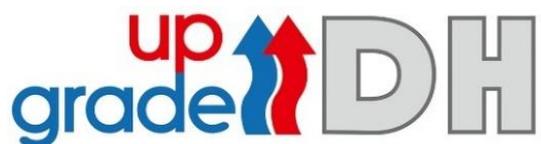




National action plan for retrofitting DH networks in Croatia



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- Dissemination Level:** Public
- Website:** Upgrade DH project website: www.upgrade-dh.eu
- Cover:** Thermal storage unit at the DH system in Zagreb (Image © UNIZAG FSB)
- Project relation:** WP6, Task 6.1, Deliverable 6.1
- Disclaimer:** This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 785014. The sole responsibility for the content of this report lies with the authors. It does not necessarily reflect the opinion of the European Union nor of the Executive Agency for Small and Medium-sized Enterprises (EASME). Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.



This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 785014.

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Acknowledgements

The action plan for retrofitting district heating systems in Croatia has been developed in joint effort with the KeepWarm project, which ran in parallel with UpgradeDH and where UNIZAG FSB was also a partner [1].

Abbreviations

DH	district heating
CHP	combined heat and power
RES	renewable energy source
NECP	National Energy and Climate Plan
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan

1 Introduction

The overall objective of the Upgrade DH project is to improve the performance of district heating (DH) networks in Europe by supporting selected demonstration cases for upgrading, which can be replicated in Europe.

The Upgrade DH project supports the upgrading and retrofitting of DH systems in different climate regions of Europe, covering various countries: Bosnia-Herzegovina, Denmark, Croatia, Germany, Italy, Lithuania, Poland, and The Netherlands. In each of the target countries, the upgrading process was initiated at concrete DH systems of the so-called Upgrade DH demonstration cases (demo cases). The gained knowledge and experiences is further replicated to other European countries and DH systems (replication cases) in order to leverage the impact.

Core activities of the Upgrade DH project include the collection of the best upgrading measures and tools, the support of the upgrading process for selected district heating networks, the organisation of capacity building measures about DH upgrading, financing and business models, as well as the development of national and regional action plans.

This document specifically focuses on the **development of a national action plan** for the retrofitting of inefficient district heating networks **in Croatia** and includes the results of the retrofitting approaches (see also the *District Heating Handbook* developed within the project [2]).

There is a considerable need for refurbishment of existing networks to increase customer confidence, energy efficiency and profitability. The fuels used for District Heating in Croatia are natural gas, oil and petroleum products (light heating oil and fuel oil), renewables which are used both in cogeneration plants and local boiler plants. The precondition for the further development of the district heating systems in the Republic of Croatia is the intensive renewal and technological improvement of the existing systems, especially in terms of switching to low-temperature district heating systems through which heat will be delivered to the previously refurbished housing fund [3].

The analysis showed that at the moment in Croatia there is no long-term national or regional action plans for sustainable DH systems. There is however a need for a national action plan which would focus on improving the efficiency of the rather inefficient but very important DH sector in Croatia. Therefore, a **list of solutions / actions / activities** that could support the development or retrofitting of DH networks was elaborated and can serve for inspiration to other countries with a similar DH market situation and legislative framework.

More specifically, an overview of the current policy framework in Croatia has been provided by the University of Zagreb (Chapter 2). District heating will have a significant role in the future energy system in Croatia, which is already pointed out in the National Energy and Climate Plan. However, various actions and measures need to be implemented in order for district heating to achieve its role. The proposed action plan (Chapter 3) has been developed based on the analysis of the current state of the sector and taking into account the already developed action plan of the KeepWarm project for Croatia, as a part of D5.2 of KeepWarm project. The document was shared with representatives of the HEP Group, the largest Croatian DH supplier, for feedback which is summarised in Chapter 4.

2 Current policy framework

2.1 EU level

Implementation of the EU Energy Package

As a member of the EU, Croatia is obligated to transpose the EU Directives into its national acts and bylaws. Here, an especially relevant directive is a recast of the Renewable Energy Directive (RED) from 2018, where articles 23 and 24 focus on the district heating systems. The articles from this directive will be implemented into the revised Renewable energy sources and highly efficient cogeneration act, which is expected in 2020.

However, it must be noted that the Article 24 of the Directive states that Member states should *“Endeavour to increase the share of energy from renewable sources and from waste heat and cold in district heating and cooling by at least one percentage point as an annual average calculated for the period 2021 to 2025 and for the period 2026 to 2030, starting from the share of energy from renewable sources and from waste heat and cold in district heating and cooling in 2020...”*, but if the share of renewables or waste heat (CHP) in district heating is higher than 60%, the average annual increase will be deemed fulfilled. Since the share of CHP in district heating production in Croatia is 79%, the country already fulfils this requirement.

Furthermore, the articles from the Energy Efficiency Directive will be transposed into the Energy Efficiency Act in 2020, which has still not been passed in the parliament.

The Croatian Ministry of economy published, in 2015, the Programme for utilising the efficiency potential in heating and cooling sectors for period 2016-2030 (based on the Energy Efficiency Directive Article 14) [4]. In this comprehensive assessment document, the potential for increasing the share of district heating/cooling are analysed, along with the potential for implementing the highly efficient cogeneration in Croatia and increasing the efficiency of the district heating/cooling infrastructure in the country. The new comprehensive assessment is expected in 2020.

Role and place of DHC in the NECP

The abovementioned facts regarding the fulfilment of REDII article 24 requirements in Croatia have also been pointed out in the Croatia's NECP [5] of 2019. Furthermore, it is stated that the increase of district heating systems efficiency is already being implemented through the State Aid Programme for increasing district heating systems efficiency, and under the Operational Programme "Competitiveness and Cohesion 2014-2020", Priority Axis 4 "Promoting energy efficiency and renewable energy sources", specific objective 4c3 "Increasing the efficiency of the heating system" through the mechanism of Integrated Territorial Investment. It is therefore expected that distribution losses will be reduced by 4% points by 2024.

Furthermore, district heating is also mentioned in the NECP in different measures proposed throughout the document, including developing a regulatory framework for RES use (assessing the importance of building new infrastructure for RES district heating), increasing the efficiency of the district heating system (refurbishing existing deteriorated pipes, developing new district heating systems using RES and cogeneration, implementing advanced metering systems as defined in the Energy Efficiency Directive recast) as well as the development and maintenance of centralised thermal systems (pointed out that district heating has been identified as one of the energy policy priorities in Croatia and that the efficiency of the production units, infrastructure and end use equipment should increase). These measures should help stop the disconnections of the end users, facilitate the integration of RES production units and thermal storage, as well as the use of power to heat technologies.

Finally, the renovation rate of the building stock on the annual level will be increased from the current rate of 0.7% to 3% in 2030 according to the NECP. This will further enable the transformation of the district heating system to the 4th generation and increase its efficiency.

2.2 National DH regulatory framework

Currently, heat sector in Croatia is regulated by several acts and bylaws mainly Heat market act, Renewable energy sources and highly efficient cogeneration act, Energy act and the Energy efficiency act. The most significant law regarding the district heating systems is the Heat market act. It provides the regulatory basis for the heat market in Croatia, even though the market itself is still non-existent at this point.

However, the act defines the following market activities: heat production, supply and buying; while heat distribution is defined as a public service. Through the act, the measures for safe and reliable heat supply, conditions for heat distribution concessions, or distribution network construction concession are regulated. Also, policies and measures for safe and reliable heat production, distribution and supply are regulated by this act. Furthermore, it defines the energy efficiency measures in heating systems and different solutions regarding the requirements of the EU directives on different aspects of heat. The act defines five key players in the heat market act, as listed below:

- *Heat producer*: Responsible for heat production in production facilities
- *Heat distributor*: Responsible for the distribution through the network
- *Heat supplier*: Responsible for buying the heat from the heat producer and making a contract with heat distributor in order to sell it to the heat buyer
- *Heat buyer*: Responsible for buying the heat in the name of owner(s) of the house/building
- *End buyer*: the end user/buyer of the heat for the own consumption

The act states that constructing new district heating systems is of interest for Croatia, as well as using various renewable energy sources and implementing highly efficient cogeneration for energy production. Furthermore, it is emphasized that district heating has a significant role in reaching the energy efficiency goals of Croatia and therefore municipalities are obliged to plan, incentivize, approve and provide advantage for implementing district heating, according to the energy efficiency measures.

It must be noted that renewable heat production is not incentivised in Croatia, which presents a burden for developing new heat-only systems since the existing old, fossil fuel systems have a very low price for the final consumer. However, when heat is produced in the highly efficient cogeneration unit, its production is indirectly incentivized through the subsidies for electricity production. These are defined in the Renewable energy sources and highly efficient cogeneration act.

The act defines highly efficient cogeneration as a combined heat and power facility which saves at least 10% of primary energy compared to separate reference production of heat and electricity (any primary energy saving for facilities with installed electric capacity lower than 1MW). The subsidies are paid in the form of the feed in premium, however it must be noted that the premium itself must be defined through the bylaws, which have still not been passed. For this reason, no new renewable energy projects have been started since 2016, when the act has been passed and when the incentive scheme has been changed from feed in tariffs to feed in premiums.

There is neither a national Renewable nor Energy Efficiency action plans. Even though there have been several initiatives in the past, there is no national DH action plan developed so far. Upgrade DH can strongly support in development of a proposal for national DH action plan in Croatia.

Based on the framework analysis and the current overview of the DH sector in Croatia, a SWOT analysis has been performed and is presented in Table 1.

Table 1 SWOT analysis of the district heating sector in Croatia

<p>STRENGTHS</p> <ul style="list-style-type: none"> • High share of CHP in the generation mix • Low prices for the end user • Some best practice examples of distribution networks refurbishment, e.g. DH system of Sisak, DH system of Zagreb • Some best practice examples with the use of renewable energy for heat production (Pokupsko, Vukovar, Sisak, Osijek) 	<p>WEAKNESSES</p> <ul style="list-style-type: none"> • Old and inefficient distribution networks with high losses • Old and inefficient production units • High share of fossil fuels in the heat production mix • High supply temperatures • Usually domestic hot water is not supplied through DH, despite the high share of CHP
<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> • High potential for using renewables (especially biomass, solar thermal and geothermal) in the district heating production • Heat market is defined by the heat market act, which in theory enables various producers to supply heat to the end users (removing monopoly) • It is possible to get subsidies for the highly efficient cogeneration, but only for electricity production 	<p>THREATS</p> <ul style="list-style-type: none"> • Old buildings with inadequate insulation • Vertical piping in the buildings • Poor public perception of district heating • Lack of zoning on the local level • Inadequate measurement and control • Lack of a coherent strategy for the development of the DH sector • Primary energy factor for DH in Croatia is among the highest, higher than natural gas, fuel oil, even coal

2.3 Regional level

In Croatia, there are 87 signatories of the Covenant of Mayors, which includes the target city of Sisak and the city from the follower community, Karlovac. This means that these cities have developed a Sustainable Energy Action Plan (SEAP), which also includes certain measures focused on the district heating sector. For example, in the SEAP of Sisak it is planned to extend the district heating network in the areas of high heat demand densities, as well as build the biomass cogeneration plant (which has been built in the meantime).

Furthermore, the city of Karlovac focuses even more on the district heating measures in its Sustainable Energy and Climate Action Plan (SECAP), with the following measures: refurbishment of the distribution network; refurbishment of the production units, including the integration of RES, energy zoning; and expanding the network.

Some funds were also available on the regional level, through the Integrated Territorial Investment mechanism but were focused solely on the city of Zagreb, in order to refurbish the district heating network in the city.

3 Proposed action plan

District heating will have a significant role in the future energy system in Croatia, which is already pointed out in the National Energy and Climate Plan. However, various actions and measures need to be implemented in order for district heating to achieve its role. The following action plan has been developed based on the analysis of the current state of the sector and taking into account the already developed action plan of the KeepWarm project for Croatia, as a part of D5.2 of KeepWarm project [1]. These recommendations have been developed for the policy makers in Croatia on the national and local level and the timeline for specific measures has been provided below. In general, most of these measures are short to mid term and are recommended to be implemented in the period of next 5-10 years.

3.1 Production

3.1.1 Increasing the share of renewable energy

In terms of heat production, despite the high share of cogeneration, these systems use fossil fuels (mostly natural gas and fuel oil), with just a few exceptions. Therefore, it will be necessary to start utilising renewables on a higher scale. There are high potentials for renewable energy in Croatia, especially solar thermal, geothermal and biomass which should be exploited in district heating.

- In order to do that, it is necessary to perform a detailed analysis of the geothermal potential, which should be a first step towards higher utilization of geothermal in Croatia and should be elaborated as soon as possible.

Biomass in district heating, in combination with solar thermal should especially be promoted in rural areas, which currently use high shares of biomass in individual boilers. In such areas there should be a possibility for the potential consumers to sell their own wood to the district heating plant to make the transfer from individual boilers to district heating easier and to ensure the broader acceptance of the local population.

- In order to facilitate the implementation of such systems on a municipal level, there is a need to establish heat planning, which should be pushed forward by the national authorities through relevant legislation.

3.1.2 Waste heat integration

In addition to developing the use of RES in DH, waste heat could also be a potential source for DH.

- In order to define the potential for waste heat integration in district heating systems, it is recommended to establish a national waste heat register, which would specify technical potential of waste heat from industries but also from the service sector buildings such as supermarkets, hospitals, data centres, etc. The inclusion of other data in the register, such as the temperatures of the waste heat source, the availability, distance to the nearest district heating network, etc. is recommended where possible, in order to facilitate planning and implementation of waste heat sources.

3.1.3 Increasing flexibility

Thermal storage units are currently used rather scarcely in Croatia, with just a couple of units in operation. Since they provide a significant amount of flexibility to the whole system, cities/DH systems should:

- Elaborate detailed techno-economic analyses for short term or long term thermal storage, in order to facilitate their roll-out. This would have to include the analysis of the site conditions due to the specifics of long term storage units (size, position, etc.).

On the other hand, thermal storage will be essential for developing smart energy systems through integration of district heating with the electricity sector, where other technologies like large scale heat pumps will provide the link between the heat and electricity sectors.

- Therefore, the potential for power to heat technologies, mostly heat pumps, needs to be investigated and supported through relevant national programmes.

3.2 Distribution

The deteriorated distribution network of the existing district heating systems is already being replaced gradually.

- The upgrade of the distribution networks should continue until all the systems use pre-insulated distribution pipes.
- The temperature levels of the end users should be closely monitored and plastic pipes should be used when the temperature levels enable that.
- Digitalization of the distribution network needs to be promoted in order to increase the efficiency of the system and enable faster response to potential faults.

3.3 End-use

3.3.1 Decreasing heat consumption

On the end-use side, focus should be on decreasing the consumption of the end-users in both private and public buildings.

- This should be done primarily through supporting energy efficiency measures in buildings. This way, district heating systems could truly be transformed into the 4th generation by reducing the temperatures in the system.
- National government should develop a plan to facilitate the refurbishment of public buildings as a lighthouse for the private households.
- Financing schemes should be developed for the private buildings in order to facilitate the refurbishment. This includes the envelope of the building but also the heating systems inside of the building.

3.3.2 Refurbishing substations

- In the existing district heating systems, old substations need to be refurbished as soon as possible.
- This measure should also include switching from the heating only systems to heat+ domestic hot water, where this is not the case. By using heat from district heating for domestic hot water preparation, the overall efficiency of the system is increased, especially in systems which use cogeneration (increasing the number of hours when heat is needed on the annual level).

3.3.3 Metering

- It is necessary to introduce advanced metering systems, which will be able to communicate in both directions, unlocking the additional flexibility of the system through smart control.

3.4 Regulatory frameworks and legislation

3.4.1 Heat mapping

As soon as possible, it is necessary to develop heating and cooling maps on the local authority level, which should be used to plan the development of the heating sector by identifying areas with high heat demand densities suitable for district heating implementation/extension, but also the available supply options.

- Heat maps should be made a requirement through the relevant national legislation.

3.4.2 Heat planning

Heat planning at the local level needs to be supported by the national authorities through relevant legislation.

- Local authorities should make plans for the heating sector based on the previously developed heat maps and designate certain areas, where the results have shown economic and environmental advantages, for district heating only.

This way district heating, as a low carbon, sustainable solution is supported on the local level.

- National government should have a significant role in heat planning through providing guidelines, training, procurement of funds for the local authorities.

3.4.3 CO₂ taxes

- Taxes for CO₂ emissions from the individual heating solutions should be introduced, which would encourage citizens to switch from the natural gas boilers in their homes to district heating as a more sustainable solution.

3.4.4 Primary energy factor methodology revision

- The methodology for calculating the primary energy factor of different energy sources in Croatia needs to be revised as soon as possible and a different CO₂ content allocation method should be used, to take into account the electricity production from the cogeneration plants.

This will decrease the primary energy factor of district heating in Croatia, which is currently the highest of all energy sources and offer a better business case for investments.

3.4.5 National action plan for heating and cooling

- An action plan for heating and cooling should be developed by the national authorities to cover the period until 2030 with the overview until 2050, which should include the measures to be taken with an exact timeline to implement them and financial estimations.

3.4.6 Funding

- The funding needs to be secured by the national and local government for two main actions: retrofitting the existing district heating systems to ensure transfer to the 4th generation of district heating; and initiating new, sustainable systems.
- For the new systems, an incentive framework similar to the one for the electricity sector is necessary, to support investments into sustainable and renewable heating solutions.

4 Promotion of the action plan and recommendations

The document was shared with the UpgradeDH Croatian working group members, i.e. the director of the heat production and the director of the heat distribution company in Sisak. Despite not being country level policy makers, they are still involved in the decision making of the HEP Group which is the largest Croatian DH supplier. Both working group members have read the document and acknowledged the good quality of the recommendations. In their opinion, all the main actions have been included in the document and they have no further recommendations.

The document will also be presented to the participants of the UpgradeDH knowledge sharing expert workshops which will be organised by UNIZAG FSB in the summer months of 2021.

References

- [1] K. Engelmann, M. Čavar, J. Buganova, S. Martinkrista, J. Čižman, M. Mladenović, K. Tomliak, Improving the performance of District Heating Systems in Central and Eastern Europe: Development of Multi-level policy Plans – Action plans for retrofitting of District Heating Systems, 2020. Available online at: https://keepwarmeurope.eu/fileadmin/user_upload/Resources/Deliverables/KeepWarm_D5.2_Development_of_Multi-level_policy_Plans.pdf.
- [2] UpgradeDH (2019): “Upgrading the performance of district heating networks Technical and non-technical approaches - A Handbook”, Public (Deliverable 2.5). Available online at: https://www.upgrade-dh.eu/images/Publications%20and%20Reports/D2.5_2019-07-02_Upgrade-DH_Handbook_EN.pdf
- [3] Euroheat & Power “Country by Country” (2019). Available online at: <https://www.euroheat.org/cbc/2019/>
- [4] Program korištenja potencijala za učinkovitost u grijanju i hlađenju za razdoblje 2016. – 2030., Zagreb, 2015. Available online at: https://ec.europa.eu/energy/sites/ener/files/documents/croatia_report_eeed_art_141update_hr.pdf.
- [5] Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030, Zagreb, 2019. Available online at: https://ec.europa.eu/energy/sites/ener/files/documents/hr_final_necp_main_en.pdf.