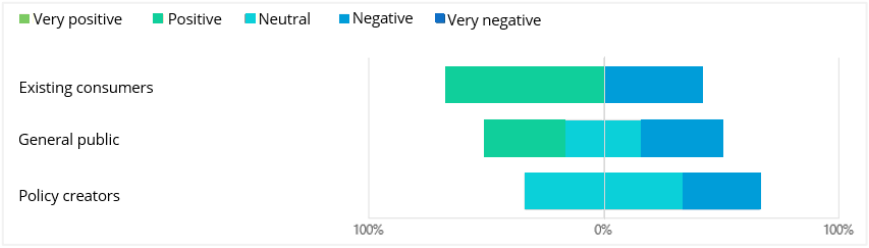

Figure 19 Assessment of perceptions of different groups on DH based on responses from Technology suppliers and contractors in Croatia

The most significant identified challenges to DH development in Croatia are attracting new customers, appropriate legislation, abandoning fossil fuels, a future decrease in heating demand, technology issues, and DH network expansion.

As the most appropriate renewable fuel for DH supply, in addition to the mentioned geothermal energy, biomass and waste use are recognized, and solar energy is less common.

Considering the development of DH systems in Croatia until 2030 and 2050, the decrease in consumption is anticipated equally with an increase of heat sales from DH combined with a larger share of renewables, as well as the presence of 'green' electricity as a competition to DH supply. More pessimistic answers consider a 20% drop in supply, and EU targets are too ambitious considering the systems' abilities in Southeast Europe. The slow development of DH in Croatia is also felt.

Regarding collaborating with industry partners, research institutions, and other stakeholders to drive technical innovation, Technology suppliers and contractors mainly consider universities and joint development projects.

The examples of successful DH initiatives are given generally, considering one local example and some in Slovenia and Serbia.

3.3.4. Financiers and investors

The Financiers and investors have responded in a limited scope, and answers came from public agencies responsible for financing energy efficiency-related projects.

The perception of the DHC sector as a financial market is thus limited since the responders are not commercial institutions.

The DH systems are financed and sustained mainly from DH operators' own financing or dedicated external funding, and co-financing through grants is being considered.

The DHC projects that can be considered for responder's financing would include new plants, reconstruction, and refurbishments – in general, all activities that result in energy savings. Presently, however, no such cases are regarded.

The responding parties are conservative about the securities/collaterals for financing eligible projects. Bank warranties, debentures and blank promissory notes are mentioned.

As the fundamental investments needed to improve existing DH systems, the typical issues are stated – difficulties in expanding the DH networks and maintaining the existing network systems. Replacing outdated hot water pipelines and reconstructing obsolete pumping and heating substations are highlighted.

The most significant identified challenges stated by responders are listed in the following figure.

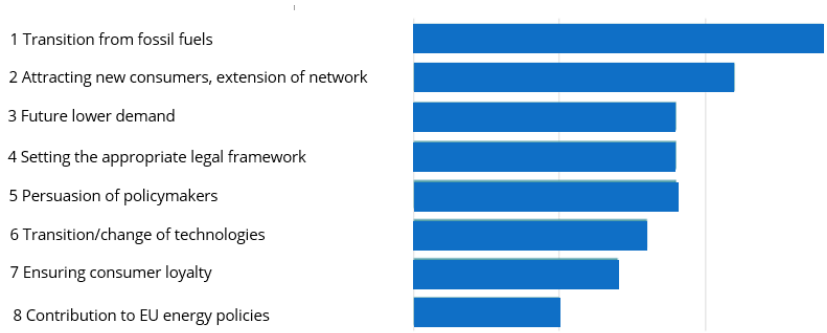

Figure 20 Biggest expected challenges for DH in Croatia based on responses from Financiers and investors

3.3.5. Consumers and media

As mentioned, an external agency was hired to conduct face-to-face interviews with the Consumers and media group, using digital devices to facilitate the process. It delivered the data in Microsoft Excel format. In total, 150 responses were received from Zagreb, Karlovac, and Osijek.

Consumers are generally not highly motivated to learn more about DHC systems or be informed about ongoing initiatives and refurbishments, as seen in the graphs below. Interestingly, 63% of respondents indicated that it is important for them that DH systems utilise RES.

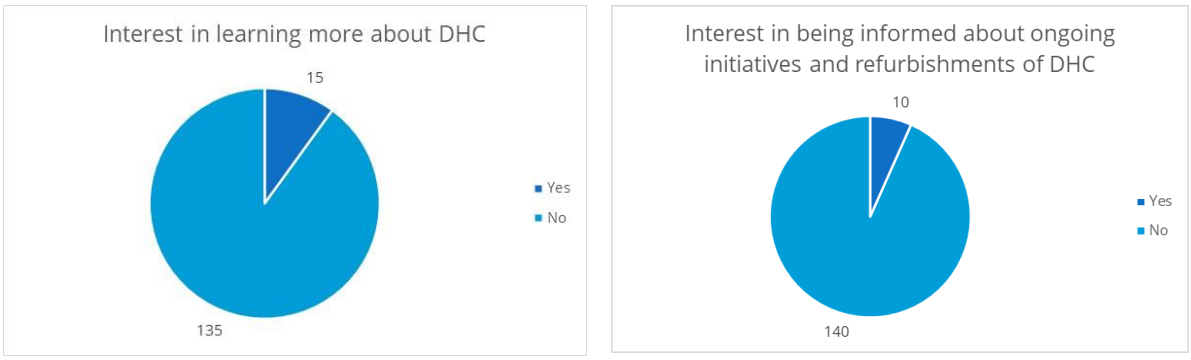

Figure 21 Consumer interests in DH in Croatia

Out of 150 consumers, only 47 believe additional incentive mechanisms are necessary. Their opinions on the form these mechanisms should take are varied but consistent in a few key areas. Many respondents emphasised the need for increased funding from EU sources and the Environmental Protection and Energy Efficiency Fund in Croatia. There is also a need for assistance with documentation and the application process for building renovations.

The following graph shows consumers' perceptions of DH. We can see that the majority think positively, with only 8% rating it negatively.

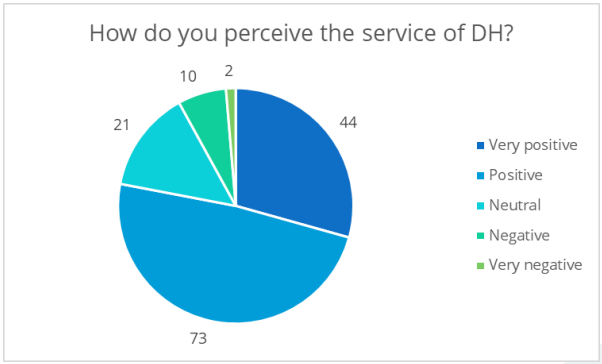

Figure 22 Consumer perceptions of DH in Croatia

Respondents identified several key factors contributing to their satisfaction with the DH service, including regulated heating throughout the year, satisfaction with the heating season's start and end, and the ability to turn off or reduce heating when not needed. Safety and reliability with prompt notifications of rare interruptions, well-maintained radiators, good thermal insulation, and ecological benefits were also highlighted. Suggestions included introducing individualised billing, addressing disruptions in heat supply, providing more accurate consumption information on bills, and managing rising heating costs to improve the service.

Consumers have identified several issues with the DH service. A recurring concern is the high cost of heating and problems with heat cost allocators. Additionally, there is dissatisfaction with the heating season starting too late and ending too early and the inability to regulate the temperature. Respondents also mentioned unreliable supply and hot water supply disruptions during summer maintenance.

Out of 150 consumers, 51 experienced disruptions in their DH service. Most of these issues were resolved promptly, with many consumers reporting that problems were fixed the same day or within a couple of days. However, a few repairs faced longer waiting periods, such as when repairs took ten days to complete. There were also reports of more severe disruptions, where ongoing maintenance and unresolved issues led to prolonged periods without heating or hot water. While most disruptions were handled effectively and promptly, there were isolated cases of significant delays.

Most consumers are satisfied with accessibility and transparency, while around 30% to a more moderate degree. Improvements could include accurate digital consumption readings, clear notifications via bills or building representatives, and understandable billing formulas. They also recommended addressing high prices.

Consumers highlighted several good examples connected to DH systems. Notable improvements include the installation of new heat allocators on radiators in 2021, ensuring better regulation and transparency of heating costs. In some neighbourhoods, energy-efficient building renovations have resulted in lower heating costs and better overall heating performance. Furthermore, the use of EU funds has been recognised a few times. Overall, satisfaction remains high when repairs and communication with residents are handled efficiently.

3.4. Hungary

Issues and challenges

Critical issues include the **low energy efficiency of residential buildings**, the **inappropriate regulatory environment,** and the **lack of development funding**.

EU funding is virtually the **only source** available **to finance DHC investments**. DHC companies cannot generate significant profit because of the regulations set by the national regulatory authority - on a bilateral basis, tailor-made to individual firms.

It is generally perceived that most DH systems have much better energy performance than typical residential buildings they supply. The **most critical issues** are on the demand side, related to wasteful **privately owned apartment buildings**. Problems (high energy consumption, low comfort, energy poverty) related to heating the streets are mostly not associated with building owners but typically with DH services.

All stakeholder groups indicated major **policy issues** that have significant negative impacts. The regulatory environment is perceived to be unpredictable and incoherent. The prices of DH services are set by law, but DH's cost is market-based. DH systems are financed and sustained by state subsidies provided on a bilateral basis (bilateral negotiations on the level of subsidies to be provided), tailor-made to firms. DHC providers are not allowed to charge market prices. Companies that improve efficiency receive less state subsidies. Each year, there is a negotiation between individual DHC companies and the central planning authority Energiahivatal on prices, the amount of state subsidy it can receive to stay solvent (alive), and the prices it can pay for various heat sources and charge to consumers.

The **regulatory system** resembles the pre-1989 (**planned economy**) system in terms of bilateral subsidy negotiations (of DHC service providers) with the state in an environment where prices are set by a central national authority based on political goals. It resembles the 'shortage economy' system described by the late Janos Kornai in his famous book. He was an internationally acclaimed Hungarian economist and Harvard University professor who also received the Legion of Honour, the highest French order of merit.

The regulatory system inhibits the utilisation of waste heat. Waste heat utilisation from private sector companies is hindered by the fact that the central authority has to approve the price of any heat purchased, and for that, it asks for pervasive information on the operations of the heat suppliers. Private companies are reluctant to share sensitive information with this authority; they would rather not sell waste heat. They are also unwilling to enter long-term commitments as factories may be closed. Regulations concerning the potential usage of waste heat in wastewater are insufficiently clear, which makes the utilisation process lengthy.

The central regulatory body Energiahivatal has recently catalysed the disconnection of many private firms from DHC after the sudden natural gas price increase due to the geopolitical situation in Ukraine when these private business clients had to pay 16 times the previous heat price suddenly. It motivated them to disconnect from DHC because of the extremely high price and the hectic, unpredictable nature of the price changes. Many office buildings are disconnected in Budapest.

The persuasion of **policymakers** and the transition/change of **technologies** are deemed to be the **largest challenges** in setting an appropriate **legal framework**. Barriers to adopting new technologies in the DH sector include the lack of funds, motivation to act in the current regulatory environment, and limited interest in new solutions. Personnel capacity issues are significant and related to salary levels and the general shortage of qualified labour (e.g., heating installers and electricians) with up-to-date knowledge.

Most primary energy used in DHC (about 70%) is natural gas imported from Russia. DHC service providers consider various heat pump solutions to be DHC's main competitors.

There is an issue with cost allocation, especially in buildings with small one-room flats. Several users turn off the radiators to be heated by the neighbours and towel drying equipment in the bathrooms where there is no cost allocator. This results in the building being heated mainly by the surface of the pipes, which is insufficient, resulting in underheated buildings. Then, building managers require higher-temperature water from the DHC company for heating, increasing costs. In Western countries, building managers are typically professional firms with a proper understanding of energy matters (that act against the above process), but this is not the case in Hungary.

Changes required

Fundamental technical, organisational and financial changes are needed to improve existing DH systems by decreasing energy waste (energy efficiency first principle) and increasing the share of renewable energy. Digital technologies are utilised to optimise DH operations and efficiency for data collection, analysis and prediction. There is a need for regulatory or legislative support to accommodate the future expansion of the DHC sector. Heat pumps and heat storage technologies are expected to have the most significant impact on DHC.

Multiple measures are required to increase network energy efficiency. DHC service providers shall install pre-insulated cables, reconstruct parts of the DHC networks, separate heating substations (to serve individual buildings tailored to their actual needs) and install digital remote monitoring and control solutions (in substations, boiler houses, etc.) to reduce network heat losses where these are too high. Low-efficiency heating and domestic hot water circulation pumps must be replaced and upgraded for energy efficiency. DHC providers try to improve these aspects when they can access funding.

DHC service providers anticipate primarily improved energy efficiency, enhanced digitalisation (resulting in energy, water, personnel costs, and material savings), and cyber safety.

According to DHC service providers, legislation stipulating that DH must be used in new buildings if the service is available within a certain distance and is the most environmentally efficient would be beneficial. It would also be necessary that the provisions of the Government Decree on National Town Planning and Building Requirements (OTEK) explicitly contain the definition of 'efficient district heating' as defined in the EU directive, so the possibility of using efficient DH should be examined in all cases during planning and implementation. However, based on international examples, most regulations encouraging the spread of DH are created at the local level. Still, national policies underpinning and defining subordinate provisions are vital in achieving optimal

results. In this way, cities can significantly increase the number of DH connections and expand systems.

A fundamental problem is the poor energy efficiency of a large share of apartment buildings. In January 2024, a new regulation was published in Hungary that makes cost allocation mandatory by 2027 unless it can be proven in a specific place that it is not economical. Detailed regulations are to be prepared by the municipalities by December 2024 (MATÁSZSZ is working on recommendations.) There are no official statistics on the usage of cost allocation in billing DHC services; its market share is estimated at 50%.

The EU Directive 2018/2002 on energy efficiency stipulates that only remotely readable devices can be installed in the territory of the European Union from October 25, 2020, and only such devices can be used from January 1, 2027. If the current cost allocator cannot be read from a distance, it must be replaced.

Building heat consumption measurement practices

The amount of heat (GJ) sold to users is measured using certified ultrasonic heat consumption measuring devices, which are placed in heat centres, heat receivers, or building parts (shops, apartments) for building part measurements.

For devices manufactured and/or certified before 1st September 2023, their certification and replacement due to certification take place every four years; the certification period for heat consumption meters manufactured and/or certified after that has changed to six years.

Heat consumption meters are installed with the service provider's seal at their place of installation, thereby ensuring the conditions for authentic measurement. They are typically read monthly - data stored on the day of the transaction and the error time are read. The amount of domestic hot water sold (m^3) is measured through authentic hot water consumption meters placed at the points of use in the buildings. Their verification period is eight years. Metering points and meters placed at measuring points, protected by service provider seals, are checked and read once a year.

The best practices mentioned by various stakeholder groups are shown in the following table.

Table 2 Best practices in Hungary

Best practice	Brief description
Kaposvár network optimisation, neighbourhood-level building deep retrofit and biomass heating plant	Due to network optimisation and neighbourhood-level deep building retrofit, heat demand has decreased by over 50%. DH supplied about 6,800 flats. Specific heat consumption decreased from a typical 33 GJ/p.a. to 16 GJ/p.a. per flat. With grant funding, this was a joint effort by the municipality, DHC company, and population. The remaining heat demand is met mainly by heat generated from biomass collected in a sustainable fashion from within 50 km. The biomass heating plant has a 15 MW capacity and uses wood chips.

Szeged geothermal heating system[6]	It supplies heat and domestic hot water to 27,256 apartments and 433 public buildings.
Miskolc geothermal heating system[7]	It currently has a capacity of 45 MW_{th} and operates from two production wells.
Győr geothermal heating system[8]	It delivers 1.8 PJ of geothermal heat.
Hódmezővásárhely geothermal heating system[9]	Natural gas is used only part of the heating season, as geothermal energy cannot provide the heating water temperature required by the not-very energy-efficient apartment buildings supplied.
Szentes geothermal heating system[10]	Beyond supplying buildings, geothermal energy is widely used in Szentes to heat foils and greenhouses used for producing vegetables, such as tomatoes.
Bóly geothermal heating system[11]	The production well heat temperature is 82-85°C. A company plans to dry soya beans outside of the heating season, which can contribute to the sustainability of the heating system.
Pécs biomass power plant	A biomass-based cogeneration plant owned and operated by the Veolia group. It has 49.9 MW electric capacity and sells about 330 GWh of electricity and 350-400 TJ heat annually.

[6] https://www.euronews.com/video/2024/04/15/hungary-boasts-the-eus-largest-geothermal-system
https://www.geothermal-dhc.eu/News/Details?id=215
https://www.crowdthermalproject.eu/wp-content/uploads/2021/10/CROWDTHERMAL_factsheet_hungary.pdf
https://innogeo.hu/en/news/fostering-the-implementation-of-shallow-geothermal-hybrid-heating-and-cooling-systems-in-the-danube-region-danube-geoheco/ https://interreg-danube.eu/projects/danube-geoheco/about-us
https://interreg-danube.eu/projects/danube-geoheco/news/budapest-based-ambassadors-of-eu-visited-geothermal-installations-in-szeged

[7] https://www.thinkgeoenergy.com/pannergy-receives-funding-for-geothermal-drilling-for-miskolc-project-hungary/

[8] https://ceenergynews.com/geothermal/hungarys-gyor-geothermal-system-produced-record-heat-energy-in-2022/
https://www.euroheat.org/dhc/knowledge-hub/100-re-district-gyor-hungary

[9] https://www.geothermal-energy.org/pdf/IGAstandard/EGC/szeged/O-8-04.pdf
https://tavho.org/uploads/eloadasok/2_Garaguly_Istvan_MAT%C3%81SzSz_Public.pdf

[10] https://www.interreg-central.eu/news/the-szentes-geothermal-field-in-hungary/
https://www2.sci.u-szeged.hu/geotermika/eloadasok_081028/szentes_szirbik.pdf

[11] http://geodh.eu/project/boly/

Kecskemét biomass power plant	A 25 MW_{th} capacity heating plant is operated by Veolia Hungary, which operates other biomass-based DH systems in Hungary and dominates heating biomass procurement[12] in Hungary.
Nyíregyháza heat cost allocation[13]	The DHC supplier claimed that intelligent digital building heating substation control, the application of thermostatic radiator valves in flats and digital cost allocation introduced for billing and other energy efficiency measures have resulted in a 50% decrease in the specific heat consumption of the apartments affected.
Budapest wastewater waste heat utilisation	A significant facility has been built in District 4 in an EU project. It supplies multiple public buildings.
Vienna wastewater waste heat utilisation	Waste heat utilisation of wastewater by Wien Energie, 2x25 MW, located at the wastewater treatment plant. It is linked to the DH system. Viennese utilities are part of the Stadtwerke.
Taufkirchen geothermal energy	Taufkirchen (Germany), near Munich, is a fully geothermal cogeneration plant linked to a DH system. It has a 4.3 MW electric capacity and 40 MW thermal capacity.
Salaspils (Latvia) combined, digitalised system[14]	1720 solar collectors with a total surface area of 21672 m^2, 3 MW wood chip boiler with flue gas condenser, 8000 m^3 heat storage and remote data reading system.
Rezekne (Latvia) public building energy management	Monitor energy consumption in public buildings using data for decision-support and building management.
National competition for most energy efficient building title, Latvia[15]	Part of a campaign by the Ministry of Economy, the competition 'The most energy-efficient building in Latvia' aims to promote good practices.
Deep retrofit of public buildings, Budapest (districts 13, 14)[16]	Reconstruction of primary school and kindergarten buildings supplied by DH decreasing their specific final energy consumption below 60 kWh/m^2 per annum.

[12] https://biomassza.veolia.hu/

[13] https://nyirtavho.hu/gyik

[14] https://salaspilssiltums.lv/en/ https://filter.eu/solution/solar-thermal-district-heating-plants/ https://www.renewables-networking.eu/documents/LV-Salaspils.pdf https://www.ceeweb.org/eufunds/best-practice.php?id=23 https://roundbaltic.eu/wp-content/uploads/2024/02/RoundBaltic-Case-Study_Solar-Panel-Park-Salaspils-Latvia.pdf

[15] https://uzladets.lv/en/energoefektivaka-eka-latvija-pieteiktas-43-ekas/

[16] https://programme2014-20.interreg-central.eu/Content.Node/DT112.pdf

Apartment building energy retrofit programme (with the EIB) in Lithuania[17]	Šiaulių Bankas, in cooperation with the EIB, has been participating in apartment building modernisation programmes for more than ten years and occupies more than 60% of this market. During this period, modernisation loans were signed for more than 720 million euros (of which more than 520 million euros are own funds of Šiaulių Bankas), with the bank providing funding for 2,380 apartment buildings.
Kredex apartment building renovation financing programme, Estonia[18]	In 10 years, 1,114 apartment buildings were refurbished with 2,8 million m^2.
Engaging residents in energy efficiency-related activities, Riga, Latvia[19]	Riga Energy Agency collects real-time air quality data in apartments and correlates it with real-time building heat energy consumption, taking into consideration also real-time weather conditions.

Of RES, **geothermal energy** is considered to be the most suitable for use in Hungary's DHC systems, followed by biomass.

3.4.1. Heat producers and utilities

The most important DHC issues, according to DH service providers, are shown in the following table.

Table 3 The most important DHC issues according to DH Heat producers and utilities in Hungary

Challenges	DHC firms
Utilising EU funding for energy efficiency projects in DH	X
Utilising EU funding for projects aimed at integrating renewable energy sources into DH	

[17] https://www.eib.org/en/press/all/2022-204-lithuania-total-financing-for-energy-efficiency-loans-with-siauliu-bankas-reaches-eur1-billion

[18] https://kredex.ee/en/kodudkorda

https://www.trea.ee/wp-content/uploads/2020/06/1_3_Case-1-Kredex-Case-2-SmartEnCity_Muiste_20200519.pdf

https://www.peeb.build/imglib/downloads/Best%20Practice%20Examples/Estonia_GlobalABC%20WA%20Finance_Stimulus.pdf https://www.fi-compass.eu/sites/default/files/publications/case_study_renovation_loan_programme_estonia_0.pdf

[19] https://smartcity-atelier.eu/allgemein/promoting-energy-retrofits-to-support-ped-development-in-riga/

Challenges	DHC firms
Installing digital technologies to decrease heat losses and operational costs of DH networks	X
Installing or improving consumption heat metering of buildings supplied with DH / Billing consumers based on the actual metered heat consumption of their building	X
Assisting consumers in improved heat regulation and control, (building) heat cost allocation	
Assisting consumers in other building energy efficiency measures (other than heat regulation, control and building heat cost allocation to apartments)	(x)
Starting or enhancing the usage of (deep or shallow) geothermal energy	(x)
Advocating for more favourable regulations, and financing conditions on the national level	X
Preventing DH consumers from leaving DH and using other types of heating	X
Improving the image of DH and consumer satisfaction	X
Increased usage of waste heat or ambient heat sources (e.g. with heat pumps)	
Creating sector coupling projects (with the electricity sector)	
Modernization and energy efficiency replacement of existing old, outdated district heating supply lines	X

3.4.2. Authorities and regulators

The most important DHC issues according to authorities and regulators are shown in the following table.

Table 4 The most important DHC issues according to Authorities and regulators in Hungary

Challenges	Policymakers
Utilising EU funding for energy efficiency projects in DH	X
Utilising EU funding for projects aimed at integrating renewable energy sources into DH	X
Installing digital technologies to decrease heat losses and operational costs of DH networks	
Installing or improving consumption heat metering of buildings supplied with DH / Billing consumers based on the actual metered heat consumption of their building	
Assisting consumers in improved heat regulation and control, (building) heat cost allocation	X
Assisting consumers in other building energy efficiency measures (other than heat regulation, control and building heat cost allocation to apartments)	X
Starting or enhancing the usage of (deep or shallow) geothermal energy	X
Advocating for more favourable regulations, and financing conditions on the national level	X
Preventing DH consumers from leaving DH and using other types of heating	X
Improving the image of DH and consumer satisfaction	
Increased usage of waste heat or ambient heat sources (e.g. with heat pumps)	
Creating sector coupling projects (with the electricity sector)	
Modernization and energy efficiency replacement of existing old, outdated district heating supply lines	

3.4.3. Technology suppliers and contractors

The most important DHC issues, according to Technology suppliers and contractors, are shown in the following table.

Table 5 The most important DHC issues according to Technology suppliers and contractors in Hungary

Challenges	Suppliers[20]
Utilising EU funding for energy efficiency projects in DH	X
Utilising EU funding for projects aimed at integrating renewable energy sources into DH	X
Installing digital technologies to decrease heat losses and operational costs of DH networks	X
Installing or improving consumption heat metering of buildings supplied with DH / Billing consumers based on the actual metered heat consumption of their building	X
Assisting consumers in improved heat regulation and control, (building) heat cost allocation	X
Assisting consumers in other building energy efficiency measures (other than heat regulation, control and building heat cost allocation to apartments)	X
Starting or enhancing the usage of (deep or shallow) geothermal energy	X
Advocating for more favourable regulations, and financing conditions on the national level	
Preventing DH consumers from leaving DH and using other types of heating	(x)
Improving the image of DH and consumer satisfaction	
Increased usage of waste heat or ambient heat sources (e.g. with heat pumps)	X
Creating sector coupling projects (with the electricity sector)	X
Modernization and energy efficiency replacement of existing old, outdated district heating supply lines	

[20] *Technology suppliers and contractors*

3.4.4. Financiers and investors

The Financiers and investors have responded in limited scope. Answers came from private bodies primarily interested in financing energy efficiency projects.

The DHC sector is primarily financed by frequently changing state subsidies of various natures, which limits financing possibilities for private investments. These can mainly concern DH service consumers who want to lower their bills. Opportunities are much smaller in the residential sector for multiple reasons, one being heavily subsidised energy prices.

Due to the nature of DHC companies' financing and operation, the dominant role of subsidy and price decisions made by central authorities and other factors, private funding for DHC production and distribution has been primarily available only for outsourced heat generation capacity development. Therefore, a large share of Hungarian DHC providers purchase a large share of the heat used from external heat providers, which are often project companies created to realise the given development. These have long-term heat offtake agreements with the DHC providers. Over 75% of the heat used by the largest DHC companies in Hungary, representing about two-thirds of residential clients (seven DHC firms with over 20,000 residential clients individually), is purchased from third parties.

Further geothermal heat production plans, strongly supported by the Hungarian government, are also likely to be developed similarly by third parties.

3.4.5. Consumers and media

Based on various DHC service providers' satisfaction measurement data, DH users are satisfied with the quality of the DH supply, while the number of users connected to the DH system is increasing yearly. Possible unfounded preconceptions against DH, such as that it's expensive and not controllable, can be observed primarily among consumers who do not use DH.

Every year, the Hungarian Energy and Utilities Regulatory Office prepares a User Satisfaction Survey (hereinafter: FEF) in the DH sector based on data from users who are highly satisfied with the actors in the DH sector.

The maximum value of the FEF-Index based on the user's answers to the selected questions can be 1,000 points. The level of satisfaction experienced in the sector continued to rise compared to the high level of previous years; based on customers' opinions, the service providers performed well in the surveys. The scores showed few differences compared to the average; all service providers in the survey graduated with results above 850 points.

In the national survey, the DH and hot water service quality had to be evaluated on a scale of 1-10. Based on this, the following results were summarised. Satisfaction with the continuity of the service (based on the last 12 months) received an average value of 9.0. The importance of the service provider properly informing about the interruption of the DH service due to pre-planned maintenance work to be carried out outside the heating period received an average value of 9.0.

Satisfaction with the length of planned regular maintenance works shows an average value of 8.9. The importance of the frequency of measurements and readings was also highly rated. The average value of satisfaction with the scanning staff's work and punctuality was 8.9 among those who answered the question. The adequacy of the correction accounting was given an average value of 9.1 in the entire sample. The interviewees rated the importance of information on the fee calculation method at an average of 8.8. The satisfaction average for information on the price and consumption of district heat is 8.4. Customers consider it most important that information on energy-saving options can be found on the website.

Among those who had an administrative relationship with the service provider, 49% started managing it personally, and another 45% made contact via phone. Reaching the chosen method was not difficult for the majority, 71%, for another 9%, it caused no difficulty, and for 20%, it only caused problems.

Usually, those who contact customer service get a satisfactory answer or solution. In addition to telephone and personal administration, online or email communication is becoming increasingly popular.

On average, the respondents rated the service providers as 7.9, indicating how well the fee paid for the DH service corresponds to the service received. Regarding the transparency and straightforward interpretation of the invoices, the satisfaction average was 8.1 at the national level. The importance of the DH provider being 'green' was 8.6 on average at the national level.

Every service provider uses a customer assessment system to develop their services and to collect information. Consumers consider DHC cost and the clarity and quick transparency resulting from the billing process important. It should be noted that for residential users and separately managed public institutions, the rates for the DH service are determined centrally by the government.

The best way to improve the perception of DH in the general public is if existing users are satisfied and share their good experiences. It is also essential for service providers to have an open, informative and friendly attitude not only among their customers but also in their wider social environment.

3.5. Republic of Serbia

In total, 25 stakeholders took part in the survey. Out of this number, eight stakeholders were representatives of DH companies (Heat producers and utilities), and eight were representatives from category Authorities and regulators. These two categories had the most responses, while the rest were present in smaller numbers: three Technology suppliers and contractors respondents, two Financiers and investors respondents, and four Consumers and media respondents.

Considering the common structure of questionnaires for the first three categories (Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors), it is interesting to compare their opinions and interests in different technical fields concerning financing, communications, and strategy issues. The average values of responses for each of the categories are presented in Figure 23.

In general, there is no significant difference in answers between categories. The most remarkable differences are in 'Start or enhance the usage of waste heat or ambient heat sources' and 'Increase heat storage capacities'. The importance of these topics for the representatives of DH companies is significantly lower than the other two categories. The decrease in heat losses in production and distribution is the most relevant for the Authorities and regulators and, to a lesser extent, for Heat producers and utilities. The significance for the Technology suppliers and contractors is even lower. Digitalization for reducing losses and operational costs in DH, installing heat meters, assisting consumers in improving energy efficiency, and introducing control systems are recognized by all categories as relevant and essential topics with a similar level of importance. Geothermal energy is more applicable to technology suppliers and contractors, while multisector coupling projects are seen as the least significant for representatives of DH companies.

Concerning financing issues, Heat producers and utilities are the most interested in using EU funding for energy efficiency improvement and the introduction of RES. Also, this category is the most interested in engaging consumers in energy-saving activities and preventing them from leaving DH. Billing consumers based on the actual metered heat consumption of their building is the absolute priority in all three categories. Improving the image of DH and consumer satisfaction has the same significance, except for the Authorities and regulators. Advocating for better financing and regulation at the national level is recognised in all categories.

Concerning the opportunity to talk to and learn through the REHEATEAST and cooperation in EU projects, the preferences of heat producers and utilities correlate with their general interest in the selected topic. The higher relevance of the topic for the DH company means that they are more ready to cooperate in relevant EU projects. Additionally, in the previously evaluated topics as less relevant, probably due to less knowledge (thermal storage, geothermal energy, waste heat, coupling with the electricity sector, improving the image of DH), this interest is more emphasised.

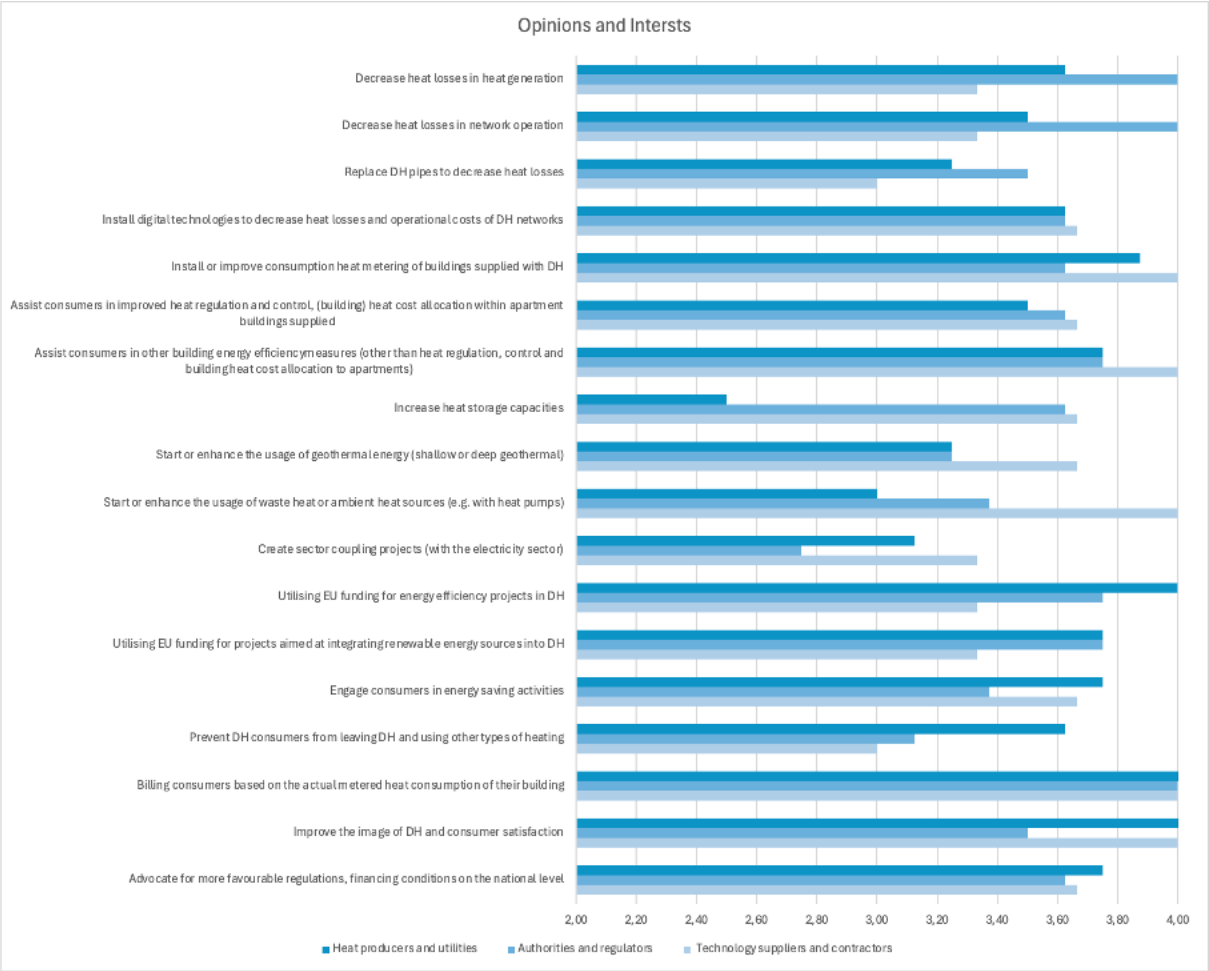

Figure 23 Comparative analysis of interests and opinions among Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors in Serbia

Representatives of Authorities and regulators emphasised that questions related to financing, communications, and strategy issues are of great importance, and they expressed openness to any knowledge exchange and cooperation aimed at improving the sector. In the technical field, there are differences in interests between different companies. Still, this category marks some technical issues as irrelevant or unimportant in a few cases.

Three representatives of Technology suppliers and contractors showed interest in cooperating with REHEATEAST, one of which indicated interest in utilising waste and ambient heat and sector coupling. In contrast, the two others showed interest in almost all technical issues. Financing, communications, and strategy issues are also recognised as possible fields for cooperation.

3.5.1. Heat producers and utilities

There were eight respondents in the category of Heat producers and utilities. The structure of responses considering several DH clients is presented in Figure 24 and relatively correctly represents the distribution of DH systems in Serbia in terms of their size. Just three of the selected DHs use RES; waste heat is not used in any of them, while the one DH system uses heat (<25%) purchased from third parties. Russian natural gas is the dominant (>95%) energy source in six DH systems. Heavy fuel oil is used in two systems in smaller amounts, mostly to cover peak demand. One small DH system (2.24 MW_{th}) uses geothermal energy (deep borehole), and one (7 MW_{th}) uses biomass. The structure of the energy mix causes significant greenhouse gas (hereinafter: GHG) emissions. It amounts from 450 tonnes for the smallest system to over 50 thousand tonnes for the most important system based on fossil fuels (natural gas and heavy fuel oil).

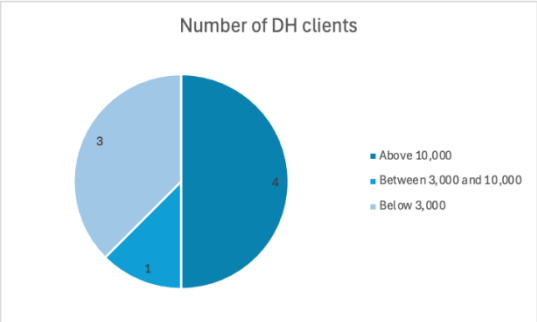

Figure 24 Number of DH clients per DH system in Serbia (in survey sample)

On the consumption side, most of DH clients are in the residential sector (approximately 70%). Just in one case, 100% of clients are municipal institutions. Hot water is produced in three DH systems (in one using RES) but for a limited number of clients. In all DH systems, heat consumption at the building level is measured. Consumption-based billing is used in five systems. In general, the average energy rating/status of district-heated buildings is D or E. The new buildings are in range from A to C.

Ongoing and planned initiatives to reduce heat losses and improve system efficiency are different and specific for every DH company. Heat source (boilers) replacement is planned for only one DH company, while the other plans introduce a flue gas heat recovery system. Replacement and maintenance of old parts of the DH network is an activity that is conducted and planned in most of the analysed DH systems, together with the introduction of central monitoring and control systems and the modernisation of substations. On the consumption side, rehabilitation of district-heated buildings is an ongoing activity in most cities due to the Ministry of Mining and Energy's ongoing program.

Heat consumption is measured at the substation level in all systems. There are procedures for ensuring the accuracy of heat measurements proposed by national technical regulations, and companies follow them. Primarily, using calorimeters and their regular calibration are the standard practice. Transparency was evaluated as satisfactory for systems with consumption-based billing systems in place.

Digital technologies are employed to varying degrees for monitoring, optimising and controlling DH systems. Most systems have implemented or are in the process of implementing SCADA for centralised monitoring and control, at least at the level of heat production.

Perceptions of DH among existing consumers, the general public, and policy creators based on the responses from Heat producers and utilities are presented in Figure 25. It is obvious that according to this pool, consumers, the public, and policy creators have positive and very positive opinions as the prevailing, especially for the existing consumers. Positive perceptions are connected with reliable heating systems that operate without interruptions in heat delivery. Although there were no suggested negative perceptions, one response emphasised that the negative perception may be related to the price of heat energy and the poor financial situation of the consumers.

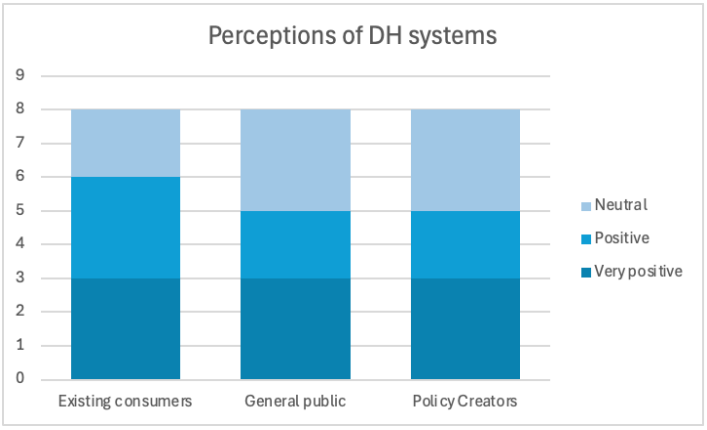

Figure 25 Assessment of perceptions of different groups on DH based on responses from Heat producers and utilities in Serbia

Respondents mostly believe that there is sufficient knowledge and capacity for the successful development of DH. Improvement of energy efficiency, enhanced digitalisation, and increased use of RES are the priority orders of anticipated activities within selected DH systems for their advancements. Expected fundamental changes to improve existing DH systems are seen in the financial field.

Based on responses from Heat producers and utilities, the most significant expected challenges for DH in Serbia are presented in Figure 26. The most important challenges are transitioning from fossil fuels to renewable sources, attracting new consumers, extending the DH network, ensuring consumer loyalty, and changing technologies. The persuasion of policymakers and the contribution to European energy policy targets are also recognised as important issues.

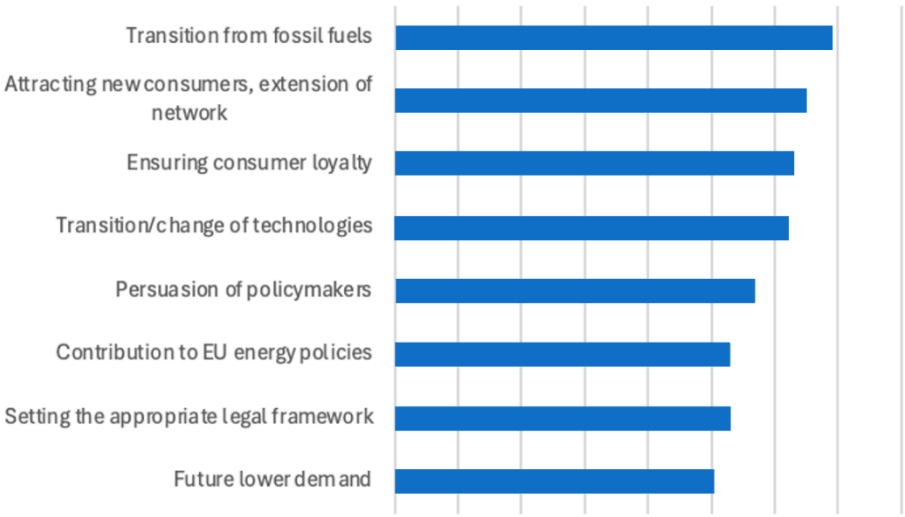

Figure 26 Biggest expected challenges for DH in Serbia based on responses from Heat producers and utilities

Geothermal energy is recognised as the most suitable RES for use in Serbia. Other sources mentioned include biomass, waste heat, and solar energy. Heat pumps are recognised as a critical technology for utilising most of these RES. The choice of energy sources largely depends on local availability and previous use experiences.

Five of the selected respondents envisage an increase in heat sales from 5 to 10% (in one case, even 80%), while the rest, due to climate change and global warming, envisage a decline in heat consumption from 5% to 20%. All respondents expect increased reliance on RES. The expected RES share in the energy mix is at least 30%. Significant improvements in energy efficiency on the consumption side are anticipated, with operating temperatures expected to drop, in some cases, to as low as 75°C/30°C.

In addition to financial issues, which are seen as the most significant barriers to adopting new technologies in the DH sector, the lack of network connectivity and equipment standardisation are also essential factors for DH sector development. As a significant segment of strategies for adapting the DH infrastructure to accommodate forthcoming technological advancements, the management on the consumption side is recognised. Respondents did not propose additional regulatory or legislative support to accommodate the future expansion of the DHC sector or additional incentive mechanisms for DH companies.

Several successful DH initiatives were shared, highlighting best practices in the sector. Examples include the introduction of biomass in a few DH systems, positive experience in geothermal energy use in one system is emphasised, with plans for expanding this project. In addition, the project of building rehabilitation through the EBRD program was presented.

3.5.2. Authorities and regulators

Eight responses were received in this category. According to Serbian Energy Law, DH systems are the responsibility of local self-governments (hereinafter: LSG); six respondents are representatives of local authorities, while the other two are institutions at the national level.

The respondents agree that there are no specific policies or incentives to promote the expansion or improvement of DH. The Energy Law allows LSGs to introduce some mechanisms for promoting RES utilisation in DH systems, but there were no examples in which LSGs introduced specific incentives. There is a practice in some LSGs for connecting to the DH network without reimbursement of justified costs. However, the respondents believe this mechanism is entirely wrong and contrary to regulatory practices because it disrupts the financial structure of the DH company itself. In addition, respondents noticed some incentives financed by EBRD grants.

Regarding regulatory challenges, some respondents suggested that a special law on district energy is necessary. In addition, there were suggestions that LSGs should introduce the obligation for investors to connect new buildings that need heating and are located close to the existing DH network.

Authorities and regulators recommend making technical upgrades, which involve replacing obsolete and ineffective equipment in the production and distribution system. They also suggest organisational restructuring and financial investments, as DH companies have low current assets. In addition, it is crucial to adhere to the deadlines outlined in the Methodology for determining the price of heat energy supplied to the end customer to sustain these systems.

Technological advancements expected to impact the sector include demand-side response, utilisation of waste heat from industry and services (directly or with heat pumps), large thermal storages, solar energy, digitalisation, and introduction of modern control solutions. The most widely recognised for its potential is geothermal energy. Heat pumps are a critical technology for utilising low-temperature energy sources.

Assessment of perceptions of different groups on DH based on responses from Authorities and regulators in Serbia is presented in Figure 27. In the opinion of Authorities and regulators who filled out the survey, existing consumers hold only positive or negative views of DH. In their opinion, positive views prevail. In the general public, positive views prevail even more, while the authorities and regulators in Serbia think that policy creators mostly have positive attitudes concerning DH systems.

Respondents find that the media has the most significant influence on the public's negative perception. Still, the high price of DH service, lack of transparency in billing, and the inexistence of measurement-based billing have a significant impact. In addition, problems were seen in complex connecting procedures and terminating the contract. Supply security, comfort, and system stability are the main reasons for positive attitudes.

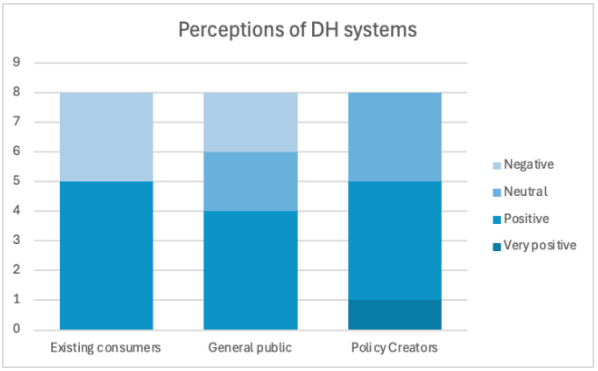

Figure 27 Assessment of perceptions of different groups on DH based on responses from Authorities and regulators in Serbia

According to Authorities and regulators, the greatest challenge for DH in Serbia is the persuasion of policymakers. The following challenges with the same significance are the transition from fossil fuels, setting the appropriate legal framework, and ensuring consumer loyalty. Future lower demand, attracting new consumers, and network extension are ranked lower. At the same time, the contribution to EU energy policies and transition/change of technologies are evaluated as the most negligible influences.

Respondents predict an increase in renewable energy integration, improvements in efficiency, and significant modernisation efforts. By 2030, it is expected that all production systems that use fuel oil and coal will be shut down or converted to RES, and the use of RES will increase from the current 2.5% to 7-15% and further to 25% by 2040, and 40% until 2050. A significant decline in heat sales is not expected, as the amount of produced heat will be distributed to newly connected customers and a reduction in specific consumption by existing customers. Lowering the starting and return temperatures in heating systems is anticipated.

As examples of good practice at the local and/or regional level respondents appointed the DH system in Šabac (ESCO in building renovation), DH in Novi Sad (all characteristics of EU DH systems except consumption-based billing), Bogatić (geothermal energy use), CHPs in Novi Sad and Belgrade (Voždovac), waste incineration plant in Vinča, biomass plants in Priboj, Nova Varoš Novi Pazar, etc.

3.5.3. Technology suppliers and contractors

There were three responses from Technology suppliers and contractors. As the main ongoing or planned technological innovations in the Serbian DH sector, they recognize activities aimed at increasing efficiency and reducing negative environmental and climate consequences – reducing emissions of GHGs, NO_x, polluting particles, etc. However, they noticed slow realization and significant lag in terms of innovation if compared to examples across the EU. The lack of human

capacities in DH companies is recognized as a critical barrier to adopting new DH sector technologies.

Concerning digital technologies in DHs, optimal control of the combustion process in heating plants, monitoring and managing the heat consumption, as well as tracking of parameters of production and distribution installations to react effectively in the event of operational problems are seen as primary areas for their implementation.

Respondents found that in the field of DH, the strategic framework in Serbia has not been adequately developed. Few DH companies focus on technological solutions and infrastructure adaptation in their strategic documents. Even rarer are LSGs that correctly take a strategic view of this aspect. At the national level, DH systems are considered through the Energy Development Strategy, although they do not cover technological progress and infrastructure adaptation to a significant extent.

The common conclusion is that Serbia's research and development initiatives focused on advancing DH technologies are relatively modest. As emerging technologies anticipated to have the most significant impact on the DH sector, respondents stated district cooling and low-temperature heating (which enables the easiest integration of different types of renewable and waste energy) combined with heat pumps.

Too complex procedures for obtaining permits for the construction of the DH network, no regulatory framework for the production, distribution, and supply of cooling energy, and governing the status of buyer-producer for heat are recognised as the primary regulatory barriers or challenges hindering the development of DH infrastructure.

Besides the necessary technical, organisational, and financial fundamental changes, respondents emphasised the need to educate employees in DH companies to overcome inertia in operation. The main activities in this process are the application of highly efficient and environmentally friendly technologies, better systematisation of jobs in the DH companies, and financial investments in technical, technological, and especially human resources.

Respondents are aware of the necessity for significant improvement of regulatory and legislative frameworks to accommodate the future expansion of the DHC sector. Firstly, heat should be processed more significantly according to the Law on Energy. Heat and DH are marginalised in the umbrella law dedicated to energy, and heat distribution is unfairly separated from energy and classified as a utility activity. Therefore, it is necessary to separate the energy activities within the DH system, foresee clear procedures for expanding the market by including new entities, predict the development of the cooling energy market, and specify the actors' roles in the market at the consumer level.

As additional incentive mechanisms for DHC, respondents recognised the connection to the DH system free of charge, lower utility taxes for users of highly efficient DH systems, unique benefits for consumers who use heat from the DH systems for preparation of domestic hot water, lower VAT rate for costs of DH, and subsidisation of producers and consumers of RES energy.

The perceptions of different groups based on the answers from Technology suppliers and contractors are shown in Figure 28. The reasons for negative perception were mainly due to the

price of heating, which does not correspond to the user's ability to pay. They are obliged to cover the costs, unlike other types of heating, in which case they can choose to heat insufficiently or use cheaper heating methods (firewood from their forest or purchased from illegal sources). As a solution for a better image, respondents suggested switching to consumption-based billing and then taking measures to reduce costs on both the production and consumption side. In addition, they emphasised that for positive perception, exchanging information on examples of good practice is very important, and the DH sector could contribute significantly to decarbonisation and reduction of local pollution.

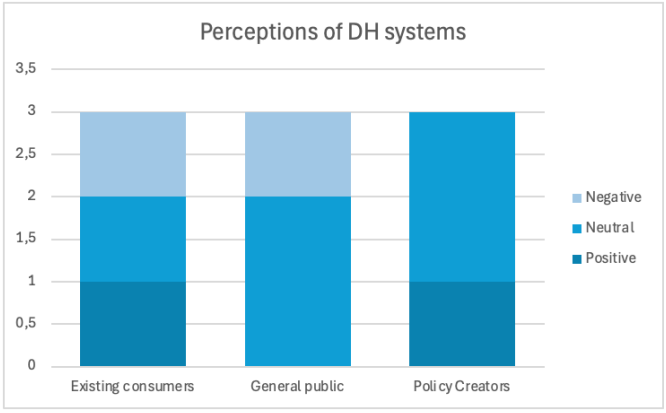

Figure 28 Assessment of perceptions of different groups on DH based on responses from Technology suppliers and contractors in Serbia

The most significant challenges to DH development in Serbia are future lower demand, transitioning from fossil fuels, setting the appropriate legal framework, attracting new consumers, and network extension. The impacts of policymakers' persuasion and the transition/change of technologies are evaluated as moderate. In contrast, the lowest impact is given to ensuring consumer loyalty and contribution to EU energy policies.

Geothermal energy, biomass, and waste are recognised as the most appropriate renewable fuels for DH supply.

Considering the development of DH systems in Serbia until 2030 and 2050, the increase of heat sales from DH combined with a larger share of renewables is anticipated, together with the lower water temperature in the DH network.

When collaborating with industry partners, research institutions, and other stakeholders to drive technical innovation, Technology suppliers and contractors mainly consider universities and joint research and development projects.

Respondents appointed the 'Majakovski kompleks' in Nis, the ESCO project for biomass utilisation in Pirot, initiatives for shutting down boiler rooms using heavy fuel oil and coal in several Serbian cities, etc., as examples of good practice at the local and/or regional level (realised or planned).

3.5.4. Financiers and investors

The Financiers and investors have responded in limited scope. Answers came from international banks and organisations responsible for financing plenty of energy-related projects in Serbia, including projects related to DH systems.

Both respondents confirmed interest in their institution in the DHC sector as a financial market and the area where significant GHG reduction can be achieved.

DH companies' operations are financed mainly through their funds, while investments are financed from their funds, loans, donations, etc. Surveyed institutions are interested in financing public and private investments to raise energy efficiency, increase the share of renewable sources and waste heat, introduce consumption-based billing, improve management in DHC, etc. Financing instruments are different depending on the institution. Unlike international banks, international institutions finance DH system projects by allocating a portion of grants only with the mandatory participation of a public company.

Projects acceptable for financing should apply innovative solutions (technical and technological solutions, digitalization, new business model), contribute to reducing GHG emissions, and simultaneously positively impact the environment, society, and local economy. Projects that comply with the Paris Agreement, EU Taxonomy, and local legislation and fall under the above investment types are eligible for consideration. The size of individual projects (in the bank case) is usually over 10 million euros, but projects can be grouped.

Concerning securities or collateral, for all projects financed by the bank, the bank's conditions stated above must be fulfilled, as well as other conditions related to the assessment of the impact on the environment and social issues, the risks of adaptation to climate change, compliance with the Paris Agreement, etc. International institution projects must have secured co-financing with at least 70% of the investment value, which can be own funds, loans, etc.

Respondents did not emphasize any specific regulatory barriers or challenges hindering the development of DH infrastructure. Still, they outlined the necessity of strictly respecting current legislation, including introducing consumption-based billing.

Fundamental financial investments needed to improve existing DH systems include (besides previously mentioned) digitization of the system (SCADA system or similar), replacing fossil fuels with renewable sources and implementing appropriate equipment and technology.

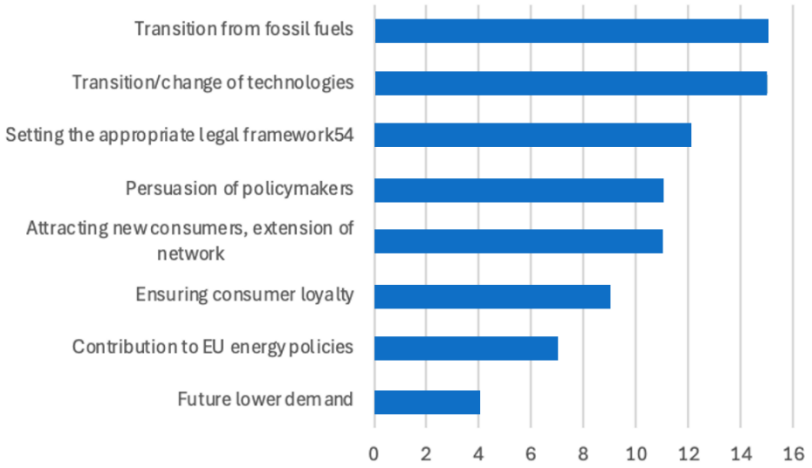

Figure 29 the biggest expected challenges for DH in Serbia based on responses from Financiers and investors

Concerning regulatory or legislative support to accommodate the future expansion of the DHC sector, the bank plans to work on unification to improve the process of connecting consumers to DH. In addition, respondents outlined the necessity of correcting the heat prices to follow actual costs.

The most significant identified challenges stated by responders are listed in Figure 29.

As examples of good practice at the local and/or regional level (realized or planned) respondents appointed their projects (realized or planned): introduction of renewable sources in DH systems (Bečej, Bogatić, Kragujevac, Kraljevo, Kruševac, Niš, Novi Pazar, Pančevo, Paraćin, Vršac, Osečina, etc.), energy rehabilitation of multi-family buildings connected to the DH systems, seasonal heat storage with solar thermal (Novi Sad), shutting down boiler plants in seven LSGs, introduction of SCADA system in Šabac DH, introduction of ESCO model in Šabac DH, etc.

3.5.5. Consumers and media

In the category of Consumers and media, representatives of four organisations responded to the survey. Two represented consumer protection organisations, while two represented respectable media companies in the sectors of interest. It is partially reflected in the responses.

Both subgroups, consumers and media, are highly motivated to learn more about DHC systems and ongoing initiatives and refurbishments, as all four survey participants confirmed that they want to learn more about DHC and new information about current initiatives and renovations of the DHC systems.

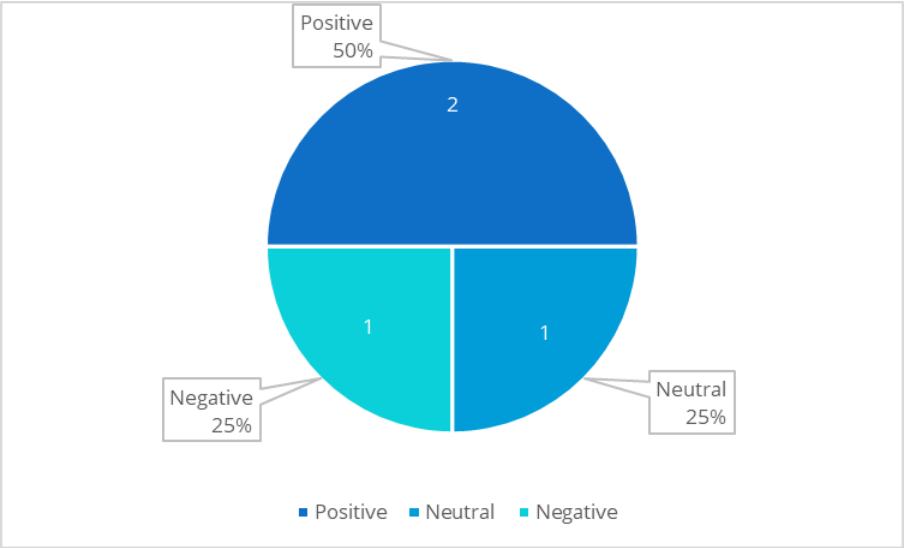

Figure 30 Consumer perceptions of DH in Serbia

All participants believe that additional incentive mechanisms are necessary. Their opinions on the form of these mechanisms differ. Still, the bottom line is that they think incentives in the field of energy efficiency are the most favourable with various forms of it.

Figure 30 shows that 50% of participants rate the perception of DH consumers as positive, while 25% rate it as neutral or negative. On the other hand, it must be noted that positive responses are coming from the representatives of the media. At the same time, neutral and negative marks are received from the representatives of consumer protection organisations.

Several key factors contributing to the negative satisfaction with the DH service would be the high prices of the service and the obligation to pay for the service during summer months when the heating is off; a monopolistic position of the DH company, which results in poor quality service; problems with individualisation of the heating costs; misuse of the fixed part of the price with calculations of the unjustified costs of the DH company; unacceptable billing of the 'indirect heating' – heating from the neighbouring apartments.

From the point of view of the reasons for positive perception of DH, survey participants have identified that consumers are much more satisfied when cost-based billing is fully implemented, that DH systems are reliable and accessible and that DH systems are much more convenient for implementing energy efficiency measures.

From the perspective of direct use of DH services, survey participants emphasised the negative experience with the companies engaged in the consumption cost allocation and their way of implementing the local regulations regarding the distribution of the costs between the apartment owners in one building. They are raising the question of the appropriate level of investments necessary for providing quality service while underlining the necessity of transitioning to cost-based billing.

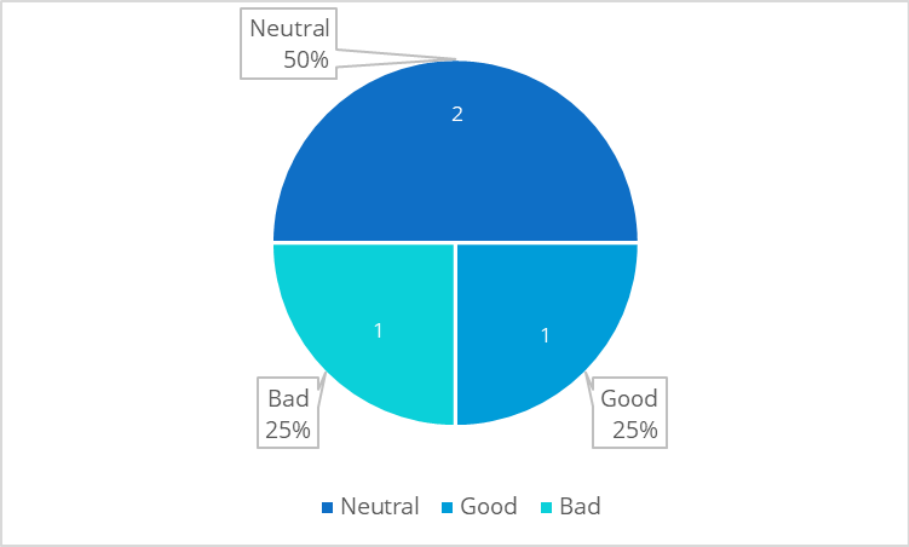

Figure 31 Consumer perceptions of accessibility and transparency of information from DH service providers in Serbia

Most of the consumers did not experience service disruption and interruption of the supply, while those who had expressed that those situations were handled regularly and resolved in reasonable time.

The prevailing perception of accessibility and information transparency is neutral since this is how half of the participants responded that way, while 25% responded with good and bad (Figure 31).

The participants who have a bad perception of accessibility and transparency feel that the perception might improve when DH companies avoid the presentation of misleading information regarding the legal framework. At the same time, they think that DH companies have to comply with the findings and recommendations of the State Audit Institution, and by doing so, their accessibility and transparency would improve.

All of the participants feel that it is very or highly important that DHC systems use RES for their operations in energy production, and one of the benefits of that is that they would create a much better environmental impact.

Consumers highlighted some of the good examples connected to DH systems. The experience of the City of Vienna was mentioned as a very good example, and it is easy to follow the results on their webpage. From the Serbian experiences, the project of using the waste heat from the Kragujevac data centre was mentioned as the one to look up to.

3.6. Romania

The report on the survey data for Romania offers an overview of the current and future perspectives of DHC systems. It covers several topics, including heat production and sales volume, the potential of RES to contribute to the decarbonisation of DH systems in Romania, perceived challenges, and anticipated advancements in DH systems. The survey also offers insight into how stakeholders perceive DH systems, and it highlights ongoing and planned technological innovations in this sector, along with strategies for optimising the operation of DH systems and overcoming barriers.

The study identifies several key challenges, including regulatory barriers, funding gaps, and infrastructure limitations. It also provides an insight into the DH system's financial landscape, aiming to encourage potential investors.

Figure 32 ranks, in order of importance (1 is the higher importance), the biggest challenges facing the DH systems sector in Romania. The most significant challenge these systems face is transitioning away from fossil fuels, while the least concerning is the persuasion of policymakers.

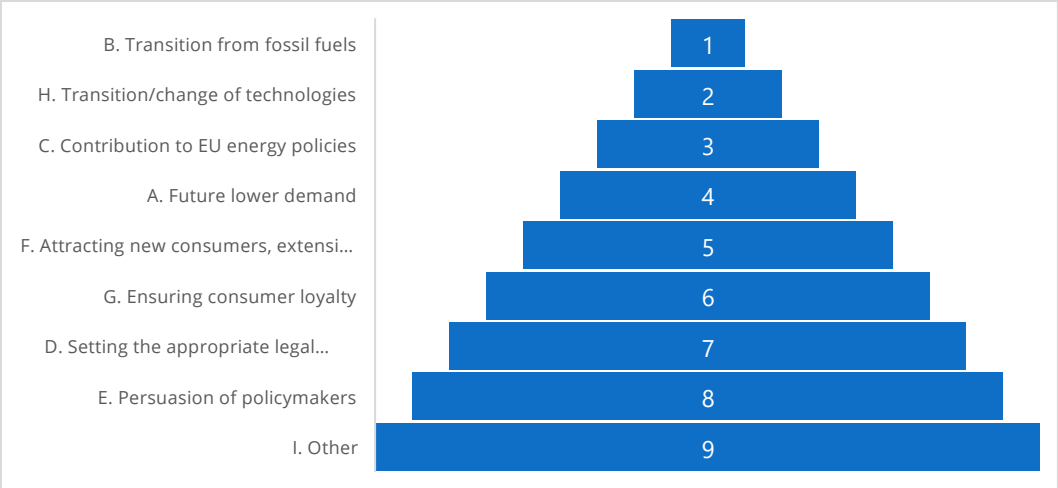

Figure 32 The biggest challenges for the DH sector in Romania

Figure 33 offers insight into the perceptions of those responsible for creating policy, the general public, and existing consumers towards DH systems. This representation employs a scale ranging from 'very negative' to 'very positive' to facilitate a comparison of the perceptions held by each group. Existing consumers have the most positive perception of DH systems, as evidenced by their scores being concentrated at the highest positive end of the scale.

A neutral position suggests that the stakeholder is not yet convinced either way or has insufficient information to form a concrete opinion about DH systems.

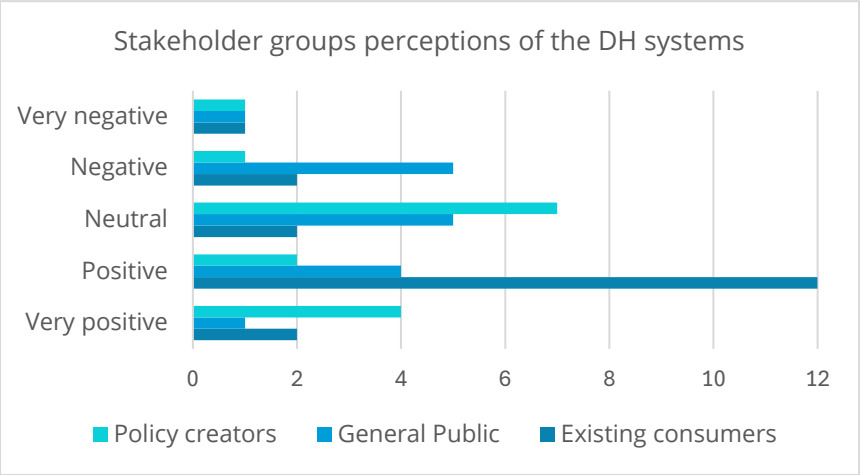

Figure 33 Stakeholder groups perceptions of the DH systems in Romania

3.6.1. Heat producers and utilities

There were five respondents in the Heat producers and utilities category from Romania. All of them rated the following six topics (from Part 1 of the questionnaire) as very important from a technical, funding, and strategic perspective:

- Installing or improving heat metering in centrally supplied buildings
- Using EU funds for energy efficiency projects in the DH sector
- Preventing disconnection of existing customers
- Billing consumers according to the actual heat consumption of their building
- Improving the image of DH and consumer satisfaction
- Support for more favourable regulations and national funding conditions

The fact that five out of six themes are related to financing and strategy, including customer relations, shows the focus on a consumer-centric strategy, but also the strategic focus on financial support for energy efficiency, aiming at sustainability and energy waste in the DH sector.

Considering the opportunities for dialogue with stakeholders, all respondents agreed that EU funds for energy efficiency projects should be the top priority. It highlights the crucial need for cooperation within the project framework and identifies the right stakeholders, such as fund operators, investment banks, and government agencies.

At least 80% of the respondents considered other topics concerning stakeholders necessary, including installing digital technologies to reduce heat losses and operational costs of DH, the efficient usage of waste or ambient heat, and support for more favourable regulations and national funding conditions. Once again, the need for stakeholders from the financial sector is highlighted, along with the need for suitable technology providers to fulfil the technical requirements.

Figure 34 illustrates the number of clients connected to the DH system for each heat supplier. One provider has a notably large client base, with over 10,000 clients. Two providers operate in a mid-range category, serving between 3,000 and 10,000 clients. The remaining two providers have fewer than 3,000 clients each.

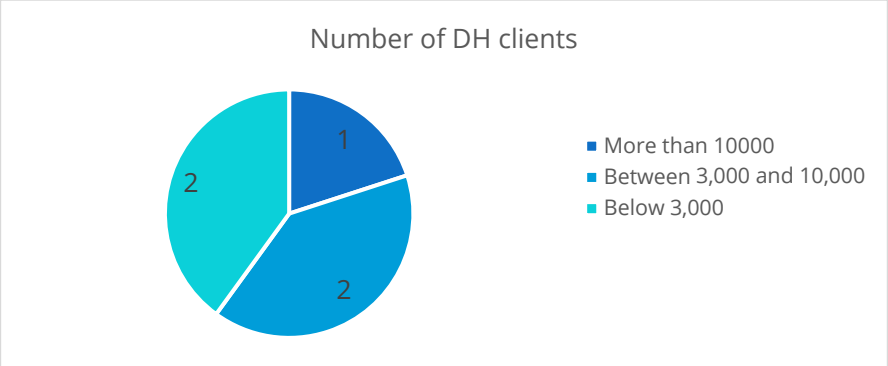

Figure 34 Number of DH clients

The table below summarises the critical data related to heat profiles for 2023 from each DH provider. It includes information on necessary items, including heat sales volumes, the proportion of RES in the primary energy mix, heat sales during the heating season, installed capacities, and energy purchased from third parties.

Table 6 Heat profiles of energy producers in Romania

General data for 2023	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5
Total heat supply in 2023 [GWh]	>500	50-100	50-100	0-50	0-50
Share of RES in the primary energy mix	5%	100%	0%	4%	0%
Heat sales in the heating season [GWh]					
Residential	80%	99%	69%	64%	34%
Municipal institutions	9%	0%	23%	36%	66%
Other non-residential	11%	1%	8%	1%	1%
Total installed DH generation capacity (MW_{th})	500-1,000	N/A	50-100	50-100	50-100
Carbon footprint (CO_2 equivalent) [tCO_2/year]	100,000-150,000	-	20,000-50,000	5,000-10,000	5,000-10,000

General data for 2023	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5
Annual number of supply outages	>100	<10	50-100	1-50	<10
Share of heat purchased from third parties	<25%	0%	>75%	25-75%	0%

One respondent reported sales of over 500 GWh per year, suggesting a large coverage area and customer base, while two others reported sales of between 50 and 100 GWh per year. In addition, two respondents reported sales of less than 50 GWh per year.

Of these, one of the DH operators relies exclusively on geothermal energy, demonstrating a renewable energy share of 100%.

Three of the five respondents indicated they rely on third-party heat purchases.

Two respondents in this stakeholder category estimated their carbon footprint to fall between 5,000 and 10,000 tonnes of CO_2 annually. One respondent reported a footprint ranging from 10,000 to 20,000 tonnes of CO_2 per year, while another respondent exhibited higher carbon footprints, exceeding 100,000 tonnes of CO_2 per year.

The data on sales during the heating season, broken down by client type (residential, municipal institution, other), suggests that the most significant client category is residential (with values ranging from 64% to 90%). However, it is worth noting that for one respondent, the largest category is municipal, accounting for 66%.

Figure 35 identifies and ranks the RES identified through the following stakeholder categories (energy, policymakers, technology, and contractors) as suitable for utilisation in Romania's DHC. This application's most promising renewable sources include heat pumps, biomass, geothermal, solar, and hydro energy.

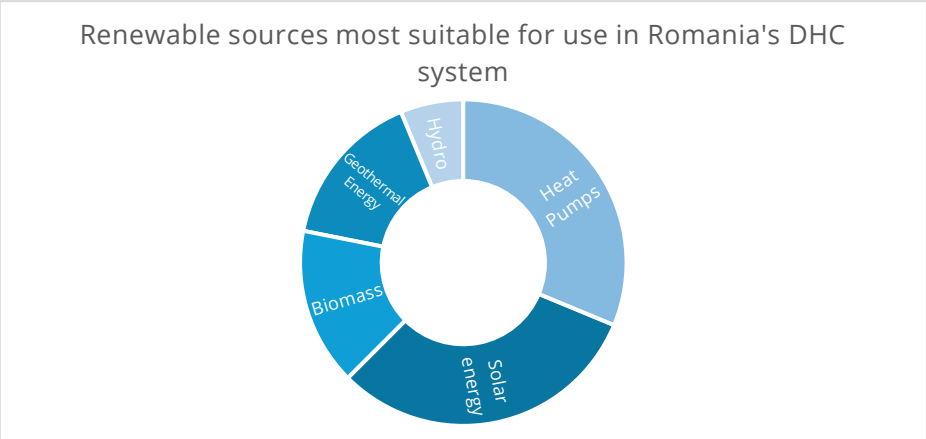

Figure 35 Renewable sources that are most suitable for use in Romania's DHC system

The following table presents an analysis of stakeholder predictions from all groups (except for consumers) on the development of DHC, focusing on the projected consumption growth and the anticipated integration of RES by 2030 and 2050.

DHC consumption is anticipated to increase considerably by 2030 and 2050. There is a visible tendency towards incorporating RES in these systems. The respondents anticipate substantial RES integration by 2050, with 30% to 90% projections.

Table 7 Stakeholder prediction on district heating and cooling development in Romania

Respondent	Development by 2030				Development by 2050			
	Consumption		RES		Consumption		RES	
								
1		5%	10%		10%		20%	
2	-	-	-	-	100%		10%	
3	10%		70%		25%		90%	
4					30%		70%	
5					15%		30%	
6					20%		40%	
7					30%		30%	
8	7%		5%		20%		35%	
9					25%		25%	

The survey of energy stakeholders also identified the specific individual heating solutions that are becoming increasingly popular in Romania compared to DH and the factors that contribute to this attractiveness.

- Affordable natural gas costs, personalised comfort, and adjustable consumption drive individual gas plants.
- In rural areas, wood-burning boilers and terracotta stoves are on the rise due to their cost-effectiveness compared to other fuels and technologies; also, the availability of firewood vouchers for forest owners contributes to their popularity.
- An increasing option involves integrating air-to-water heat pumps with photovoltaic technology.

3.6.2. Authorities and regulators

Considering the responses from decision makers in Romania for Part 1 of the questionnaire, it is concluded from the received responses that both technical and financial strategic aspects are crucial. Vital technical considerations include the installation of digital technologies to reduce heat losses and operational costs, the replacement of DH pipes, the expansion of storage capacities, the utilisation of geothermal energy, the efficient use of waste or ambient heat, and the development of sectoral coupling projects with the electricity sector. Financial, communication,

and strategy aspects are highly important for the respondent decision-makers, as they all considered six out of seven topics enlisted in this category as important. Like the Heat producers and utilities group, maintaining strong consumer relationships is essential. These relationships are pivotal for ensuring customer satisfaction, fostering trust, and encouraging the adoption of new technologies or services. Additionally, securing funding from the European Union is also regarded as critical. EU funding supports innovation, infrastructure development, and sustainability initiatives, enabling companies to enhance their operations and meet regulatory requirements effectively.

Authorities and regulators prioritize several key topics when engaging with potential stakeholders. One of the foremost concerns is increasing storage capacities, which is essential for ensuring energy reliability and meeting peak demand periods. Another significant area of focus is the use or more efficient use of geothermal energy, whether shallow or deep. It aligns with the broader goal of enhancing sustainability and reducing dependence on fossil fuels. Additionally, creating sectoral coupling projects, particularly with the electricity sector, is a high priority. These projects facilitate the integration of different energy systems, promoting overall grid stability and efficiency.

In conclusion, these priorities reflect a comprehensive strategy to advance energy efficiency, sustainability, and resilience. By focusing on these areas, Authorities and regulators seek to foster innovation, optimise resource use, and build a more interconnected and robust energy infrastructure.

Respondents from this category had outlined multiple energy policy initiatives to enhance its DH systems. These include 'The 2021–2030 Integrated National Energy and Climate Plan', 'The Energy Strategy of Romania 2025–2035, with the perspective of 2050' and alignment with EU directives on energy efficiency. Financial support for DH expansion and modernization is crucial to these plans. Romania has allocated substantial funding from various sources, including the National Recovery and Resilience Plan and the Modernization Fund, to achieve its DH goals. These policies and incentives demonstrate a strong commitment from Romanian authorities at national and local levels to leverage DH as a critical component of their energy strategy.

Most respondents, including policymakers, heat producers, financiers and investors, technology suppliers, and contractor groups, believe there is a need for regulatory or legislative support to accommodate the future expansion of the DHC sector. In light of the responses, it may be beneficial to consider including some of these regulations:

- developing local heating system strategies
- modifying, completing, and adapting the technical regulations and norms concerning the design, construction, and operation of central heating systems
- ensuring compliance with EU legislation, leveraging international experience, and adopting best practices in urban heating and cooling
- implementing strict energy efficiency requirements and green construction certification
- promoting RES and supporting intelligent infrastructure

3.6.3. Technology suppliers and contractors

Eight respondents participated in the questioning process regarding Technology suppliers and contractors.

From a technical standpoint (Part 1 of the questionnaire), the results reveal that this category shares identical interests with decision-makers. There is a high level of interest in the previously mentioned topics, such as increasing storage capacities, enhancing the use of geothermal energy, optimising waste or ambient heat usage, and developing sectoral coupling projects with the electricity sector. Additionally, strategic topics of interest for this category include preventing the disconnection of existing customers and improving the image of DH. Enhancing customer satisfaction is also a key focus. Technology suppliers and contractors aim to strengthen their relationships with existing customers and attract new ones by adopting a business-oriented approach.

Some emerging technologies identified in Figure 36 are predicted to have the most considerable influence on the DH sector by stakeholders. Three technologies - heat pumps, hydrogen-based technologies, and cogeneration - hold the most tremendous significance.

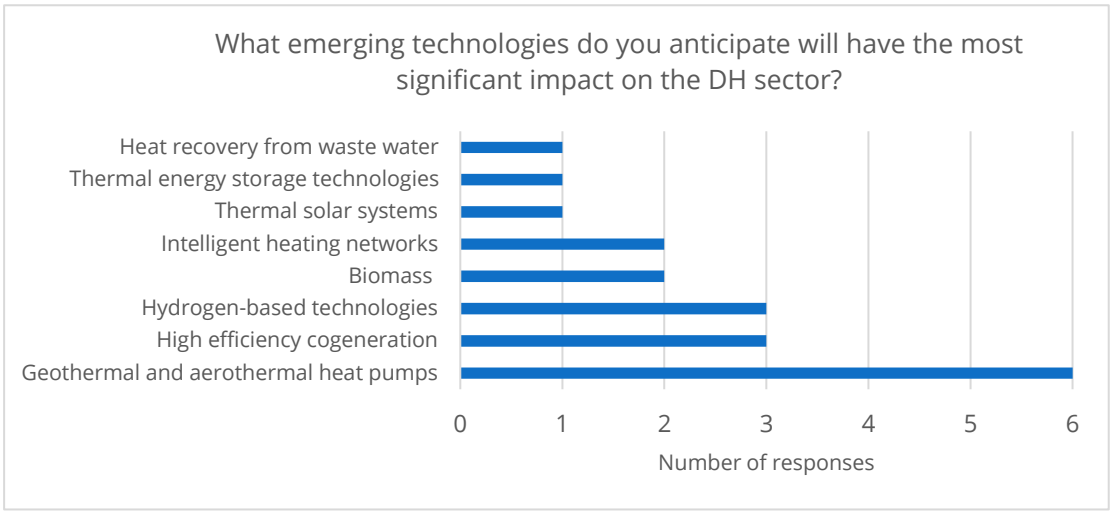

Figure 36 Emerging technologies with the greatest potential impact on the DH sector in Romania

This study also aimed to gain insight into the potential applications of digital technologies within the DH field. Those participating in this category were able to identify several digital technologies that could potentially enhance efficiency and sustainability in DH systems. These technologies should be further investigated:

- Using centralised management platforms (SCADA)
- Monitoring energy consumption in real-time using smart meters
- The use of AI and machine learning to forecast heat demand

The potential obstacles to the uptake of new technologies within the DH sector in Romania were also considered. Some of the main obstacles that were brought to light by our research included:

- High upfront expenses associated with adopting new technologies
- Insufficient subsidies and financing for the adoption of new technologies
- Specialised skills are necessary for implementing and operating new technologies effectively

Feedback from this stakeholder group emphasises the importance of collaboration with industry partners, research institutions, and other stakeholders to foster technical innovation. Below are some of the types of collaboration they mentioned:

- Communication with design companies is crucial for adhering to current legislative and technical requirements in project execution.
- Partnering with up-to-date technology suppliers and manufacturers.
- Staff must keep up to date with new technologies and work practices through continuous professional development (attending industry-led workshops and seminars featuring experts, researchers, and stakeholders.)

3.6.4. Financiers and investors

Three out of five organisations in this category group responded to the questionnaire. The results confirm a strong institutional interest in the DHC sector as a viable financial market (three out of three respondents).

Figure 37 explores what DHC projects are considered eligible for financing. Concerning financial viability, 40% of respondents view new production capacities and infrastructure development as potentially eligible projects for funding.

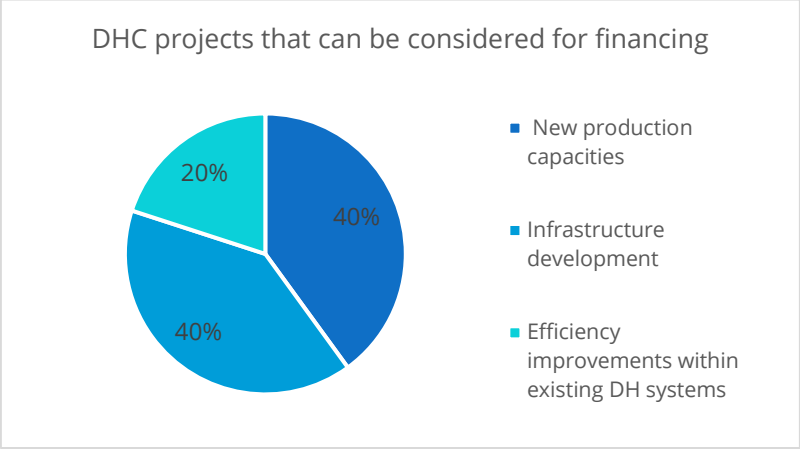

Figure 37 DHC projects that can be considered for financing

In response to the question of 'How are DH systems financed and sustained?', respondents have identified a range of funding methods that can enhance the economic viability of DH systems: municipal budgets (which offer operational and price subsidies), national co-financing initiatives, and EU funding and private investments facilitated through bank financing.

Several financial investments would be needed to improve current DH systems. According to stakeholder responses, these are:

- Infrastructure modernisation
- Solving situations of insolvency and financial distress faced by certain operators
- High-efficiency cogeneration through incentive-based support schemes and shared investment funding
- Thermal energy storage
- The use of digital solutions for monitoring and controlling central heating systems

3.6.5. Consumers and media

There are a total of four respondents categorised as consumers or media representatives. On the one hand, all of them are interested in learning more about DHC and being informed about ongoing DH modernization incentives and projects. The results are shown in Figure 38 as well. The results reflect this category's high need for informational and awareness campaigns.

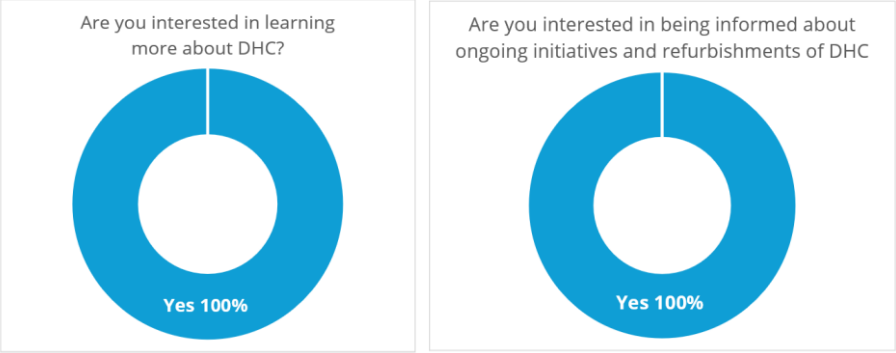

Figure 38 Consumer and media respondents' answers for Romania

The responses indicate a strong agreement among consumer and media representatives on the need for additional mechanisms and incentives for DHC. Most agree that centralised energy consumers and producers should receive financial support, highlighting the environmental benefits of reduced fossil fuel use and pollution. Specifically, state subsidies are suggested as a preferred incentive, with two of the three substantive responses choosing this approach.

The responses to the question 'How do you rate district heating services?' were uniformly positive, indicating a favourable perception of the DH among the respondents. Several factors contribute

to this success. Respondents appreciate not having to invest in or maintain their own heating plants, as this reduces their effort and responsibility. Using heating as an outsourced service removes the hassle of maintaining equipment, making it an easy option for consumers. Additionally, the competitive pricing of DH and renewable energy makes it an attractive and environmentally friendly choice. Effective collaboration and timely service further enhance consumer satisfaction, contributing to the overall positive perception of DH services.

When asked about the main fears or problems with the system, the respondents and users of the DHC services indicated several common concerns, such as being worried about interruptions in heat supply, which can disrupt comfort and daily routines. There's also concern about potential breakdowns and higher future costs for repairs or replacements. Additionally, users express concern regarding the reliability of the heating systems, mainly due to their age, which raises doubts about efficiency and longevity.

Overall, the answers highlight worries about reliability, continuity of service, and potential future expenses associated with DHC systems as perceived by their users.

Figure 39 shows how the respondents rated the accessibility and transparency of the information provided by the DHC service provider as 'good', while one out of four respondents remained neutral, and one respondent rated it as 'poor', and also suggested improving the communication services.

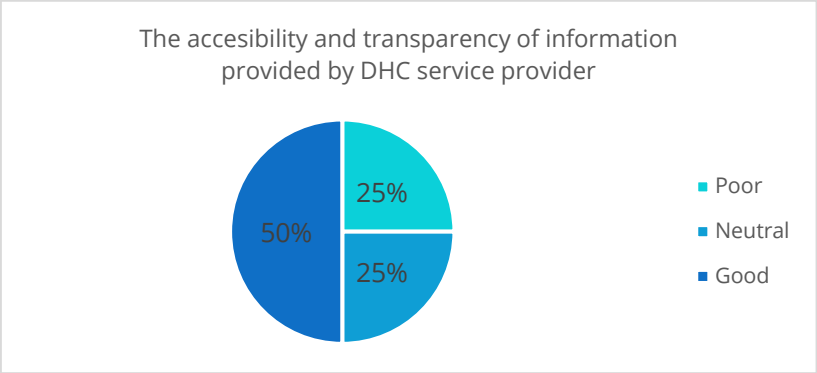

Figure 39 Share of respondents regarding the rate for accessibility and transparency of the information received from the DH or cooling service provider

All respondents consider using RES in DH systems very important. This shows that users already know the need to integrate RES in such systems.

Part 3 or 4 of the questionnaire was designed to identify some examples of good practices in our region. The respondents mentioned a few examples of good practices.

One example of good practice is a city in Romania that is almost 75% heated by geothermal energy; the network extension is planned to complete coverage of the thermal needs of the town.

Another example of good practice is a new DH project with a capacity of about 20 MW, designed and implemented by one of the respondents (a contractor).

3.7. Slovakia

In Slovakia, the Via Carpatia EGTC (hereinafter. Via Carpatia) primarily utilised Google Forms to conduct stakeholder surveys. To better understand the purpose of the survey, we had several informal meetings and telephone calls with the stakeholder representatives to gain better results. In the following subchapters, we will present the insights gained from the answers provided.

According to available information, Slovakia is characterized as a developed DHC system covering more than 53% of the total heat consumption.

Heat production within the DHC is dominated by production in larger heating systems (heating plants with combined production of heat and electricity). Another production is secured in local or district sources with heat distribution systems in the relevant heat circuits (heating plants, central boiler rooms).

From the point of view of the input energy sources from which heat is produced in Slovakia in DHC systems, in general, heat production dominated for a long time from:

A. Natural gas
B. Coal
C. Another traditional source of lesser importance - miscellaneous types of heating oil

In recent years, it has been rising at the expense of fossil fuel use of renewable resources, of which biomass has the most significant share.
However, the rate and possibilities of using fuels for heat production in the Slovak Republic differ by type-specific production equipment - e.g. solid fossils predominate in heating plants fuels, in central boiler rooms and heating systems, from the fuel base in more than 86% is natural gas.

Approximately 340 companies operate stably in Slovakia and are business entities in heat production and supply. In some larger cities where there are manufacturing resources with a considerable capacity, are the production and distribution of heat vertically separated, operated by independent business entities (e.g. Košice, Prievidza, and Bratislava in some of its urban areas). In most smaller towns and villages, however, the production and supply of heat to end customers connected to DH systems is provided by a single entity that owns or operates both production and distribution facilities. It currently exists in the thermal energy market in the Slovak Republic as part of the DH system's several forms of ownership, namely:

A. State ownership
B. Local government ownership
C. Private ownership
D. Mixed ownership

The Slovak Republic's Energy policy, developed by the Ministry of Economy, is a primary document dealing with the development and direction of the Slovak energy industry, including the thermal

management branch. This material should define the prerequisites for the effective functioning of individual energy sectors in the long term, set goals, and determine the necessary measures to achieve them.

3.7.1. Heat producers and utilities

Here's an overview of the current state, key challenges, and prospects for DH in Slovakia from the perspective of the Heat producers and utilities:

1. **Extent and coverage**: Slovakia has a well-established DH network, with a significant portion of the population relying on it for heating and hot water. The DH systems serve various residential, commercial, and industrial sectors.
2. **Energy sources**: Slovakia's DH systems have traditionally relied heavily on natural gas and coal. However, there is a growing trend towards incorporating RES such as biomass, geothermal, and solar energy.
3. **Technological advancements**: modernisation efforts are underway to improve system efficiency and reduce heat losses. It includes upgrading old infrastructure, installing energy-efficient boilers, implementing advanced control systems, and adopting digital technologies like SCADA and smart metering for better monitoring and optimisation.

One of the key challenges is the transition to renewables, which will reduce dependency on fossil fuels and increase the share of renewable energy in DH systems. The transition requires significant investment in new technologies and infrastructure.

Slovakia has supportive policies and regulations to promote energy efficiency and renewable energy integration. However, there is a need for continuous policy updates and more substantial incentives to accelerate the transition. There is also a need to improve public awareness about the benefits of DH and renewable energy. DH in Slovakia involves a mix of old infrastructure and ongoing modernisation efforts, with a significant focus on transitioning to renewable energy sources and improving system efficiency. The following paragraphs provide an overview based on available information.

Current state and challenges in Slovakia

Slovakia's DH primarily relies on natural gas, coal, and biomass. There is a growing emphasis on incorporating RES, including geothermal, solar thermal, and waste heat recovery. Some producers have already started integrating biomass and geothermal energy. Efforts are being made to reduce heat losses and increase efficiency by replacing old pipes with pre-insulated ones, upgrading boiler systems, and implementing advanced control and monitoring technologies.

Producers stated that the Slovak government provides financial incentives and subsidies for upgrading DH systems and integrating RES. DH projects also use EU funds to improve energy efficiency and reduce GHG emissions.

Public perception of DH in Slovakia varies, with some consumers viewing it as expensive compared to individual heating systems. Better consumer education is needed on the benefits of DH, particularly regarding its potential for lower costs and environmental impact.

Producers aim to implement advanced technologies such as SCADA for centralised monitoring and control and TERMIS for network optimisations. They are also involved in projects that utilise waste heat from industrial processes and energy recovery from waste. They aim to enhance customer satisfaction by improving service quality and transparency. Most companies provide educational programs to inform consumers about the benefits and cost-effectiveness of DH systems.

3.7.2. Authorities and regulators

The four responses from Authorities and regulators highlight several key insights and perspectives on the current state and future of DH systems. We divide Authorities and regulators into segments between ministries on the national level and self-governing regions and municipalities on the local level.

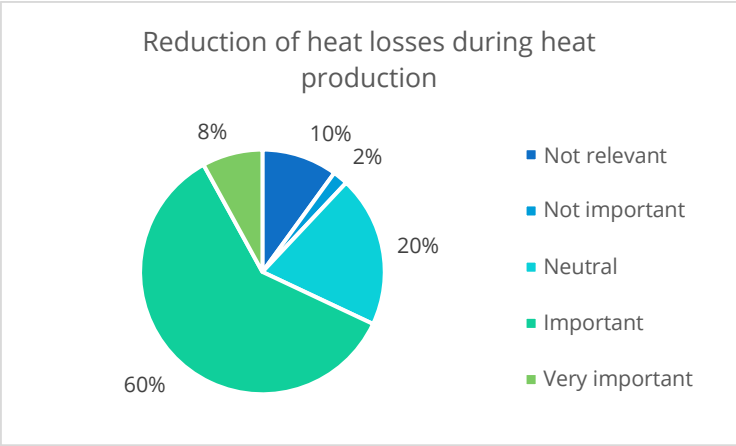

Figure 40 Interest in the reduction of heat losses during heat production in Slovakia

We asked them about their opinion on how important it is for them to decrease heat losses in heat generation and decrease heat losses in network operation. This question creates a diversity of answers. On the national level, it's essential to focus on this topic since we have several regulations related to it. On the local level, it's not a critical case. The new European legislation significantly

changes the rules in the field of DHC. According to it, it was necessary to adapt Slovak legislation as well.

The directives capture some parts of the heating industry focused more on measurement and budgeting, control of heating and air conditioning systems, and long-term planning in heating and cooling. Slovakia wants to follow this example as well. While The rules for calculating heat costs in apartment buildings have changed, they were applied for the first time in May 2024 in the 2023 bill.

The Slovak government and relevant ministries view the utilisation of waste heat as an essential part of energy policy that can contribute to reducing energy dependency, improving energy efficiency, and meeting environmental goals.

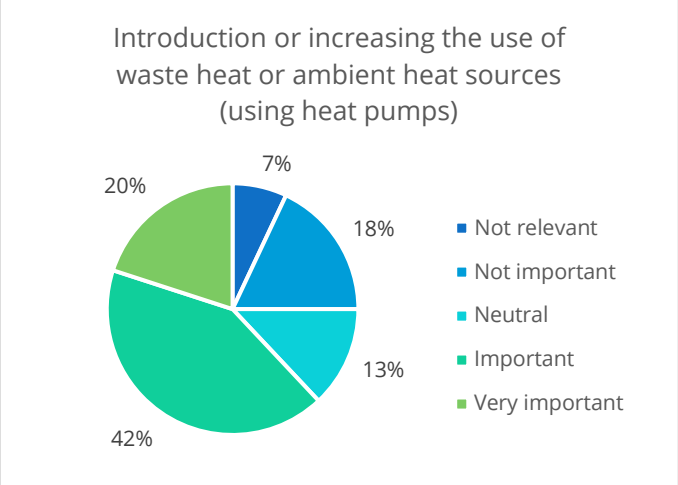

Figure 41 Interest in the introduction/increasing use of waste heat sources in Slovakia

In cooperation with the Ministry of Environment, the Ministry of Economy of the Slovak Republic supports measures to enhance energy efficiency, including using waste heat in industry and urban areas. EU funds and other state grants often fund these initiatives to reduce greenhouse gas emissions and primary energy consumption.

Various national strategies, such as the National Energy and Climate Plan, are prepared and implemented as part of Slovakia's energy policy. This plan includes goals for reducing emissions, increasing energy efficiency, and supporting RES, including measures for effectively using waste heat.

One of the main objectives of the Decree of the Ministry of Economy of the Slovak Republic No. 503/2022 Coll., which was prepared in cooperation with the Association of Heat and Water Estimates Slovakia, the Slovak Trade Inspection, and the Slovak Innovation and Energy Agency, was to ensure that the costs of heat and hot water for apartment building owners were distributed as

fairly as possible and that the new decree also includes solutions for current methods of heat supply.

The following figure describes the views of the government on raising awareness of DHC systems among consumers. It explains that DHC systems are crucial to improving energy efficiency, reducing emissions, and supporting sustainable development.

The state is likely willing to invest in supporting these initiatives, as they offer long-term economic and environmental benefits.

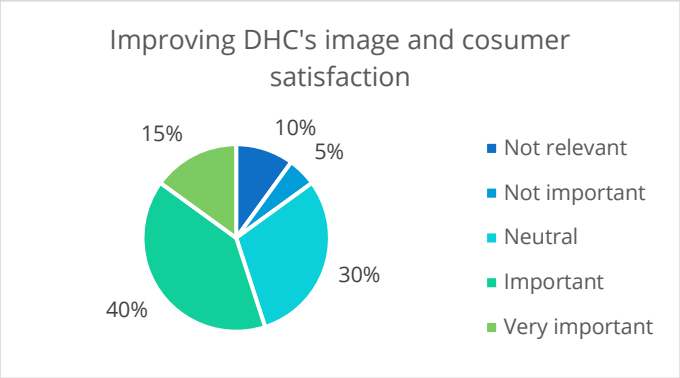

Figure 42 Interest in improving DHC´s image and consumer satisfaction in Slovakia

Every respondent agreed on the joint intersectoral cooperation, especially using green energy sources such as geothermal energy. Since the new regulations from the EU and Slovakia decided to follow those trends, it's still essential to use EU co-financing on energy efficiency projects.

3.7.3. Technology suppliers and contractors

Suppliers of heat production technologies for DH systems in Slovakia are adapting to various energy sector challenges and trends. Below is an overview of their critical approaches, reflecting a blend of trends, responses to regulatory challenges, and technological innovations.

Transition to RES requires innovation in biomass boilers. Many suppliers are focusing on developing and implementing more environmentally friendly biomass boilers. Biomass is considered a crucial renewable resource that can replace traditional fossil fuels. Deploying heat pumps and solar collectors in DHC systems is another priority. These technologies can significantly reduce dependence on natural gas and coal.

Suppliers also focus on implementing smart metering systems that enable more efficient heat distribution management and cost optimisation. Through digitalisation, suppliers can monitor equipment conditions and predict failures, enhancing the efficiency and reliability of DH systems.

Many suppliers are integrating cogeneration units, which allow for the simultaneous production of heat and electricity with high efficiency, thereby reducing emissions and optimising fuel

consumption. They are working on modernising existing equipment to increase energy efficiency and reduce fuel consumption.

Regarding legal requirements, suppliers stated that they must comply with strict regulations regarding emissions and efficiency, influencing their technological choices and the development of new solutions. Securing financial support from European funds for green projects in the DHC sector is a crucial aspect of suppliers' strategies.

Due to the energy crisis and the pressure to reduce reliance on Russian gas, suppliers are diversifying energy sources. It includes investments in alternative sources such as biomethane, hydrogen, and waste heat.

These approaches reflect the broader energy trends in Slovakia, where suppliers must address sustainability, efficiency, and regulation challenges while ensuring the stability and reliability of heat supply for end consumers.

3.7.4. Financiers and investors

Not only from the survey itself but also from other in-person meetings and conferences, we found out what opinions building owners have and what investors or developers are currently thinking.

The DH system is a vital component of the energy infrastructure in Slovakia, but the approach of developers and investors towards it is varied. Based on the survey and interviews with experts from the real estate and energy sectors, some fundamental attitudes and trends can be identified:

1. **Economic perspective:** many developers in Slovakia view DH as a cost-effective solution, especially in large-scale projects. DH can be cheaper than individual solutions, particularly in areas with existing infrastructure. Investors often appreciate the stability of heat prices from DH, which allows for better cost prediction.
2. **Ecological and regulatory factors:** Slovakia, like other EU member states, faces pressure to reduce GHG emissions. DH using renewable resources, such as biomass or waste heat, can help meet these environmental goals. Developers and investors are increasingly seeking more eco-friendly DH options, which can offer benefits not only in terms of sustainability but also in meeting regulatory requirements.
3. **Flexibility and independence:** some developers prefer individual solutions, such as heat pumps or boilers, which provide greater control over energy supply and costs. They view DH as less flexible, particularly when connecting to the system is complicated or where DH does not offer competitive prices.
4. **Public infrastructure and urban development:** in urban projects, especially in city centres or high-density areas, DH is often a necessary part of the infrastructure. Investors are more inclined to use it in these cases, as it is considered in urban planning and is frequently accounted for from the early stages of project planning.
5. **Availability and condition of existing infrastructure:** connection is more straightforward and cost-effective in areas with well-developed DH infrastructure.

Developers in such locations often prefer DH. Conversely, connection costs may be higher in areas with insufficient infrastructure, reducing DH's attractiveness to investors.

6. **Support from the state and local government:** state and local support, including subsidies, legislative adjustments, or other forms of incentives, can significantly influence the decision-making of investors and developers. Slovakia's noticeable effort to support more eco-friendly forms of DH could be a decisive factor for some projects. Since investors and developers are forced by the currently valid legislation to build family and apartment buildings in energy class A0, they use renewable resources in their projects. You can feel the rising trend; e.g. the heat pump market rose year-to-year from 5,000 to 12,000 units, and the photovoltaic market went up threefold; only one company sold 15 MW.

Ultimately, developers' and investors' approaches to DH in Slovakia depend on several factors, including economic, ecological, and technical aspects. The availability of existing infrastructure and the legislative environment also plays a significant role. As Slovakia strives for emission reductions and increased energy efficiency, interest in modernised and sustainable forms of DH is expected to grow.

We are registering a positive trend towards conscious construction and operation. We have two groups of developers in Slovakia:

1. On the one hand, some need to fulfil the obligation of energy class A0 and are looking for low acquisition costs (they do not consider the efficiency of operation in the time horizon).
2. On the other hand, some are more aware of what they want to bring, in addition to efficient operation, comfort and a pleasant and healthy indoor climate (90% of the time, almost 22 hours a day, we spend indoors) for residents and users.

We perceive a positive and rising trend among developers and investors. In the projects of smaller apartment buildings and administrative buildings, solar collectors for water heating and heat pumps are increasingly used as heat sources. Interest in photovoltaics is also growing. For these projects, however, it is necessary to meet legislative requirements.

We also register a growing trend in the increased prices of buildings with RES when sold. Developers thus can use more energy-efficient solutions and increase their profits when selling such buildings. On the contrary, investors place growing emphasis on cost-effective housing.

When 2020 Act No. 555/2005 Coll. was passed regarding the energy efficiency of buildings, many investors perceived it negatively. However, due to the increase in user demands and the impact of the overall societal situation, the view on this issue has changed significantly, and investors and developers see the use of RES as a possibility for competitive advantage. The construction of green buildings is currently a considerably rising trend.

Investors and developers take a positive approach. The use of RES is also on the rise, as energy pricing is highly turbulent, as we have experienced recently. In addition to unstable prices, the requirements of applicable regulations also play a role, which obliges investors to be energy efficient during the construction or renovation of residential buildings.

Current investors and developers are increasingly considering using RES in their projects. Here are some ways they approach their use:

- Inclusion in the design: when designing new projects, investors and developers should consider using RES. These resources are included in the building's plan and design so that energy consumption is minimized and resources are used as efficiently as possible.
- International certification systems: sustainability certificates such as BREEAM (Building Research Establishment Environmental Assessment Methodology) or LEED (Leadership in Energy and Environmental Design) support the use of RES as part of the certification criteria for reducing energy intensity and greenhouse gas emissions beyond legislative requirements.
- The use of solar panels: investors often consider installing solar panels on the roofs of buildings. These panels capture the sun's radiation and turn it into heat or electricity, which can then be used to power equipment in the building or fed into the power grid.
- Implementing heat pumps: heat pumps are another popular renewable energy investment choice.
- Use of geothermal energy: in some cases, investors investigate the possibility of using geothermal energy if it is available in the location. Some projects have already been implemented but are still a green field in the Slovak Republic. This energy is obtained from heat stored in the ground and can be used to heat and cool buildings.
- Adapting to standards and regulations: investors are also trying to adapt to standards and regulations in building energy efficiency. In Slovakia, there are regulatory requirements for RES, and the energy efficiency of buildings, investors, and developers ensure that their projects meet these requirements and adapt to sustainable development. The goal of investors and developers is to create sustainable and energy-efficient buildings that will contribute to environmental protection and, at the same time, offer users economic and ecological benefits.

Many medium and larger investors and developers approach renewable resources positively, as their use is directly related to environmental protection, better energy efficiency, and financial sustainability. All these points fit together and thus create a win-win situation in the market; hence, the rising trend of the use of renewable resources can be felt.

3.7.5. Consumers and media

The survey revealed that many consumers appreciate the potential for improved energy efficiency and subsequent cost savings. Upgraded DHC systems promise lower energy bills, which is a significant incentive for households and businesses.

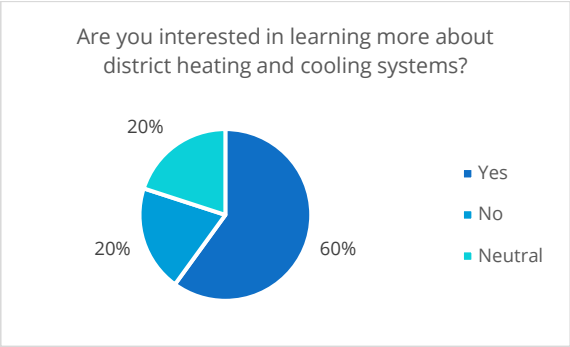

Figure 43 Consumer interest in DHC in Slovakia

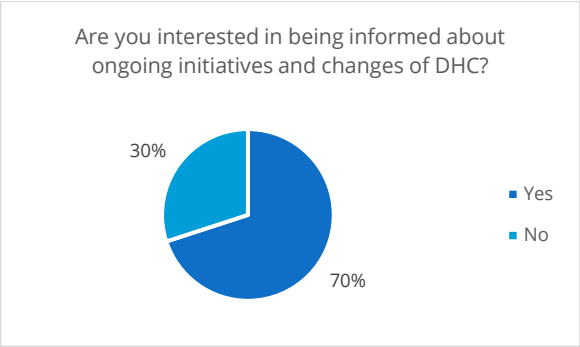

Figure 44 Consumer interest in being informed in Slovakia

Eco-conscious consumers support changes that align with sustainability goals. Reducing GHG emissions and integrating RES resonate with a growing demographic concerned about climate change and environmental preservation.

Conversely, some consumers are wary of the initial costs associated with upgrading DHC systems. Concerns about increased taxes or utility rates to fund these projects are prevalent. Additionally, disruptions during the transition period, such as temporary outages or construction inconveniences, can lead to dissatisfaction.

Certain consumer groups are sceptical about the long-term benefits of these changes. Doubts persist about new technologies' reliability and ability to deliver promised savings and efficiencies.

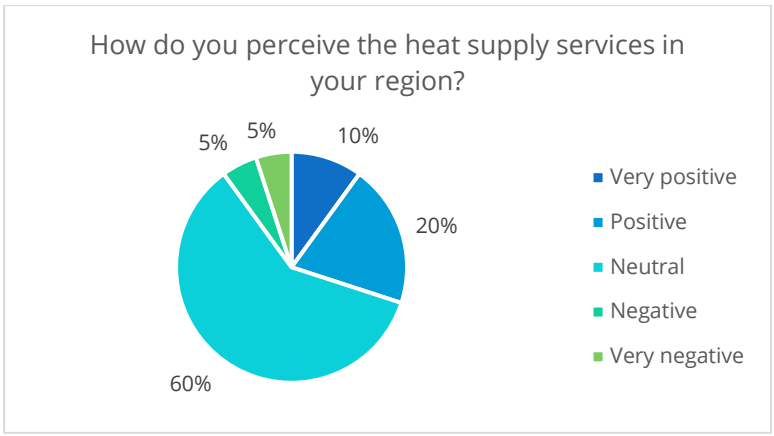

Figure 45 Heat supply service in the Slovak region

Media coverage often highlights success stories from other countries implementing similar DHC upgrades. These stories emphasise the benefits of modernisation, such as enhanced energy security, economic savings, and environmental protection. Media outlets frequently feature expert opinions and analyses supporting DHC system changes. Reports from ecological scientists, energy

economists, and industry professionals provide credibility and reassurance to the public about the benefits and feasibility of these upgrades.

Slovakia's DHC systems changes are crucial for advancing national and EU sustainability goals. Successful implementation can significantly reduce the country's carbon footprint and contribute to global climate targets.

Building public trust and engagement is essential for the successful transition of DHC systems. Transparent communication, public consultations, and addressing consumer concerns can foster a supportive environment for them to change their perception.

The perception of changes in Slovakia's DHC systems is multifaceted, shaped by environmental, economic, and technological factors. While potential cost savings and environmental benefits drive significant support for these changes, initial costs, disruptions, and long-term reliability concerns persist. Media coverage is crucial in shaping public opinion, with supportive and critical narratives influencing consumer perceptions. The broader implications for Slovakia's energy sector are profound, with the potential to advance sustainability goals, drive economic growth, and enhance public trust and engagement. Effective communication and transparent policymaking will ensure the successful transition to a modernised DHC system in Slovakia.

3.8. Slovenia

In Slovenia, the surveys were partly collected by the partner LEA Pomurje and partly by the Jožef Stefan Institute. The latter prepared an online survey and collected the data in Microsoft Excel for further analysis. In the following chapters, data from the answers obtained by the respondents are presented.

Figure 46 below shows how the first three groups of stakeholders (Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors) assessed the importance of the mentioned topics for their organisation. The responses from Heat producers and utilities reveal that reducing heat losses in the network is very important in the technical field, followed by enhanced usage of waste heat and sector coupling. In financing, utilising EU funds for energy efficiency and RES projects and advocating for more favourable regulations are essential. Installing or improving consumption heat metering of buildings supplied with DH is the least important topic for Heat producers and utilities.

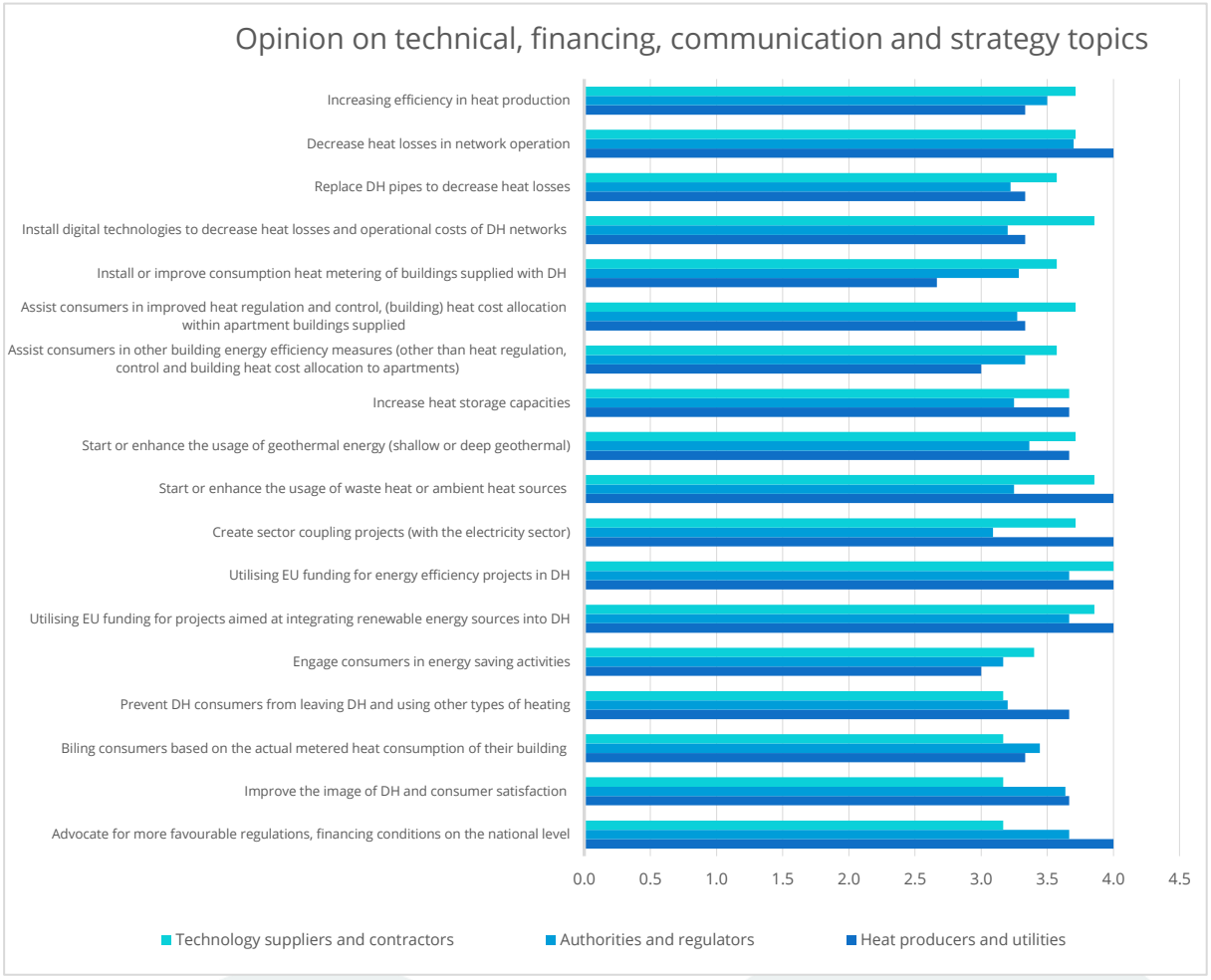

Figure 46 Opinions on the importance of various topics among Heat producers and utilities, Authorities and regulators, and Technology suppliers and contractors in Slovenia

When looking at the other two groups, Authorities and regulators show similar interests, but with lower ratings, they put less emphasis on sector coupling. Technology suppliers and contractors rated technical improvements, such as installing digital technologies to decrease heat losses and operational costs of DH networks and starting or enhancing waste heat usage, as significant while placing less emphasis on consumer-related issues. Ultimately, we can emphasise that all three stakeholders agree on the importance of utilising EU funds for energy efficiency and RES projects for their organisation.

The statements in the following subchapters analyse stakeholder perspectives on DHC systems. The analysis revealed several key insights:

1. **Potential for improvement:** The stakeholders recognised the significant potential for further integration and expansion of DHC systems. It suggests that while infrastructure is already in place, opportunities exist to enhance and broaden its usage.
2. **Challenges:** Despite the potential, the analysis identified several barriers to further development. These include:
    - **Regulatory hurdles:** The process often stalls at the stage of obtaining necessary permits, which implies that legal and regulatory frameworks might be complex or cumbersome.
    - **Bureaucratic delays:** Lengthy bureaucratic procedures are another significant challenge, indicating that the administrative process could be slow and inefficient.
    - **High investment costs:** The stakeholders noted that the initial investment required for these systems is substantial, which could deter expansion or adoption.
    - **Technological integration:** The difficulty of integrating these technologies into existing spaces was highlighted as a critical issue. It may involve challenges related to urban planning, infrastructure compatibility, or the physical space required for the systems.

In summary, while DHC systems have considerable potential, regulatory, financial, and technological challenges currently hinder their expansion.

3.8.1. Heat producers and utilities

Three respondents from Slovenia were Heat producers and utilities. Figure 47 illustrates the number of clients connected to the DH system for each heat supplier. Two providers have a large client base, with over 10,000 clients. One provider operates in a mid-range category, serving between 3,000 and 10,000 clients. There was no provider with clients of fewer than 3,000. Two respondents (the two with above 10,000 clients) indicated that they had incorporated renewable energy, including waste heat, into their systems. Two systems utilise heat purchased from third parties, from 25-75% heat share.

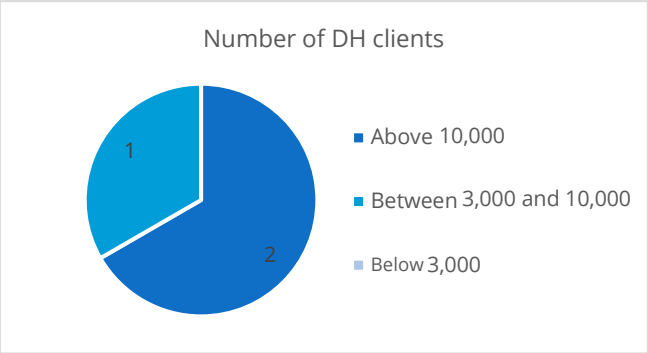

Figure 47 Number of DH clients per DH system in Slovenia

Several ongoing and planned initiatives aim to reduce heat losses and improve system efficiency. These include renovating the network to increase supply reliability, reduce heat losses, eliminate leaks, improve pressure conditions, and continuously lower temperature and pressure levels of system operation according to the actual needs of customers. Other activities mentioned include optimisation of the minimum supply temperature with the TERMIS optimisation tool and effective remote control of consumption points as a prerequisite for the operation of TERMIS. Renovation of heating stations, designing a biomass boiler house, and determining the potential of waste heat (PEDvolution) are also mentioned for reducing heat losses.

Consumers measure heat consumption at the point of heat acceptance in the heating station with a heat meter. The accuracy of measurements is ensured by regular and legally prescribed certified control of measuring devices/heat meters (verification).

All systems have implemented SCADA for system monitoring. One respondent described the process at the level of heat extraction, where data is transmitted from heat meters (heat consumption, supply temperature, return temperature, flow rate). At the level of the distribution system and production sources, the pressure, temperature and flow conditions of the network are monitored, and the data on the operation of the sources are transferred to the SCADA process information system, where they are evaluated and serve to manage and optimise the operation of the system.

Figure 48 ranks the most significant challenges the DH systems face in Slovenia in order of importance (1 being the highest). According to Heat producers and utilities, the most important challenges in Slovenia, in descending order, are transitioning from fossil fuels, attracting new consumers and expanding the network. At the same time, the least concerning is the persuasion of policymakers.

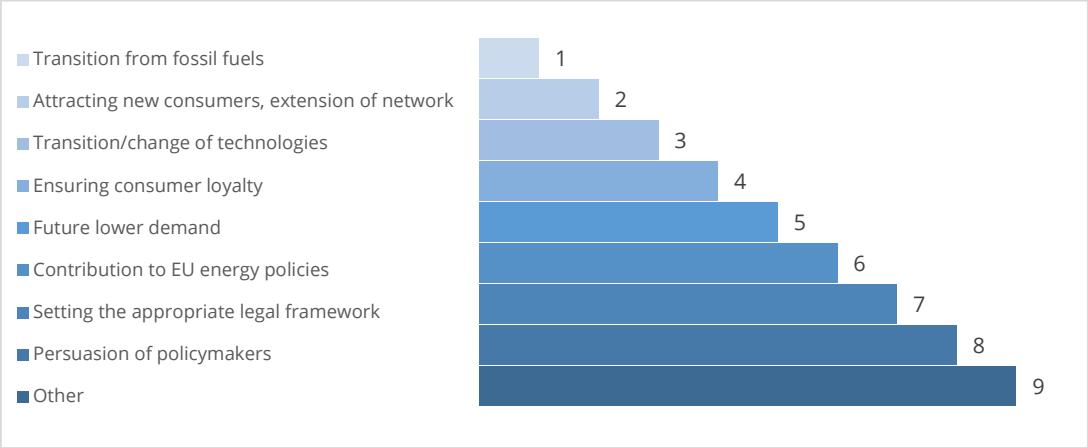

Figure 48 The biggest expected challenges for DH in Slovenia based on responses from Heat producers and utilities

On which RES are most suitable for use in DHC systems in the region of respondents, one answer stated wood biomass and, in a smaller proportion excess heat without and with a heat pump. In another area, respondents mentioned that the energy use of part of municipal waste, wood biomass, and energy from the river Drava and shallow geothermal energy would be most suitable.

All the respondents cited demanding spatial placement and high investment costs as the main obstacles that make introducing new technologies in the district heating sector difficult. Another obstacle is coordinating investments, heat consumption, or technologies with end clients or system owners.

Responses to the need for regulatory or legislative support and additional incentive mechanisms for DHC show their significant role. At the moment, the Heating and Cooling Strategy for Slovenia (in preparation), priority connection to DH (EZ-2), and LEK/local community ordinances (partially existing) are important. Regarding incentives, financial mechanisms that would reduce the product's final price are necessary.

3.8.2. Authorities and regulators

Thirteen responses were received from Authorities and regulators. They give their comprehensive views on DH's current state and future.

Regarding existing policies, programs, and incentives that support the establishment, expansion or improvement of DH systems, the respondents said that the policies align with EU directives, and EU funds are available for financial incentives in the form of tenders. The need to exploit the geothermal potential to expand or improve DH systems is highlighted. It is stated that the legal regulations are very restrictive regarding the choice of heating in compact settlements.

Existing policies are flawed because they focus on all remote systems and are not tailored to the specifics of individual systems.

Regarding tenders, the Ministry of Environment, Climate and Energy has published a Public Tender for co-financing the restructuring of RES district systems from 2023 to 2025 (NOO – DO OVE 2023).

The action strategic document (NEPN, engl. Integrated National Energy and Climate Plan) envisages modernising existing DH systems, increasing their efficiency and switching to RES such as biomass, geothermal energy and waste heat.

The Energy Act (EZ-1) regulates the energy field and sets the rules for energy distribution, supply and use. The law defines DH as critical infrastructure that needs to be developed and maintained for energy efficiency and environmental sustainability. The law promotes the use of RES in DH systems and determines energy companies' obligations regarding improving energy efficiency.

Within the framework of the *Operational Program for the Implementation of the European Cohesion Policy,* European funds are available for financing projects that improve energy efficiency and reduce emissions. DH projects are eligible for financing if they contribute to greater energy efficiency and RES. This includes the modernisation of existing systems, the construction of new networks and the integration of RES.

Local policies: many local communities in Slovenia have their own programs to support DH. These programs may include subsidies for connection to DH, exemptions from municipal contributions or other financial incentives for businesses and households. Local programs often also support projects that use local RES, such as wood biomass or geothermal energy.

Regarding the regulatory and other obstacles that inhibit the realisation of the potential for developing DH infrastructure, respondents stated that obtaining permits for developing and expanding DH systems is often complicated and time-consuming. Complex administrative procedures and requirements for numerous consents can slow down the implementation of projects. Although subsidies and financial incentives exist, the costs of investing in DH are high. Local communities and small businesses often do not have sufficient financial resources for initial investments and necessary upgrades. Although Slovenia is rich in renewable resources, their availability and integration into DH systems is not always easy. Logistic and technical obstacles can make exploiting local renewable resources, such as wood biomass and waste heat, difficult.

Additional incentive mechanisms for DHC are needed to encourage investments in higher system efficiency without subsidies. Energy savings should cover future investments. An individual respondent explains that mechanisms are needed to sensibly cover all areas of renewable resources intended for heating and cooling. The answer was also given that two measures are possible: subsidising the construction or stopping subsidising individual heating devices (heat pumps).

Technological advancements expected to impact the sector include information and communication technologies, advanced analytics with artificial intelligence, machine learning, control, and advanced insulation materials. Cascade use and further development of high-temperature heat pumps and geothermal energy without pumping are highlighted. Heat pumps should be used, and heat consumption should be reduced in new and renovated buildings

that could use alternative heat sources. Digitisation and introduction of artificial intelligence and long-term energy storage are also mentioned.

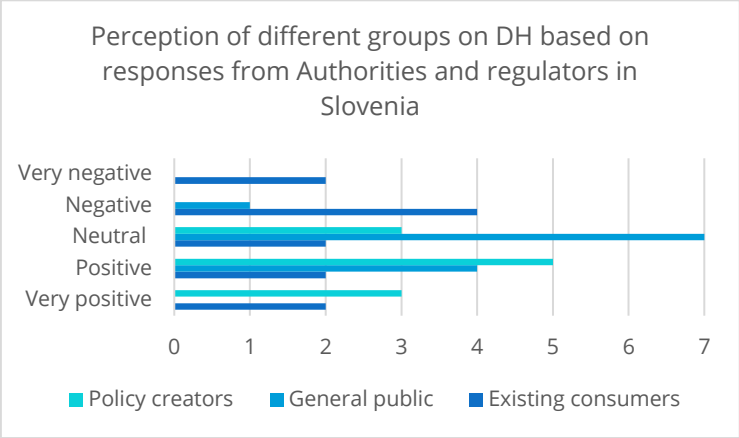

Figure 49 Assessment of perceptions of different groups on DH based on responses from Authorities and regulators in Slovenia

In the opinion of Authorities and regulators who filled out the survey, existing consumers predominantly hold negative or neutral views of DH, mainly due to high heating costs. The solution should be modernising the remote network system and measures of efficient energy use on the customer/building side. DH was perceived negatively by consumers as they had no direct power over energy management. However, the clumsiness of DH managers in terms of explanation and transparent business contributed a lot to the resentment. Policymakers show more positive views of DH, though with some neutrality. To address the positive view, they think DH can be the cheapest form of heating that could be launched within the energy community.

Figure 50 ranks, in order of importance (1 is the higher importance), the biggest challenges facing the DH systems sector in Slovenia. According to Authorities and regulators, the most significant challenges for DH in Slovenia are, in descending order, the transition from fossil fuels, the attraction of new consumers, and the expansion of the network. At the same time, the least concerning is the future reduced demand.

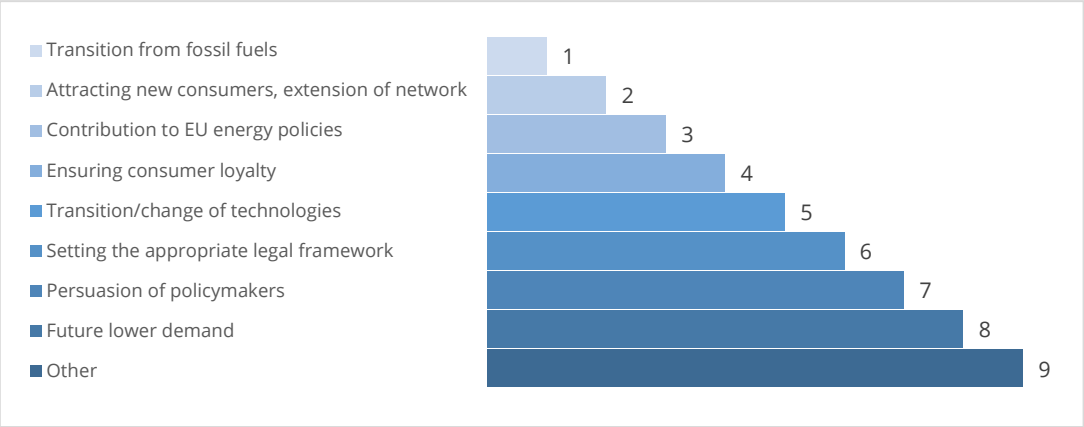

Figure 50 The biggest expected challenges for DH in Slovenia based on responses from Authorities and regulators

Respondents predict an increase in heat sales of up to 30%. The transition from fossil fuels to RES will be felt the most. The leading technologies will be heat pumps and hydrogen technologies, while the renewable source will be biomass.

The last part of the questionnaire was designed to identify some examples of good practices at a regional or local level. The following websites were listed in the surveys by respondents:

Economy:

- Terme Vivat - geothermal energy utilisation system (https://vivat.si/)
- Terme 3000 (https://www.sava-hotels-resorts.com/sl/terme-3000/) and Grede d.o.o. (https://grede-tesanovci.si/) – geothermal energy utilisation system

Respondents gave a lot of examples and information. Here are summarised information and listed web pages:

- Indirectly, DOLB (Daljinski sistem ogrevanja na lesno biomaso, Slovenian) in the municipality of Metlika and the initial phase of the development of the Sustainable District Heating Plan for the municipality of Grosuplje.
- DOLB Lenart, The Lenart DH system consists of a wood biomass boiler and an oil boiler, the total installed power of which is 7 MW. Contacts: https://www.interenergo.com/slo/nasi-sistemi.htm
- Project 3Diverse (https://www.3diverse.eu/)
- Project for the reconstruction of the boiler room of the DH system Ptuj, more information: https://www.js-ptuj.si/novice/126
- Successfully implemented district heating system using wood biomass in the Dob prison area, Kolektor

3.8.3. Technology suppliers and contractors

There were seven responses from Technology suppliers and contractors.

The following answers from Technology suppliers and contractors were given to the question 'Which technologies or technological innovations currently have the greatest impact on the development of district heating?':

- Digitization of DH systems
- Integration of RES and their cross-sector integration
- Utilisation of waste heat at a lower temperature, more efficient water circulation technology - circulation pumps with high efficiency
- Use of heat pumps for self-heating
- Advanced insulation materials, smart meters, energy reuse

According to respondents, the most common barriers to adopting new technologies in the DH sector in Slovenia are:

- Financial barriers
- Technological barriers, including seasonal storage of heat obtained from RES in the summer
- Long sit-in procedures or lengthy procedures because the companies are mostly municipally or jointly owned
- Ownership of heating stations - the owner is a user who is not interested in the systemic impact of a lower return temperature as well as the optimisation of flows in the network

Figure 51 (a,b) below shows regulatory barriers and challenges to DH infrastructure development. Lengthy procedures for obtaining permits for expanding the network, or bureaucracy in general, are recognised as obstacles that inhibit the development of the DH infrastructure, followed by political and financial obstacles. Ownership of systems and infrastructure is also highlighted as an obstacle. It is mentioned that the Danish system should be implemented, where the owners are the users.

One respondent described: 'Slovenia does not have a heating and cooling strategy, nor a hydrogen strategy'. These two documents are necessary for all further steps. There is a lack of demonstrative pilots based on which incentives are formed for smart and sustainable financing of the expansion of remote systems in Slovenia. It is necessary to develop a new regulatory framework to finance the development of remote systems in Slovenia. The challenge is that they cannot be considered separately but cross-sectorally together with the electricity sector. It is also essential to evaluate the positive macroeconomic effects on the economy, the final price of energy, and the sufficiency of supply at any moment.

The need for more effective regulatory and legislative support is strong. It is pointed out that simplifying the obtaining of permits for constructing networks and classifying remote systems among the priority systems for heating compact settlements are necessary.

The adoption of Slovenia's heating and cooling strategy and the hydrogen strategy are necessary. Then, the amendment of the existing legislation follows. An additional 'motive' is needed for the renovation of existing production sources without RES.

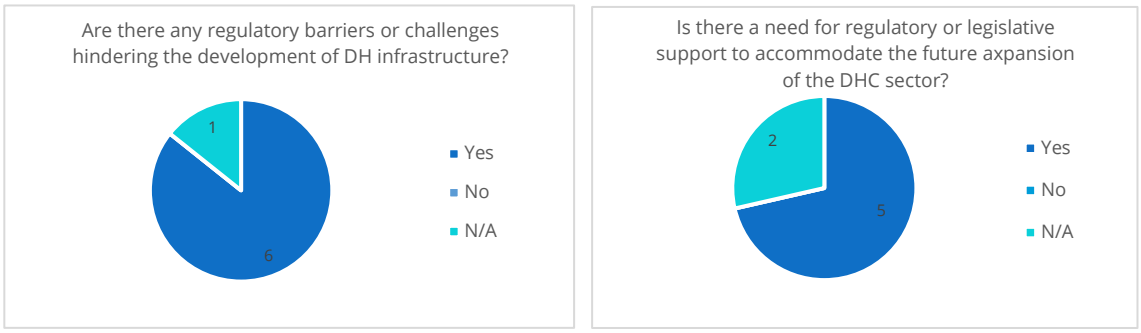

Figure 51 (a,b) Responses from Technology suppliers and contractors in Slovenia – Regulatory issues

The need for additional incentive mechanisms for DHC is clearly expressed. For this, financial incentives for investments and awareness are stated. Also, the nature of these mechanisms should be on the part of local communities and the state to ensure the most cost-effective heat price.

The perceptions of different groups based on the answers from Technology suppliers and contractors are shown in Figure 52. The reason for the negative perception was the increase in energy prices in recent years. The solution lies in the complicated process of stabilising energy prices for end customers, which in the future will mainly be represented by remote systems where possible — upgrading existing buildings together with energy sources, energy renovations, and construction of new ones. Smartly communicate with the public through energy offices and other channels.

When the perception is positive, policymakers are primarily aware of the necessity of empowering remote systems. It is necessary to communicate with the general public through professional popular expression. Still, of course, the economics of the projects must be carefully worked out in the background together with the municipalities. The national and local decision-making levels need to start working more closely together.

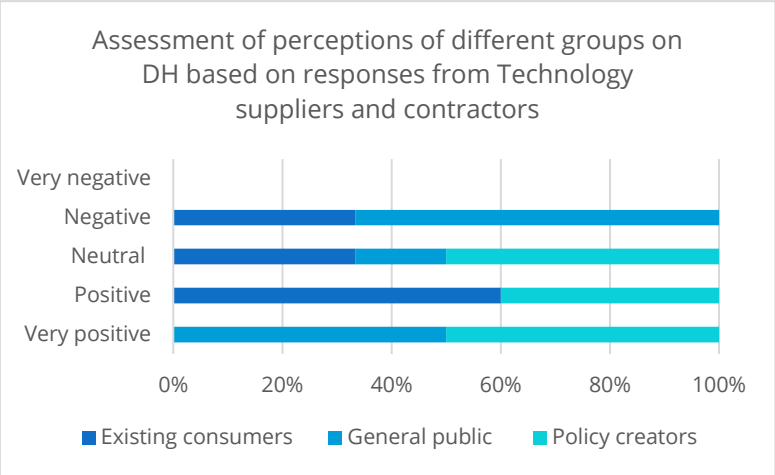

Figure 52 Assessment of perceptions of different groups on DH based on responses from Technology suppliers and contractors in Slovenia

The following are the most appropriate renewable sources for DH supply: renewable gases, waste wood biomass, geothermal energy, thermal treatment of waste, excess heat, solar energy, and electricity – a mix of the above and not all at once. Then, heat is wasted from industry and cooling systems.

One given example of good practice describes that in 2024, with the initiatives and implementation of the transition of buildings to a lower heating temperature regime, a significant reduction in the temperature regime of the principal, primary and secondary network was carried out and, as a result, the heat losses of the entire heat distribution system of the Šaleška Valley were reduced.

3.8.4. Financiers and investors

Only two organisations responded to the survey. One represents a financial institution promoting environmentally friendly investment, including transitioning from environmentally harmful energy sources to more environmentally friendly ones. The second is a public financial institution.

When asked if their institutions are interested in the DHC sector as a financial market, they responded that for several public appeals, they co-finance the renovation of heating stations in individual, business and public buildings for DH. The renovation and sustainable transformation of DH systems should be financed with non-refundable funds (subsidies) and favourable credit, partly grants, partly own funds, and loans.

Measures and investments that can be considered for financing in the DHC field include replacing heating stations and connections to DH. The main approval criterion is energy savings. The second respondent pointed out that for new buildings and reconstructions, for approval project region and decarbonisation benefits stand out as approval parameters.

To the question, 'Which regulatory or other obstacles are holding back the development of district heating infrastructure?', the first respondent states the fragmentation of settlements or individual buildings in smaller towns and placing boiler rooms in the surrounding area. The second respondent states that when it comes to the public sector, the insurance requirements are minimal. Smaller, even if it were a unique form of financial instruments.

The most significant challenges for DH, stated by two respondents, are ensuring consumer loyalty, attracting new consumers/extension of the network, and persuading policymakers and future lower demand.

One respondent gave an example of good practice:

- https://obcina.bovec.si/objava/780030 (DOLB Bovec)

3.8.5. Consumers and media

A total of eleven respondents were categorised as consumers or media representatives. Nine of them represent consumers, and all of them are users of DH services. The main factors that they decided on such a heating source are the connection of the building where they live to DH, followed by reliability and affordability. Most are interested in information about current initiatives related to DHC and the future of urban heat supply.

Two media respondents are not users of DH services, but both are interested in information about current initiatives related to DHC and the future of urban heat supply.

The answers to the question, 'What is your opinion on the need for the development and accessibility of district heating?' were positive and indicated sympathy for the need and development of DH (Figure 53).

Arguments for development and accessibility include:

- Higher property value. By connecting to DH, there is no need to worry about service and maintenance of the heating device, chimney etc.
- Information on how to reduce the costs of DH and the possibility of including DH in the energy community
- Operational reliability and affordability
- A policy that would expand the development of DH to other parts of the city. Development oriented towards sustainability and the transition to RES (geothermal, wood biomass, etc.)
- Greater efficiency, reduction of environmental pollution, improvement of air quality as well as greater utilisation of natural resources and potentials

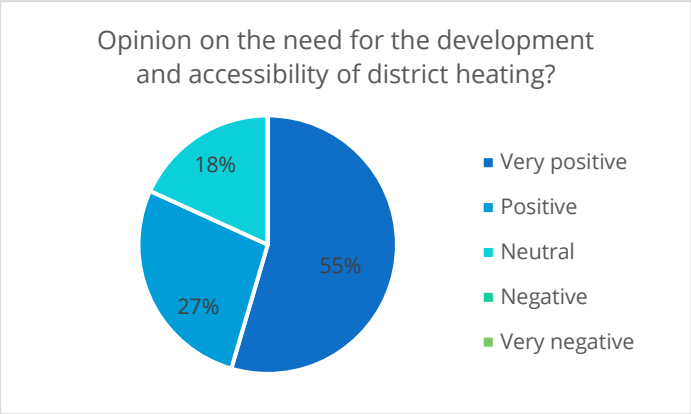

Figure 53 Respondents' opinion on the need for the development and accessibility of district heating in Slovenia

When asked if there are any concerns or worries regarding DH compared to other sources or methods of heating, concern is shown in the rationality of the management of the DH system, and the importance of switching to a renewable source is emphasised, which would reduce the impact on the environment as well as on the final price, highlights the geothermal source as suitable due to the proximity of an already existing well. This is followed by concerns in coordination with all users/stakeholders, dependence on one energy source, market instability and impact on price, and the great challenge of integrating district cooling and maintaining competitiveness while simultaneously reducing consumption.

Figure 54 shows how the respondents rated the accessibility and transparency of the information provided by the DH service provider – five out of eleven respondents rated it as 'good', the same for 'neutral', and one respondent rated it as 'excellent'. We can conclude that there is still room for improving the accessibility and transparency of DH information from the service provider.

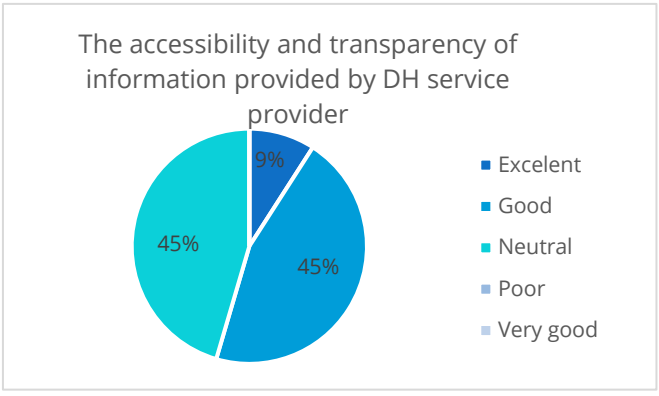

Figure 54 Share of respondents regarding the rate for accessibility and transparency of the information received from the DH service provider

When asked about the importance of using RES in the DH system, it is stated that the use of RES is significant from the point of view of fuel supply reliability. In addition to supply security, switching to RES makes sense. Even more so, because a local renewable source of energy (geothermal and wood biomass) is available, it is unnecessary if it represents a higher price and if the question is technical feasibility.

Both responses among media representatives indicate agreement with the need to promote the use of DHC further. One answer states that a DH network should be built in the first phase because currently, except for a few blocks, this option does not exist in the city. On the other hand, the nature of the incentives should be to inform the users about the advantages and highlight the transparency of the costs of managing and using the DH system.

The answers about the need for additional promotion of the use of DHC from the 'customers' point to the fact that they are necessary and should be aimed at reducing energy poverty in multi-apartment buildings; there should be incentives from the state/Eco Fund for new connections. New incentives could be provided by local communities/municipalities. It has also been pointed out that this is the only way to achieve carbon neutrality in major cities.

The last part of the questionnaire was designed to identify some examples of good practices at the regional or local level. The following websites were listed in the surveys by respondents:

- https://www.delo.si/novice/slovenija/v-murski-soboti-ne-stavijo-vec-na-geotermijo
- *https://www.petrol.si/za-dom/energenti/daljinsko-ogrevanje/lendava*
- http://www.guessingerfernwaerme.at/index.php/unternehmen, (Güssing, Austria)

Some information about examples of good practices:

- Utilisation of excess heat in SIJ Metal Ravne and connection to the DH system Ravne na Koroškem
- In the City of Ljubljana, the participation of the Public Company Energetika Ljubljana in the construction of gas pipelines for new residential buildings (financing by tying for 20 years) is considered good practice.

4. SWOT analysis

This chapter presents the SWOT analysis of DH systems in the Eastern Danube region, as shown in Table 8. SWOT, which stands for Strengths, Weaknesses, Opportunities, and Threats, is a strategic planning tool used to identify and analyse these four critical aspects of the topic.

This analysis aims to gain a comprehensive understanding of the challenges and potential within the REHEATEAST region. This deliverable's SWOT analysis is based on stakeholders' inputs across all REHEATEAST regions. By incorporating diverse perspectives, the analysis aims to provide a holistic view of the current state and prospects of DH systems in this area.

Table 8 SWOT analysis of DH systems in the REHEATEAST region

STRENGTHS	WEAKNESSES
• Strong interest from stakeholders in improving system performance and leveraging EU funding • Potential and growing demand for various RES sources • Availability of advanced technologies and equipment, such as SCADA, TERMIS, Nordic leak control systems • Various projects aimed at reducing heat losses and improving system efficiency • Implementation of measures and initiatives to improve energy efficiency in buildings; replacing pipelines and monitoring systems on the supply side • Strategically developing long-term initiatives to enhance and establish robust infrastructure capable of integrating RES and sector coupling • Interest from various stakeholders and their financial capacity in investing in DH projects	• Limited and varying levels of technological advancement among different DH systems • Challenges in coordinating infrastructure improvements • Persistent high dependence on fossil fuels, which also negatively impact air quality • Limited possibilities for the development of RES due to protection categories and regulatory barriers • Lack of clear guidelines for expanding and modernising heating systems • Complicated and time-consuming process of obtaining permits for developing and expanding DH systems • Poor coordination of different stakeholders

OPPORTUNITIES	THREATS
• Use of EU funding for energy efficiency and RES integration projects • Ongoing and planned initiatives to incorporate RES • Establishing partnerships and collaborative efforts of various stakeholders in energy planning and development to drive innovation and expansion • Leveraging regional strengths for tailored solutions → enabling the production of affordable and reliable energy from local RES • Potential for setting good examples of successful transformation in sustainable energy practices • Attracting investments to implement energy efficiency services and the use of RES • Municipality support in preparing and implementing long-term plans for energy development • Enhancing energy security and reducing dependency on external sources	• Community resistance to changes required for new energy solutions, potential pushback from consumers and stakeholders • High initial costs and slow return on investment • High energy prices in certain regions make it difficult to implement measures and ensure the profitability of investment • Financial challenges in securing necessary funding for projects and initiating new developments • Lack of consistent and transparent policy frameworks • Negative consumer perceptions about high energy costs and lack of transparency

The table above presents a SWOT analysis for the whole region, while in the subsequent paragraphs, we will highlight some of the specificities.

The strengths of DH systems primarily lie in their capacity to provide centralised, reliable heating, which reduces individual reliance on fossil fuels. When considering the integration of specific RES technologies, there are varying emphases across countries. For instance, Croatia's survey responses frequently highlight its significant geothermal potential and the role of heat pumps. In the Western Balkans and Slovenia, solar energy and heat pumps are noted for their potential to modernise the systems. Romania identifies biomass, hydrogen-based technologies, and heat pumps as holding the greatest promise. Bulgaria views biomass as particularly suited to its local context, while Slovakia increasingly focuses on geothermal, solar thermal, and waste heat recovery technologies.

When considering weaknesses, Hungary and Romania particularly highlight the need for clear regulatory frameworks. Their high reliance on fossil fuels complicates the transition to RES. In Croatia and Slovenia, consumers tend to have a more negative perception due to, e.g., high prices, limited public awareness, etc. Across the region, DH systems are grappling with the need for substantial investment to update infrastructure and improve efficiency.

Despite the challenges, opportunities for the region persist. The increasing availability of EU funding and incentives offers avenues to modernise DH systems and expand the use of renewable energy. Moreover, the growing public and political interest in sustainability provides momentum for attracting new consumers and extending DH networks.

Threats continue to affect the region. In Bosnia and Herzegovina, there is an ongoing risk of fossil fuels remaining a primary energy source, as key stakeholders still view them as essential. Bulgaria faces difficulties in establishing an appropriate legal framework and anticipating future demand. Critical issues in Hungary include the low energy efficiency of residential buildings, the inappropriate regulatory environment, and the lack of development funding. Croatia, Serbia, and Slovenia encounter challenges related to moving away from fossil fuels and attracting new consumers. Romania also notes challenges in transitioning to new technologies and aligning with EU energy policies. Generally, the slow pace of regulatory reform continues to be a challenge, as outdated policies and bureaucratic delays endanger efforts to integrate new technologies and renewable sources effectively.

5. Conclusion

This analysis provided a comprehensive overview of the survey results. Various groups of stakeholders were involved in the surveys to gather data. These groups included five distinct categories, ensuring comprehensive coverage of all relevant areas and facilitating the development of survey questions tailored to the specific interests and concerns within each group: Heat producers and utilities, Authorities and regulators, Technology suppliers and contractors, Financiers and investors, Consumers and media. Therefore, project partners gathered and analysed those stakeholder perspectives in this report.

The survey process has laid a strong foundation for ongoing communication with the stakeholders. Maintaining this engagement with stakeholders is crucial. By placing a strong emphasis on stakeholder engagement, we are effectively opening channels for continuous dialogue, feedback, and collaboration. This proactive approach not only supports more informed decision-making but also fosters a sense of shared purpose among all parties involved. With the right mix of policy support, technological innovation, and public engagement, the REHEATEAST region is well-positioned to reduce its dependence on fossil fuels, enhance energy efficiency, and achieve long-term sustainability in DH systems. Furthermore, this aligns with the project objectives of encouraging and maintaining international, cross-sectoral, public-private collaboration.

The future of DH systems in the REHEATEAST region is promising but requires coordinated action across multiple fronts. Cross-sectoral collaboration is essential to create a supportive policy environment that facilitates the transition to RES. At the same time, significant investments are needed to modernise infrastructure and implement advanced technologies like smart metering and digital monitoring systems.

This deliverable will inform decision-making processes, shape targeted interventions to address identified challenges and capitalise on opportunities within the REHEATEAST project scope. These results provide essential insights for subsequent project stages, guiding the partners in developing effective strategies and solutions for the DHC sector.