KeepWarm
Renewing district heating

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

Work package N°5: Development of Multi-level policy Plans

Deliverable N°5.1: Regulatory framework and barriers review for retrofitting DHS

Horizon 2020 (H2020-EE-2017-PPI)
Project N°784966

немачка сарадња
DEUTSCHE ZUSAMMENARBEIT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under **Grant Agreement N°784966**.

This project received co-funding from the German Federal Ministry of Economic Cooperation and Development.

PROJECT INFORMATION	
Lead partner for the deliverable	Jožef Stefan Institute - Energy Efficiency Centre
Document type	Report
Dissemination level	Public
Date of submission	16 September 2019
Author(s)	Jure Čižman, JSI Jolana Buganova, TSCR
Reviewer(s)	Stefanie Schädlich, GIZ

List of Abbreviations

AP	Action Plan
AT	Austria
CEE	Central and Eastern Europe
CF	Cohesion Fund
CoM	Covenant of Mayors for Climate and Energy
CHP	Cogeneration of Heat and Power
CRO	Croatia
CZ	Czech Republic
DH	District Heating
DHC	District Heating and Cooling
DHS	District Heating System
EC	European Commission
EE	Energy Efficiency
EED	Energy Efficiency Directive
EMS	Energy Management System
EU	European Union
GHG	Greenhouse Gas
LV	Latvia
NECP	National Energy Climate Plan
NEEAP	National Energy Efficiency Action Plan
NG	natural gas
NGO	Non-Governmental Organisation
NREAP	National Renewable Energy Action Plan
RES	Renewable Energy Source(s)
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
SI	Slovenia
SRB	Serbia
UKR	Ukraine
WP	Work Package

Summary of the project

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

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

Project objectives

KeepWarm’s specific objectives are:

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

KeepWarm consortium partners

LOGO	PARTNER NAME	SHORT	COUNTRY
	Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) GmbH	GIZ	Germany
	University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture	UNIZAG FSB	Croatia
	Landeskammer für Land- und Fortwirtschaft in Steiermark	LWK	Austria
	Regionalna Energetska Agencija Sjeverozapadne Hrvatske	REGEA	Croatia
	Jožef Stefan Institute, Energy Efficiency Centre	JSI	Slovenia
	ICLEI European Secretariat GmbH	ICLEI Europe	Germany
	Teplarenske Sdruzeni Ceske Republiky	TSCR	Czech Republic
	Biedriba Zemgales Regionala Energetikas Agentura	ZREA	Latvia
	Zavod Energetska agencija za Savinjsko, Šaleško in Koroško	KSSENA	Slovenia
	LLC KT-Energy Consulting	KT-Energy	Ukraine
	Institut za nuklearne nauke Vinča	VINCA	Serbia

Content

Executive summary

The switch from a fossil fuel and inefficient DH system to clean and renewable alternatives with low level of losses is a challenging task. Moreover, other competitive heating solutions in heating sector make it difficult for other heating alternatives, such as DH to compete. Besides DH systems often were not able to provide appropriate value of their services from technical, environmental, societal as well as economic perspective. This analysis provides the regulatory background review and tackles barriers of DHS development in seven countries involved in this project, in order to support development of new multi-level policy plans which will enhance integration of cleaner heat sources which will through DHS become more accessible to individual users (e.g. geothermal heat, industrial waste heat, waste incinerations).

The analysis of district heating systems' (DHS) regulatory framework in pilot countries shows that on policy level district heating (DH) is in general considered as important infrastructure for heat supply while action plans lack of clear goals and more concrete measures and instruments to establish practical improvement of DHS. The review indicates that DH is being visible element of strategic energy planning on national level in all involved countries. The strategies and action plans related to improvements of energy efficiency in buildings hardly seldom explicitly address DHS as possible and viable path, the majority of action plans only partially covers multifaceted nature of DH sector development. A complex process of developing a DHS is often disabled by a lack of knowledge and experience within local government institutions and a lack of commitment and support due to conflicting interests of the stakeholders.

There is obviously divergent technical state of the art of DHSs through pilot countries, wherein those with longer DHS tradition mainly report higher grade of systems' disrepair, poor energy efficiency and larger technical potential for improvement. As a rule, DH is considered economically viable in areas with higher heat demand density, however there is an impression that planning support (e.g. software tools, data, methodologies, etc.) is not available or has very limited practical usefulness. This is indicated by absence of practical implemented examples. Another limiting factor regarding implementation of DHS refurbishment is a combination of high investment costs that come with large infrastructural projects (like networks/systems improvement or extension projects) and lack of attractive financial instruments or funds, which makes public involvement necessary for further development of systems.

Various stages and long-term nature of DHS project development require strong support and firm relationship among stakeholders as well as a determined initiator to mediate the process. The role of municipality in this context is inevitable, particularly as its ambition to reduce GHG emissions and ensure sustainable energy supply of the community can be strongly dependent on existence of efficient DHS.

Introduction

The report is a result of the analysis carried out under the tasks T5.1, Regulatory DHS framework review, and T5.2, Identification of key barriers, opportunities and stakeholders for retrofitting of DHS. The objective of T5.1 is to **provide good overview of the existing regulatory and policy framework in pilot countries which is influencing DHS retrofitting and modernisation**, whereas the T5.2 objective is **to support and ease pilot's implementation and to provide proper basis for preparation of Action Plans for retrofitting of DHS**. The pilot countries included in the analysis are Austria, Croatia, Czech Republic, Latvia, Serbia, Slovenia and Ukraine.

The input was collected by two questionnaires: (1) on regulatory and policy framework, influencing DHS retrofit and modernisation, and (2) on identification of key barriers, opportunities and stakeholders for retrofitting of DHS. The input for (1) was provided by project partners from the pilot countries and was related to the following topics:

- How is the strategic role of district heating set in the key national energy strategy documents?
- How are DH systems (including their retrofit) addressed through policies, measures and instruments for DHS (e.g. in APs)?
- How does DHS potential, its retrofit and CHP potential in DHS have been evaluated in the national Comprehensive assessment of the potential for the application of high-efficiency CHP and DHC according to Article 14 of the Energy Efficiency Directive?
- Which instruments (could) provide incentives for DHS retrofit?
- Which key legislative acts relevant for DHS operation and retrofitting?

In order to ease access to more extensive background information and data source, a number of hyperlinks is noted in the text.

The canvas (2) was used to collect input primarily from DHS operators and utilities in pilot countries, which were invited to stress their views and specify their experiences about obstacles they are facing during planning, preparation or implementation of retrofit and modernisation of DHS. The objective of this activity was to identify and define vital improvements of policies, strategies and action plans as well as provision of knowledge and tools which will support renovation and improvement of DHSs' energy efficiency and their attractiveness on the market. The following crucial influencing factors concerning retrofitting of DHS were examined:

- opportunities for successful DHS retrofit,
- key barriers preventing DHS improvement, extension or retrofit and
- decisive stakeholders, which have crucial role in the retrofit process, indicating their positive (supportive) and negative role in the process of DHS modernisation.

This review is considered as important starting point, which will in one of the later project stages help to create common framework for understanding the processes of retrofitting and modernisation of DHS at implementation level, enable definition of recommendations and provision of instruments and tools to achieve mitigation of and finally help overcome negative or ineffective practices. Such an overview is essential to support the implementation of needed DHS improvement across all involved countries, regions and cities.

Regulatory framework review for retrofitting of DHS

The review of regulatory and policy framework for DHS retrofitting (laws, bylaws, energy policy, strategies and programs) was done for all 7 pilot countries (AT, CRO, CZ, LV, SRB, SI, UKR). The focus was on the specific aspects relevant for the pilot DHS modernisation and their integration, which include the following key areas:

A. Strategic role of DH

B. DHS and DHS retrofitting support in action plans

C. Comprehensive assessment of the potential for the application of high-efficiency CHP and DHC

D. Support instruments for DHS and DHS retrofit

E. DHS legislative framework

A. Strategic role of district heating

It has been demonstrated that district heating (DH) could play an essential role in order to decarbonise the European energy system, a 2016 EU energy strategy also suggests increased use of DH. In the respective communication note EC invited national and local authorities to prepare strategies for the promotion of renewable heating and cooling. DHC systems have been set out as important pillars of the future energy and climate strategies. The future role of DHC systems is to some extent indicated in NECPs provided by EU member states which are retrievable on the following site:

https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/governance-energy-union/national-energy-climate-plans.

This chapter highlights DH goals which were set in the key national energy (and climate) strategy documents and action plans, national target shares and DHC sector specific development strategies with particular focus on the role of DHS retrofit. The review indicates that DH is being visible element of strategic energy planning on national level in all involved countries. However, the induction of DHC in action plans at regional or local level is diversely successful, in cities where DHS exists it is normally well addressed and stipulated, but elsewhere these systems are often not mentioned in plans. Integration of individual or small local heating systems into a larger centralised system, gradual switch to RES, further upgrade of CHP and reduction of heat losses are the most common measures in support of strategic positioning of DH in the future energy sector.

AT Austria

National energy strategy	Energy Strategy Austria (*Energie Strategie Österreich*) was published by Austrian Federal Ministry of Economy, Family and Youth (BMWFJ) in 2010. A threefold energy strategy is aiming to increase EE, energy saving and expansion of RES, to achieve climate protection goals, drastically reduce dependence on energy imports and to give a strong boost to the

AT Austria

	economy and employment. The importance of DH is addressed mainly through the following aspects: • efficient use of primary energy and use of waste heat; • the priority means of domestic heating are either by DHS (CHP, biomass, waste heat) or by renewable central heating (solar, biomass, heat pumps); • DHS support with target-oriented subsidies; • increase the use of biomass in DHS; • support of creating new biomass-DHS and the optimization of existing ones; • subsidise customers changing to DHS; • strengthening of renewable energies; • securing energy supply. https://www.bmdw.gv.at/Ministerium/Staatspreise/Documents/energiestrategie_oesterreich.pdf (in German)
National Energy Climate Plan (NECP)	Mission 2030 – Austrian Climate and Energy Strategy (*Die österreichische Klima- und Energiestrategie*) was prepared in 2018 by two Austrian federal ministries, the Ministry for Sustainability and Tourism (BMNT) and the Ministry for Transport, Innovation and Technology (BMVIT). According to the strategy, the building sector has huge potential for reduction of energy use and CO_2 emissions especially through thermal renovation, shunning fossil fuels in newbuilds and by switching to RES and high-efficiency DH in the existing building stock (e.g. replacing 700 thousand oil central heating devices with RES). This will enable emissions to be reduced in a socially and economically appropriate manner by 3 – 5 mt CO_2 equivalent (from current 8 mt CO_2eq). The strategy directly addresses the following main aspects of DHS: • energy infrastructure development and energy spatial planning: An efficient DHS for buildings and factories will be essential, especially in urban areas. Aside from supplying DH from various RES (biomass, geothermal, solar thermal, photovoltaics, etc.) and power/heat coupling, storage and waste heat from production processes will also be vital; • public sector role model: the right environment should be created for switching the heat supply to RES, including DH for public buildings used by federal, regional and local authorities' public sector; • renewable heat among flagship projects: The Federal Government and regional authorities are preparing a joint heat strategy that focuses on reducing the thermal energy demand of buildings and replacing fossil fuels with RES high-efficiency DH (e.g. replacing 700.000 oil central heating systems with renewable solutions); • use of solutions, which create and secure local growth and jobs https://mission2030.info (in German)
Regional energy strategies / concepts	All nine federal regions (*Bundesländer*) have developed their regional strategies in line with the federal guidelines. The Climate and Energy Strategy Styria 2030 (*Klima- und Energiestrategie Steiermark 2030, KESS 2030*) was confirmed in January 2018 by the regional parliament, the first three-year action plan (*Klimaaktionsplan 2019-2021*) has been recently approved by the regional government. The following main concerns about DHS are stated in the Styrian strategy:

AT Austria

	• in terms of security of energy supply, special efforts must be made to secure the DH supply; • the optimization potential regarding heat distribution losses (increase of efficiency) should be considered; • technical and business challenges due to the continuously decreasing heat demand of buildings and the need for (district) cooling offers new opportunities for the grids; • as Styria is being rich with local renewable resources, its clear goal is to increase biomass production, where ecologically feasible. • Energy related aspects to be further promoted: direct use of biomass for heat generation, conversion into RES (bio)gas, liquid biogenic fuels and renewable DH. Additional (annual) use of biomass for energy purposes is estimated at 7,1 PJ and 1,9 PJ of waste heat. http://www.technik.steiermark.at/cms/ziel/128523298/DE/ (in German) The Upper Austrian energy strategy "*Energiezukunft 2030*" was launched to integrate climate actions across a number of economic sectors. It also sets the target for the region to reach 100% renewable electricity and heat by 2030. RES currently cover 80,7 % of Upper Austria's total electricity consumption and 44,5 % of its total heat consumption. Also, about 30% of its municipalities already use mainly biomass for heating. In 2017, the energy strategy was further developed in a stakeholder process with the involvement of experts, in the direction of an equally climate- and location-oriented energy strategy, which resulted in an upgraded energy concept "*Energy-Leitregion Oberösterreich 2050*". https://www.land-oberoesterreich.gv.at/files/publikationen/esv_Energiestrategie_Leitregion.pdf (in German) In February 2014, the government and state parliament confirmed the Lower Austrian Climate and Energy Program 2020 (*NÖ Klima- und Energieprogramm 2020*). As plans are in place to decommission the remaining coal fired power plant in the state by 2020, the renewable energy development is continuing. Furthermore, the state is planning to generate 50% of all the state's total energy demand via renewable sources by 2030. This includes increasing the production of bio-fuels for transmission and heating/cooling needs. http://www.noe.gv.at/noe/Klima/KlimaEnergieprogramm2020.html (in German)
Local energy strategies / concepts (SEAP/SECAP)	There is a number of SEAPs available across Austria, a couple of them where created during the project "SEAP Alps", which aimed to integrate adaptation to climate change into Sustainable Energy Action Plans. http://www.innovationszentrum-weiz.at/veranstaltungen-aktuelles/detail/projekt-seap-alps (in German) The "e5-programme" for energy-efficient communities supports communities that want to contribute to a sustainable energy policy and urban development through the rational use of energy and an increased use of renewables. In Austria it was established in 1998. Currently more than 100 communities from 7 out of the 9 Austrian provinces are participating in the programme (Vorarlberg, Tyrol, Salzburg, Carinthia, Styria, Lower Austria and Burgenland). The communal action programmes, which cover all energy-related fields of municipalities (e.g. development & spatial planning, buildings & facilities, energy supply), are developed and adapted annually. https://www.e5-gemeinden.at/ (in German)

CRO Croatia

National energy strategy	Final versions of the basic documents for the elaboration of Croatian energy strategy were published in February and May 2019, respectively. Based on documents – Green Paper (*Analize i podloge za izradu energetske strategije Republike Hrvatske, Zelena knjiga*) and White Paper (*Analize i podloge za izradu energetske strategije Republike Hrvatske, Bijela Knjiga*) and draft version of Energy Development Strategy of the Republic of Croatia until 2030 with a vision to 2050 (*Strategija energetskog razvoja Republike Hrvatske do 2030 s pogledom na 2050*) – was prepared and put forward for public discussion in May 2019. According to the strategy, construction and development of DHSs, production of heat using highly efficient cogeneration and renewable sources are in the interest of Republic of Croatia. Decrease of 11% and 40% of heat energy consumption are estimated in different scenarios. Share of heat produced in DHSs is expected to remain the same or decrease because of the extended use of heat pumps. https://mzoe.gov.hr/UserDocsImages/UPRAVA%20ZA%20ENERGETIKU/Strategije,%20planovi%20i%20programi/Analiza%20i%20podloga%20za%20izradu%20Strategije%20energetskog%20razvoja%20Republike%20Hrvatske%20-ZELENA%20KNJIGA%20_kona%C4%8Dna%20verzija%20(002).pdf (in Croatian) https://mzoe.gov.hr/UserDocsImages/UPRAVA%20ZA%20ENERGETIKU/Strategije,%20planovi%20i%20programi/BIJELA%20KNJIGA%20--%20Analiza%20i%20podloge%20za%20izradu%20Strategije%20energetskog%20razvoja%20Republike%20Hrvatske.pdf (In Croatian) https://esavjetovanja.gov.hr/Econ/MainScreen?EntityId=10936 (In Croatian)
National Energy Climate Plan (NECP)	The Ministry of Protection of the Environment and Energy (*Ministarstvo zaštite okoliša i energetike*) prepared a Draft Integrated National Energy and Climate Plan from 2021 to 2030 (*Prvi Nacrt Integriranog energetskog i klimatskog plana za razdoblje od 2021. do 2030. godine*). The document states that significant energy losses are present due to old and poorly maintained networks. In order to reduce energy losses, funds for network reconstruction in the sum of 80 MEUR are available in the period until 2030. https://ec.europa.eu/energy/sites/ener/files/documents/croatia_draftnecp_hr.pdf (in Croatian)
Regional energy strategies / concepts	Regional energy strategies are, as a rule, set in county strategic documents, which covers all aspects of regional development. A detailed review of the Development strategy of Zagreb county by 2020 (issued in October 2017) reveals that it has no explicit reference to the status or strategic role of DH. The County of Zagreb is the largest and most densely populated Croatian counties and one of the most developed ones, but DHS is not listed among energy (infrastructure) development problems or needs in Table 19 of the aforementioned strategy document. http://zacorda.hr/wp-content/uploads/2017/11/glasnik_29-2017.pdf (in Croatian)
Local energy strategies / concepts (SEAP/SECAP)	The reconstruction and renovation of DHS in cities, which have DHS, is addressed in SEAPs. The development of new systems in other cities, which do not have DHS, is not mentioned in the plans. Replacement of plants powered by fossil fuels with gas or RES is the most common measure. Connecting existing closed and individual heating systems in one centralised system and extension of existing networks are planned in all SEAPs. Additionally, measures such as network reconstruction and integration of renewables are stated in the SEAP of Zagreb. Examples: (1) Sustainable energy development action plan of Velika Gorica (*Akcijski plan energetski održivog razvitka Velike Gorice*), July 2011

CRO Croatia

	http://mycovenant.eumayors.eu/docs/seap/15979_1438167163.pdf (in Croatian) (2) Sustainable energy development action plan of Zaprešić (*Akcijski plan energetski održivog grada Zaprešića*), October 2010 https://mycovenant.eumayors.eu/docs/seap/1389_1372_1311589425.pdf (in Croatian) (3) Sustainable energy and climate action plan of City of Zagreb (*Akcijski plan energetski održivog razvitka i prilagodbe klimatskim promjenama Grada Zagreba*), June 2019 https://eko.zagreb.hr/UserDocsImages/arhiva/dokumenti/seap/Akcijski%20plan%20energetski%20odr%C5%BEivog%20razvitka%20Grada%20Zagreba%20do%202020..pdf (In Croatian)
Other strategic documents	1. Background for the development of Croatian Low Carbon strategy by 2030 with 2050 vision: DHS are essential for establishing a low carbon energy system. The goal for 2050 is estimated at 40% of households to be supplied by DH. Opportunities for development of DHS are recognised in improving EE, using biomass and heat pumps, providing ancillary services using heat storage and enabling more flexible operation of large CHP plants. https://mzoe.gov.hr/o-ministarstvu-1065/djelokrug-4925/klima/strategije-planovi-i-programi-1915/strategija-niskouqljicnog-razvoja-hrvatske/1930 (in Croatian) 2. Programme of Exploiting Heating and Cooling Efficiency Potential for 2016-2030 (issued by Ministry of the Economy in November 2015): DHS are determined as one of the priorities of Croatia's energy policy, but the existing ones require substantial investments in order to be revitalised and modernised to increase the reliability and safety of supply. The most significant potential for the improvement and development of DHS in Croatia is in an EE increase of production units, end-user infrastructure and equipment, as well as by improving the reliability and safety of supply. This may be achieved primarily by (1) use of the latest CHP, biomass and waste incineration technology and knowledge in the field, (2) by the replacement of old pipeline networks (with high heat losses and leakage) with new pre-insulated pipelines, and (3) by the introduction of advanced technologies for the management of DHS. https://ec.europa.eu/energy/sites/ener/files/documents/croatia_report_eed_art_141update_en.pdf 3. Analysis of DHS and use of geothermal potential in larger urban area of the City of Zagreb (local level): The main revitalisation goal is increasing of the EE, both in heat production and distribution. Focus is set on the reduction of heat and water losses, particularly in Zagreb. In smaller systems, like those in the neighbouring cities Velika Gorica, Samobor and Zaprešić, the goals are to combine smaller DHS into one centralised system, to cover heat demand with RES as much as possible and to optimise the operation of existing gas boilers. https://www.zagreb.hr/UserDocsImages/arhiva/strategijsko_planiranje/ANALIZA%20SEKTORA%20TOPLINARSTVA-UAZ-Studija.pdf (in Croatian)

CZ Czech Republic

National energy strategy	The Ministry of Industry and Trade prepared the State Energy Policy (SEP) which was approved in May 2015 through the resolution of the Government of the Czech Republic. The SEP provides clear articulation of the priorities and strategic intentions of the state within the energy sector. SEP builds on the national natural comparative advantages, given by the possibilities of using individual types of energy resources within the limited natural potential and economic characteristics of the state. One of the stipulated priorities is to preserve (economically and energetically) efficient DHS. Renovation, transformation and stabilisation of DHS based predominantly on domestic resources (nuclear, coal, renewable energy, secondary energy sources) supplemented by NG forms the core of national energy strategy in heating sector. Restructuring of energetically and economically inefficient DHS should be supported whenever achievement of higher EE, flexibility of fuel use or better parameters from the sustainable development point of view can be anticipated. By 2040, the state energy policy sets the target to ensure at least 20 % of heat supply from DHS to be covered by RES and at least 60 % by heat from CHP. This relates to one of the SEP priorities (PII.5), which stipulates switch of most heating plants to high-efficiency cogeneration, wherever economically viable, making efficient use of heat pumps and cutting heat distribution losses. Biomass is the only supplementary RES, which is already available on a relatively large scale in CZ for the needs of the heating sector. Other forms of RES are limited for heating sector purposes due to technical and other (socio-environmental) reasons. The potential of geothermal energy is for the moment untested, but according to preliminary analyses may be significant, although for the time being associated with high costs. Wind and water energy are not suitable for heating purposes and the use of solar energy does not have sufficient potential for centralised heating supplies. A greater focus is put on the use of biogas, first of all in agriculture. One of the main objectives of heat generation and supply (Ch 5.4) is to support the use of biomass, other renewable and secondary sources and the maximum use of waste in combination with other fuels for heat supply networks, particularly for medium and small-sized sources and reasonable collection distances (D.2.). Furthermore, the objective also includes “the lasting availability of coal for heating systems and prioritise coal supply to high-efficiency heat supply installations throughout the entire production system (i.e. also including heat distribution systems) over low-efficiency sources”. Another objective of SEP is to secure a gradual shift towards CHP generation combined with the efficient use of heat pumps for all heating boilers (D.3.). One of the specific objectives (Da.2) supports the transition of (particularly) medium and small-sized heat supply systems to multi-fuel systems, making use of local biomass, NG and other fuel, if available, where in particular NG is playing a stabilising role and serving as a supplementary fuel. Another specific objective is related to secondary sources of energy and waste (Ag.2), aiming at priority support for the direct (thermic) use of non-

CZ Czech Republic

	recyclable waste without prior treatment for co-generation heat supply systems in accordance with environmental protection. The component objectives for energy conversion efficiency includes “a shift towards high-efficiency CHP in all heat supply systems” (Fb.3.). The component objectives for NG sources includes “create the conditions for developing micro co-generation sources and their intelligent integration into networks with priority use of electricity for own use” (Ae.2.). The component objectives for secondary sources of energy and waste includes “support CHP in biogas plants using biodegradable waste from the usable parts of municipal and agricultural waste and food industry waste as fuel” (Ag.4.). https://www.mpo.cz/dokument158059.html (in Czech) https://www.mpo.cz/assets/dokumenty/52841/60946/636123/priloha001.pdf
National Energy Climate Plan (NECP)	The Draft National Energy and Climate Plan of the Czech Republic was prepared in December 2018 and contains the main targets and policies in all five dimensions of the Energy Union for the period 2021–2030 with a view to 2050. The main part of the draft plan sets, as CZ contribution to the European climate and energy targets, the reduction of GHG emissions and the increase in the share of RES and EE. The draft plan is based on two main strategic documents, State Energy Policy (SEP) and the Climate Policy of the Czech Republic (approved in 2017). According to the draft document, heat supply systems represent the energy infrastructure that is necessary for the efficient use of heat from renewable and secondary energy sources, which are impossible or inefficient to be acquired and used separately in individual buildings (less valuable biomass, biogas from biowaste, geothermal energy, waste heat from industrial processes, etc.). The use of local heat sources contributes to the decentralisation of the energy sector, reducing the dependence on fossil fuel imports and strengthens the local economy. CZ has a developed heating sector that needs to be gradually transformed for the use of low-carbon energy sources, including energy from secondary sources and waste heat, and the efficient energy distribution to the consumers, especially in urban agglomerations. In view of achieving the 2030 target, an increased use of RES in existing heat supply systems will be crucial. CZ plans to support mainly the modernisation of existing heat supply systems in order to meet the requirements for efficient energy supply systems under EED. However, there is also room for the creation of new (especially smaller) renewable heat supply systems, for example through the use of heat from biogas stations, which today are mostly used only for electricity generation but have also potential in heat supply. District heating is mentioned explicitly in relation to: (1) the necessity to build new infrastructure for DHC produced from RES, (2) energy-related priority areas within the national priorities, where high-efficiency cogeneration (and trigeneration) in DHS in partial load operations (system services) is one of them, and (3) the results of national assessment in regards to the potential of high-efficiency cogeneration and efficient DHC for CZ in accordance to Article 14(1) of the Directive 2012/27/EU. Infrastructure development is set as one of the strategic energy priorities,

CZ Czech Republic

	but it is not fully clear if DHC is included in the infrastructure priority list. It is desired to maintain DHS where their operation is more efficient and more environmentally friendly than individual heating technology. In order to ensure a sufficient level of energy security in the heating sector, a maximum use of domestic primary energy sources is needed. Centralised heat sources mainly involve the most efficient use of domestic coal within high-efficiency CHP, in line with best available techniques (BAT). At the same time, it is desirable to increase the share of biomass, whether in the form of co-firing with coal in centralised heat sources or in the form of domestic biomass boilers. Within centralised heat supply, it is necessary to create suitable conditions for the use of waste heat. https://ec.europa.eu/energy/sites/ener/files/documents/ec_courtesy_translation_cz_necp_0.pdf
Regional energy strategies / concepts	CZ is divided into 14 regions. Each of them must have adopted its regional energy concept according to the Act on energy management (406/2000 Coll. as amended). Compulsory content of regional energy concepts is defined by Government regulation 232/2015 Coll, which stipulates the provision of targets for operation and development of DHS including tools for their achievement. The regional energy concepts contain information on defined and expected areas or corridors for construction projects of public interest to develop the energy economy, while considering the potential to use efficient heating and cooling systems, particularly if they make use of high-efficiency CHP as well as heating and cooling using RES where appropriate. The regional energy concept is the basis for preparing the Territorial Development Principles or the urban plan. The Territorial Energy Concept of the South Moravian Region, which is designed for the period 2018 to 2043, can be presented as an exemplary regional concept. https://portal.cenia.cz/eiasea/download/U0VBX0pITTAyNUtfdnlob2Rub2NlbmlfNTgxNzg5OTc2NjEwODg4NTE0NS5wZGY/JHM025K_vyhodnoceni.pdf (in Czech)
Local energy strategies / concepts (SEAP/SECAP)	There is no obligation for municipalities (with the exception of City of Prague, which is municipality and region at the same time) to have energy concepts adopted. However, a number of larger municipalities such as Brno, České Budějovice or Plzeň adopted own energy concepts. Since DHS are present in all larger cities in CZ, local energy concepts typically cover the retrofit and development of DHS. As an example, the Territorial Energy Concept of the City of Pilsen, which was updated for the period 2015 – 2040, can be exposed. This concept was elaborated in 4 scenarios covering different levels of city development. Conclusions are in line with the adopted State Energy Concept, as prescribed by current legislation. https://energetika.plzen.eu/Files/energetika/koncepcni_dokumenty/uzemni_koncepce/UEKmP2015sprilohami_verzekeschvaleni.pdf (in Czech)
Other strategic documents	The update of the National Action Plan for Smart Grids (NAP SG) is based on measures implemented in its first stage, responding to changes in energy development and EU legislation since the first NAP SG has been approved in 2015. Its aim is to create such conditions in the energy sector, which will meet the requirements contained in the EU legislative documents in the “Clean Energy for All Europeans” package, thus responding to technological developments and current trends in the EU energy sector. https://www.mpo.cz/assets/cz/energetika/elektroenergetika/2016/11/Narodni-akcni-plan-pro-chytre-site.pdf (in Czech) https://www.mpo.cz/assets/cz/energetika/konference-seminare/2019/4/Aktualizace-NAP-SG.pdf (in Czech)

LV Latvia

National energy strategy	Energy Strategy of Latvia 2030 (*Enerģētikas stratēģija 2030*), which was developed by Ministry of Economics, outlines three key policy objectives, namely the impact on the economy, the sustainability of energy and the security of energy supply. The main measures leading to an increase of EE in the heat supply sector are the following: supporting the principle of centralization in heat supply; improving EE in the production process; increase EE of CHP units; EE in buildings; use of RES; the use of advanced fuel combustion and heat production technologies for local and individual heating. Performance indicators: • Reduction of consumption of thermal energy in buildings up to 100 kWh/m^2 per year, in order to achieve total energy savings of up to 10 TWh per year in the sector, including the average consumption of new buildings of 50 kWh/m^2 per year by providing appropriate State aid instruments; • Provision of support for investment in creating attractive environment and economic development, promoting the transition to EE technologies and reducing the energy costs of energy users, to save energy in heating supply sector. The pace of increasing EE in DH is hampered by large amount of investment required, the limited ability of municipalities to take loans, and the low return on capital. Support for the use of RES in heat production (e.g. grant mechanism for the reconstruction and increase of efficiency of centralized heat supply systems) has been foreseen. http://www.latea.lv/userfiles/news/14122011_Energetikas_strategija_2030.pdf (in Latvian)
National Energy Climate Plan (NECP)	The draft NECP for 2021-2030 was submitted to the EC in December 2018. Among others, long-term targets for the energy performance of buildings encompass promotion of EE and use of local RES in DH with the 60% target share of renewable energy. Target indicators are defined as an increase of the output from RES to 70 MW and reconstructed heating networks in total length of 70 km, all to be implemented by 2023 with the indicative financial support of 53 MEUR from EU funds. DH EE programme is implemented in the framework of the specific support objective “To promote EE and use of local RES in district heating” of the Operational Programme “Growth and Employment” of the 2014–2020 programming period for EU funds. The estimated funding sum of the project is 150 MEUR with the Cohesion Funds co-financing in the amount of 60 MEUR, and it is planned to continue the programme also in the 2021–2027 programming period for EU funds as it makes a substantial contribution to improve and modernise the DH system and increase EE. NECP refers to the Latvian Energy Long-term Strategy 2030 - Competitive Energy for Society (*Latvijas Enerģētikas ilgtermiņa stratēģija 2030 – konkurētspējīga enerģētika sabiedrībai*), which imposes higher requirements for DHS with regard to the reduction of energy loss in networks by assessing the effectiveness of investments and reducing the benchmark of loss to 10% in 2030. https://www.em.gov.lv/lv/nozares_politika/nacionalais_energetikas_un_klimata_plans/ (in Latvian)

LV Latvia

Regional energy strategies / concepts	Example - Zemgale Planning Region (consists of 22 municipalities): • Long term development strategy 2015-2030; • Development program 2015-2020 – Action ID R.4.1.5. to promote the implementation of EE and energy measures in accordance with their regional energy action plan https://www.zemgale.lv/attistibas-planosana/planosanas-dokumenti/category/35-zpr-attistibas-programma-2015-2020 (in Latvian) • 1st Sustainable Zemgale Energy Action Plan 2012-2020 (prepared in 2011) among others includes the following topics: RES and EE; Long – term vision of Zemgale region; Main challenges in achieving the goals of the Covenant of Mayors in Zemgale region - building new biomass CHP plants, promoting RES usage for DH and hot water preparation. http://www.zrea.lv/upload/attach/5%20SEAP%20of%20Zemgale%20region%202009%20FINAL%20engl_1Dec2011.pdf (in Latvian) • Zemgale Region Energy Action plan for 2018-2025 (elaborated in 2017-2018)
Local energy strategies / concepts (SEAP/SECAP)	Examples (limited to Latvian project pilot plant sites): (1) In Zemgale Planning Region there were 16 municipal Energy Action Plans for 2018-2025 elaborated in 2017-2018. They include the following topics: RES, EE and EMS; Planned actions for implementation in energy production sector – the increase of EE in boiler houses and co-generation stations, change of heat pipes and decrease of heat losses, new connections to DHS, increase of fuels quality, promotion of RES in DHS, installation of heat meters for energy billing. https://www.zemgale.lv/informativie-materiali/category/22-prezentacijas (in Latvian) (2) Sustainable Energy Action Plan for Jekabpils city 2010-2020 (elaborated in 2010) refers to the following topics: Long-term vision of Jekabpils city; Main challenges in achieving goals of Covenant of Mayors in Jekabpils city - building new biomass CHP plants, promote RES for DH and hot water preparation. (Sustainable Energy and Climate Action plan up to 2030 is under development.) http://www.zrea.lv/upload/attach/SEAP%20of%20Jekabpils%20municipality_26Oct2010.pdf (3) Auce County Energy Action Plan for 2018-2025 was elaborated in 2017-2018, its strategical goals encompass also an increase of EE in heat production (including improvement of heat pipes and reduction of heat losses) and connection of new consumers to DHS. (4) Ozolnieki County Energy Action Plan for 2018-2025 was elaborated in 2017-2018. The strategical goals include EE in heat production (including EE measures in boiler houses, renovation of heat pipes and reduction of heat losses), connection of new consumers to DHS, promotion of RES in heat production, increase of fuel quality in DHS.

SRB Serbia

National energy strategy	The Energy Sector Development Strategy of the Republic of Serbia (until 2025 with projections to 2030) was prepared by the Ministry of Mining and Energy and published in December 2015 (Official Gazette of RS, No. 101/15). It sets

SRB Serbia

	strategic priorities for the development of the energy sector, where DH is addressed through the following strategic goals: • Providing heat for safe supply of households and industry by strictly following environmental protection norms; • Increase EE in generation, transmission, distribution and heat use; • Higher use of RES; • Sustainable business operation of heat producers. Strategic actions: • Continuous modernisation of the existing DHS; • Establishing and applying unique tariff system for heat production, distribution and supply; • Institutional connection of systems; • Extension of the existing DHS; Promotion of fuel switch and more efficient use of resources: • Reducing share of liquid fuel and coal; • Higher usage of biomass (possible co-combustion in existing coal-fired heating plants); • Use of municipal waste; • Sanitary (domestic) hot water preparation - switch from electric boilers to DH; • Combined production of electricity and heat; • Capacity increase of local self-governments regarding market regulation Priority activities: • Reduction of energy losses in networks; • Introducing measurements of heat consumption at end users and billing according to supplied energy; http://www.mre.gov.rs/doc/efikasnost-izvori/23.06.02016%20ENERGY%20SECTOR%20DEVELOPMENT%20STRATEGY%20OF%20THE%20REPUBLIC%20OF%20SERBIA.pdf
National Energy Climate Plan (NECP)	The Law on Climate Change (*Zakon o klimatskim promenama*) as well as related action plan are still under preparation (by the Ministry of Environmental Protection / *Ministarstvo zaštite životne sredine*). Two important novelty proposals may be anticipated: (1) the law will enable the government to define limitations on GHG emissions, and (2) plants emitting GHG will be obliged to obtain emission permits.
Regional energy strategies / concepts	The development program for Autonomous Province (AP) of Vojvodina and the related Action Plan for implementation of priorities are examples how regional development is planned. DHS is not directly addressed in the programme, although it includes energy sector goals, which among others, state higher share of RES and development of agricultural biomass market. The Action Plan explicitly supports projects which switch from fossil fuels to RES heat plants and construction of biomass cogeneration plants. http://programrazvoja.vojvodina.gov.rs/rs/ (in Serbian)
Local energy strategies / concepts (SEAP/SECAP)	The review shows that many cities with DHS infrastructure elaborated their Sustainable Energy Action Plans (SEAP) or documents of similar purpose and defined DHSs as one of the principle energy systems in regards to: • Possible increase in EE (coupled with reduction of heat losses in buildings);

SRB Serbia

	• Amount of investments in DHS network and heat plants; • Increased use of RES (with focus on biomass); • Construction of new CHP units. Examples of SEAPs: (1) Revised Strategy for Sustainable Development of the City of Šabac With Action Plan 2017 – 2020: http://sabac.rs/files/downloads/file_sr/revidirani_slor_sabac_final_ceo_dokument_2.pdf (in Serbian) (2) Action Plan for the Energy Sector of the City of Valjevo: https://www.valjevo.rs/Dokumenta/PrivredaGradValjevo/Dokumenta/Akcioni_plan_energetskog_sektora_grada_Valjeva_do_2020_godine-publikacija.pdf (in Serbian) (3) Sustainable Energy Action Plan of the City of Niš: http://www.ni.rs/wp-content/uploads/141224-seap.pdf (in Serbian) (4) Integrated development strategy of the City of Zvornik (period 2018-2027): http://www.gradzvornik.org/wp-content/uploads/2015/08/Strategija-integrisanog-razvoja-2018-2027-.pdf.pdf (in Serbian)
Other strategic documents	The National Sustainable Development Strategy (Official Gazette of the RS, No. 57/2008) stipulates that the reduction of heating energy has the highest potential for the increase of EE (> 50%) through improvements in building insulation and decrease in use of electricity for domestic heating. http://www.gs.gov.rs/english/strategije-vs.html (list in English, document in Serbian)

SI Slovenia

National energy strategy	**Energy Concept of Slovenia** – Support of energy efficient DHS in dense populated areas, special focus on the use of excess heat, biomass (CHP), other RES and heat from waste. http://www.energetika-portal.si/dokumenti/strateski-razvojni-dokumenti/energetski-koncept-slovenije/ (in Slovene)
National Energy Climate Plan (NECP)	Draft NECP was prepared in December 2018 and is accessible among others EU NECPs on the official EU website. DH is considered as one of priority means on how to accelerate the implementation of RES measures to achieve renewable share goals. Effective DH systems exceed the prescribed obligatory share of RES. The requirements of the building's energy performance are considered to be met if the supply of final energy for heating and cooling and the preparation of sanitary water are provided from the DH system. Waste wood biomass is considered of great importance in the production of heat (and electricity) in DH systems, using the latest technologies that contribute to the reduction of air pollution. Co-financing of RES based DH systems is being considered as support to reach goals of the EE AP by 2020. The support scheme for heat generation from RES for heating and cooling is listed in draft NECP among additional policies and measures in the area or RES. https://ec.europa.eu/energy/sites/ener/files/documents/ec_courtesy_translation_si_necp.pdf
Regional energy strategies / concepts	No regional strategies available.

SI Slovenia

Local energy strategies / concepts (SEAP/SECAP)	Rules on the methodology and mandatory content of the local energy concept (*Pravilnik o metodologiji in obvezni vsebini lokalnega energetskega koncepta; UL RS, 56/16*) determine the methodology of preparation and the mandatory content and reporting on the implementation of activities deriving from the local energy concept (LEK) – reference to DH is as follows: • Analysis of energy supply shall include analysis of DH systems; • Estimated future energy consumption and guidance for future energy supply shall include a mapping of DH systems with planned plans for its development. Example: By Rules on heating the Municipality of Ljubljana has prescribed mandatory means of buildings' heat supply in the municipal area (for ecological and EE reasons), setting DHS as the second most favourable source/mean (following RES and followed by distribution gas network for heating and cooling purposes). Ordinance on the municipal spatial plan with guidance on preferential use of DH is referred in SEAP, although this document mainly contains the review of current situation, analysis of shares and consumption but is very poor in energy planning aspects. There exists an indication of DH system (pipeline) extension possibilities and connection of new consumers while in remote neighbourhoods or settlements with a higher plot density (located outside DH system networks) it evaluates that is reasonable to build local DHC systems (connected to the NG or CHP). The document contains the municipal energy supply SWOT analysis for various sectors which includes /addresses DHC. Wooden biomass is considered as source with the largest energy potential for DH. The municipal Action and investment plan support the use of RES to achieve goals of RES share in final energy consumption as well as EE and fuel switch from fossil to RES. The reduction of heat losses in the municipal DH network in the period between 2011 and 2020 is aiming at 4% including reduction of electricity consumption for operation of the system. DH is also listed among priority measures for achieving reliable energy supply in the municipality.
Other strategic documents	National operational programme for reduction of GHG (OPTGP 2020) addresses DH in section related to Air quality and reduction of GHG where DH (RES, CHP or waste heat based) is listed as the highest priority mean for heat supply when considering incentives for the heating sector in buildings and settlements.

UKR Ukraine

National energy strategy	The Energy Strategy of Ukraine, until 2035, entitled "Security, energy efficiency, competitiveness" was approved by the order of the Cabinet of Ministers of Ukraine #605 in August 2017. It foresees three stages of its implementation: (1) energy sector reform aiming at development of competitive markets and investment incentives – till 2020; (2) innovative development and optimization of the energy sector with implementation of major modernisation and new construction projects – till 2025; (3)

UKR Ukraine

	ensuring sustainable development – till 2035. The 2nd stage foresees the development of local heat supply systems based on economically feasible potential of local fuels, supply logistics, as well as regional and national energy infrastructure. Besides, an increase of heat supply efficiency in existing DH networks is also among the priorities. The 3rd stage foresees to meet the requirements of the National Plan of Emission Reduction from Large Combustion Plants (for boiler houses and CHPs with the thermal capacity above 50 MW). The main areas of EE improvements include a number of actions related to DH: • increase EE in DHS by optimization of energy generation capacities and modernisation projects; • reduction of energy losses in heat transmission and distribution systems by technical modernisation and review of energy supply schemes, taking account of recent developments in decentralized energy supply, RES use and energy demand management; • evaluation of the potential of DHS optimization by switching to individual heating solutions in the regions and objects, where such option is economically feasible; • implementation of measures allowing regulation of heat energy consumption by consumers (switch from central heating units to individual heating units, reconstruction of heating systems and installation of heat metering in buildings/apartments); The main measures to reduce energy consumption in DHS include: • optimization of energy generation facilities with the focus on cogeneration capacities and increase of efficiency; • potential switch from the least efficient sources to module boiler houses; • replacement of old pipelines with the pre-insulated pipes and reduction of heat energy transmission losses; • modernisation of heating units; • use of industrial excess heat from technological processes; • creation of market conditions for an open access of third parties to DHS; • use of frequency converters for the pumping equipment; • automation and digitalisation in heat supply; • switching to individual heating solutions in cities where current technical state of DH causes increased cost and leads to inefficient use of energy; • implementation of energy demand management and energy services mechanism as alternatives for energy generation. https://www.kmu.gov.ua/ua/npas/250250456 (in Ukrainian)
National Energy Climate Plan (NECP)	In December 2017 the Cabinet of Ministers of Ukraine (Decree #878-p) approved the action plan on implementation of the Concept of state policy implementation in the area of climate change until 2030. This document foresees the development and approval of a complex National plan on energy and climate for the period 2021-2030 in the year 2020. http://zakon.rada.gov.ua/laws/show/878-2017-%D1%80 (in Ukrainian)
Regional energy strategies /	Modernisation of DHS is often included in regional development strategies, regional economic and social development programs, as well as regional energy efficiency programs. In Zhytomyr region, for example,

UKR Ukraine

concepts	DHS priorities are reflected in the following documents: • Zhytomyr region development strategy for the period till 2020 defines areas to invest financial resources in the mid-term perspective, which include reduction of dependency from NG in heat generation systems and its substitution with local alternative energy sources, use of solar energy for hot water production at public buildings, and development of other alternative energy sources. http://economy-zt.gov.ua/files/Strateg/strategia2020.pdf (in Ukrainian) • The economic and social development program of Zhytomyr region for 2019, which was approved by Zhytomyr regional council, defines priorities that include (1) technical retrofitting of heat supply systems by replacement of outdated equipment (boilers, burners, pipelines), decentralization of boiler houses, installation of individual heating units; (2) development of alternative energy sources and implementation of energy saving measures; (3) ensuring 100% heat metering in residential buildings. http://bit.ly/2yHr0w2 (in Ukrainian) • Program on supporting residents and household owner associations of Zhytomyr region in efficient use of energy resources and energy saving for 2015-2020. • Program on increasing energy efficiency of public buildings in Zhytomyr region for 2018- 2022. Similar programs on increasing EE and energy savings exist in other regions and municipalities.
Local energy strategies / concepts (SEAP/SECAP)	Local energy plans are developed by municipalities on a voluntary basis. There are 228 SEAPs/SECAPs developed and submitted by Ukrainian cities and communities within the Covenant of Mayors for Energy and Climate initiative. http://com-east.eu/en/plans-and-actions/action-plans Amongst others, all four cities participating in KeepWarm project have developed and submitted SEAPs/SECAPs: 1) Bila Tserkva - SECAP for the period 2017-2030 was adopted in 2016 and includes DH as a major sector for GHG emissions reduction. The following goals related to DH apply: increase of heat energy generation efficiency to min 92%, replacement of pipelines and reduction of thermal losses to 5%, increasing of RES share to min 50%. 2) Khmelnytskyi - SEAP covers the period 2016-2025. The cut in GHG emissions of DH sector (by 1.4% from the baseline emission inventory levels) is planned to be achieved by reduction of heat distribution losses, modernisation of boiler houses and increased use of alternative fuels. 3) Ternopil - SEAP was adopted in 2013 and covers the period till 2020. The following DH related projects are listed: modernisation of 23 boiler houses, installation of 2 CHP systems, renovation of pipelines and pumping equipment, installation of the 8 MW biomass boiler system, installation of SCADA system, integration of solar heat collectors. 4) Zhytomyr - SEAP covers the period of 2015-2024. The priority actions encompass modernisation of DH system which includes replacement of inefficient NG fired boilers and burners, installation of boilers on alternative fuels, replacement of pipelines with pre-insulated pipes.

UKR	Ukraine
Other strategic documents	a) *The Concept of State Policy Implementation in the area of heat supply* defines expected results of heat supply system modernisation before 2035 as following: • ensuring quality, reliable, safe and affordable DH energy and hot water supply services, as well as an increased payment rate for the services provided; • increase the share of alternative energy sources to 40% and strengthen energy independence of the country; • reduce environmental pressure of heat supply system; • attract foreign investments in the heat supply sector; • ensure efficient operation of DHS operators and reduce debts for energy resource supply; • reduce thermal losses to 10 %; • implement energy saving measures and consumption-based billing. http://zakon.rada.gov.ua/laws/show/569-2017-%D1%80) b) *The goal of the Concept of state policy implementation in the area of climate change for the period till 2030* is to ensure the achievement of nationally determined contribution (NDC) for 2030, which will not exceed 60% of emission level in baseline year 1990, as well as ensure NDC ambition increase before 2020, considering conditions of social and economic development of the country. The start of the process on NDC update has been announced at COP24 and the results are expected by the end of 2019. https://www.kmu.gov.ua/ua/npas/249573705)

B. DHS and their retrofit support in action plans

Renewable energy and energy efficiency are at the core of the Energy Union's priorities. Action plans on EE, RES and GHG mitigation shall provide structured measures and instruments in support of following RES and EE policies and achieving targets at national and EU level. This review shows how and to what extent DHS is being addressed in order to support meeting targets and sustain these levels onwards. Particular interest was not only put to investigation of types of measures, but also if (and how) DHS retrofit has been explicitly addressed. EU members' NEEAPs are accessible through the EC website: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans, while the latest national renewable energy action plans can be found on https://ec.europa.eu/energy/en/topics/renewable-energy/national-renewable-energy-action-plans-2020.

An extensive list of measures can be found in reviewed national action plans on EE and renewables. They are covering technological, regulatory, financial and spatial planning/ mapping aspects of DHS, but the majority of action plans only partially covers multifaceted nature of DH sector development. Specific actions related to DHS can only seldom be found in GHG mitigation action plans. Country specifics in terms of anticipated measures are described below.

AT Austria

National Energy Efficiency action plan (NEEAP)	The (second) NEEAP (*Zweiter Nationaler Energieeffizienzaktionsplan der Republik Österreich 2017gemäß Energieeffizienzrichtlinie 2012/27/EU*, NEEAP 2017) was published in April 2017 by the Federal Ministry of Science, Research and Economy (BMWFW). It appraises DH in a number of exemplary measures (at national and provincial level): • Promotion of biomass DH in Lower Austria as an additional measure in the building sector; • Impulse programme for environmentally friendly energy and energy subsidies through the Provincial environmental fund in the province of Carinthia; • Building renovation strategy in the province of Tyrol. As no new CHP plants have been built in recent years due to non-viable economics, the emphasis is being placed on maintaining the existing plants, in particular those that sustain public DH supply. It refers also to a financing of energy supply measures where for DH subsidies within the framework of the Extension of District Heating and Cooling Infrastructure Act in the sum of approximately 90 MEUR has been made available from Federal Government funds since 2009. https://ec.europa.eu/energy/sites/ener/files/documents/at_neeap_2017_en.pdf
National Renewable energy action plan (NREAP)	The NREAP-AT (*Nationaler Aktionsplan 2010 für erneuerbare Energie für Österreich*), which was published in June 2010 by Austrian Federal Ministry of Economy, Family and Youth (BMWFJ), considers importance of DHS particularly in the following aspects: • mobilising biomass for use in DHS • financial support for new DHC systems • use of waste heat • special focus on small scale DHS (for rural areas) http://www.ebb-eu.org/legis/ActionPlanDirective2009_28/national_renewable_energy_action_plan_austria_de.pdf (in German)
GHG mitigation action plan	The Climate Change Act (*Klimaschutzgesetz*, KSG), enacted in 2011, is one of the major pillars of Austria's climate change policy up to 2020. It sets emission ceilings for a total of six sectors and defines rules on the development and implementation of effective climate mitigation measures outside the EU emissions trading scheme. An annual progress report documents the work accomplished in the context of KSG implementation. In May 2018, the national Climate and Energy Strategy for Austria was adopted. Based on its objectives the Energy and Climate Plan (*Integrierter nationaler Energie- und Klimaplan für Österreich*) was drafted and submitted to the EU Commission in December 2018. The plan is addressing DHS as an important pillar, e.g. related to (1) the use of waste heat and establishing of waste heat distribution grids, (2) switching to high-efficiency DH in the existing building stock, (3) the mitigation of dependency on imported fossil fuel by increased use of biomass, solar heat and ambient heat in DH and (4) assessment of infrastructure measures needed for DHC from RES. https://www.bmnt.gv.at/umwelt/klimaschutz/nekp-entwurf.html (in German)

CRO Croatia

National Energy Efficiency action plan (NEEAP)	The fourth National Energy Efficiency action plan for the period from 2017 to 2019 was drafted in April 2017 as guidance on the energy efficiency policy for the relevant three-year period. It is explicitly addressing heating energy supply security of DHS in Zagreb, Osijek and Sisak. Amongst other EE measures the following can also be considered as related to DHS: detailed mapping of the energy system (HC.1), Replacements and reconstructions of the hot water and steam network (E.7) and Installation of new measurements of temperature and energy losses (E.4). https://ec.europa.eu/energy/sites/ener/files/hr_neeap_2017_en.pdf
National Renewable energy action plan (NREAP)	The Ministry of Economy proposed the National Renewable energy action plan by 2020 in November 2013. It outlines that an increase of the use of RES in DHC systems from the current 1,1 to 2,9 PJ in 2020 is expected. DHS based on RES is primarily considered in smaller urban areas of up to 10 thousand inhabitants, in areas rich in forest biomass and geothermal sources, however in these areas DHS have not been developed yet. The NREAP assumes that by 2020 new DH systems will be developed in 10 to 15 cities and new heating pipeline network in the length of 30 km will be constructed. DHS are listed among EE improvement project, which can participate in the funds of the Environmental Protection and Energy Efficiency Fund (FZOEU) http://europski-fondovi.eu/sites/default/files/dokumenti/Nacionalni%20akcijski%20plan%20za%20obnovljive%20izvore%20energije%20do%202020.%20godine%20%28prijedlog%29.pdf (in Croatian)
GHG mitigation action plan	Croatian Low Carbon strategy (by 2030 with 2050 vision) is under preparation. The background for its development considers DHSs essential for establishing a low carbon energy system. In this relation, opportunities for development of DHS are recognised mainly in improving EE, using biomass and heat pumps, providing ancillary services using heat storage and enabling more flexible operation of large CHP plants. https://mzoe.gov.hr/o-ministarstvu-1065/djelokrug-4925/klima/strategije-planovi-i-programi-1915/strategija-niskougljicnog-razvoja-hrvatske/1930 (in Croatian)

CZ Czech Republic

National Energy Efficiency action plan (NEEAP)	The National Energy Efficiency Action Plan (*Národní akční plán energetické účinnosti*, NAPEE) is prepared by the Ministry of Industry and Trade and describes planned measures to increase EE and energy savings anticipated or achieved, including savings in the supply, transmission and transmission and distribution of energy as well as in final energy use. The first revision of NAPEE was published in 2007. The last (fifth) update is dated of April 2017 and includes “Assessment of the potential for high-efficiency cogeneration and efficient DHC for the Czech Republic” with deep evaluation of DHC systems potential (Annex 5). Resulting from this analysis, CZ needs to create conditions for development of CHP according to “CHP scenario”, which provides highest societal benefits. The concrete measure to achieve strategic targets is operating and investment support for high efficiency CHP. The evaluation of potential for the EE improvement of the DHC infrastructure (Annex 5, Ch. 6) shows that about 1,6 million households (40 %) are connected to DHS. DH networks are of approx. 10 thousand km length, about 15 % of them are steam networks (1458 km). Almost 900 km of steam networks need to be reconstructed which would bring about energy saving of 5,2 PJ. Investment support for DHS retrofits is provided by operating program

CZ Czech Republic

	Energy savings in DHS under the program Enterprise and Innovation for Competitiveness financed by ERDF. https://www.mpo.cz/cz/energetika/energeticka-ucinnost/strategicke-dokumenty/narodni-akcni-plan-energeticke-ucinnosti-cr--150542/ (in Czech)
National Renewable energy action plan (NREAP)	The National Renewable Energy Action Plan (*Národní akční plán pro obnovitelné zdroje energie, NAP pro OZE*) is one of the steps to reduce dependence on fossil fuels. Document was prepared by the Ministry of Industry and Trade and approved by the government in January 2016. AP is based on the Directive 2009/28/EC, setting the targets for CZ at 13% share of renewable energy in gross final energy consumption. The latest revision of *NAP pro OZE* anticipates the following target shares of renewable energy in 2020: 15,3 % in gross final energy consumption and 10 % in gross final consumption in transport. In the sector of heating and cooling the target RES share by 2020 is set at 18,9 %. AP also stipulates concreate measures to achieve the targets, which include operation support for heat produced from biomass and geothermal energy sources, supplied to DHS. https://www.mpo.cz/cz/energetika/elektroenergetika/obnovitelne-zdroje/narodni-akcni-plan-pro-obnovitelne-zdroje-energie--169894/ (in Czech
GHG mitigation action plan	Climate Protection Policy defines the main objectives and measures in the field of climate protection on national level to ensure fulfilment of GHG emissions reduction goals in relation to obligations arising from international agreements. Climate policy is focused on the period 2017-2030 with a view to 2050. Its performance will be assessed by the end of 2021 and the update will be scheduled for the review of commitments under the Paris Agreement by the end of 2023. The main task of Climate policy is to set a suitable mix of cost-effective measures and tools in key sectors, which will ensure the achievement of GHG emissions mitigation goals. https://www.mzp.cz/C1257458002F0DC7/cz/politika_ochrany_klimatu_2017/$FILE/OEOK-POK-20170329.pdf (in Czech) https://www.mzp.cz/C1257458002F0DC7/cz/politika_ochrany_klimatu_2017/$FILE/OEOK-Posouzeni_Natura_2000-20161201.pdf (in Czech)
Other action plans	In the Implementation plan of Strategic Framework Czech Republic 2030 (*Strategický rámec Česká republika 2030*) the following measures are related to DHC: (a) Create suitable economic conditions for energy use of residual municipal waste after sorting out recyclable parts in the new act on waste so that reaching the target for recycling, according to the Circular economy package, would not be endangered; (b) Ensure continuation of operating support for high efficiency CHP and RES heat for installations put into operation from 2021; (c) Equalise conditions of efficient DHS and individual heating systems in the area of internalization of externalities (emissions of pollutants, CO_2, etc.). The recommendations are as following: (a) Increase taxation of fossil fuel consumption in stationary sources outside of CHP in installations not included in EU ETS to the appropriate level corresponding to at least cost of emission implied by expected price of emission allowance; (b) Earmark appropriate resources to incentivise reconstruction and development of efficient DHS after 2020. Use e.g. mechanism of free allocation of allowances for projects of reconstruction and development of efficient DHS; (c) Consolidate available valid statistics of DHS so that it would be possible to monitor share of efficient DHS; (d) Consider possibilities to decrease VAT rate for heat. https://www.cr2030.cz/strategie/dokumenty-ke-stazeni/ (in Czech)

LV Latvia

National Energy Efficiency action plan (NEEAP)	The Draft National energy and climate action plan was submitted to EC for evaluation in December 2018, currently the Plan is being improved by the Ministry of Economics and is to be submitted to EC by the end of 2019. The major long-term targets for the energy performance of buildings: • Promoting EE and use of local RES in DH. • Share of renewable energy in DH: 60%; target indicators: increase of the output from RES (70 MW), reconstructed heating networks (70 km, by 2023), indicative funding: 53 MEUR. https://em.gov.lv/lv/nozares_politika/nacionalais_energetikas_un_klimata_plans/ (in Latvian) https://ec.europa.eu/energy/sites/ener/files/documents/ec_courtesy_translation_lv_necp.pdf In order to improve the efficiency of DHS the activity "*To promote EE and the use of local RES in DH"* is being implemented under the EU funds programme in the 2014-2020 programming period. As part of this activity, support is provided to promote EE and the use of local RES in DH as well reconstruction of heat sources will be supported to improve EE and to switch to the use of RES (incl. purchase and installation of heat generation equipment; energy efficiency improvement of the heat transmission and distribution system and conversion of the cogeneration plant into a heat source). There is expressed a need to attract EU financial support for investments in establishing new regional DH networks and renovating the existing (old) networks in the municipalities where the existing or planned heat network intensity exceeds 2 MWh/m. http://www.buildup.eu/sites/default/files/content/lv_-_energy_efficiency_action_plan_lv.pdf The total funding of the project is estimated at 150 MEUR with co-financing from the Cohesion Fund in the amount of 60 MEUR, and it is planned to continue the programme also in the EU Funds programming period 2021–2027. Within it, a support programme for district cooling systems (in public buildings) is planned to be developed. This contribution is vital for improving and modernising of DHC systems.
National Renewable energy action plan (NREAP)	Action Plan of the Republic of Latvia in the Field of Renewable Energy (*Latvijas Republikas Rīcība atjaunojamās enerģijas…*) for Implementing the Directive2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC by 2020 (LV RES Action Plan 2020): emphasis is placed on the development of the existing DHS, where potential for more extensive use of biomass is exposed for both, DH and electricity generation. https://ec.europa.eu/energy/sites/ener/files/documents/dir_2009_0028_action_plan_latvia.zip
GHG mitigation action plan	The Environmental Policy Strategy for the 2014 – 2020 period was adopted in 2015, setting the annual GHG emission reduction targets which are adjusted to the obligatory targets for 2020, as well as main action directions are given, but DH is not specifically addressed.

SRB Serbia

National Energy Efficiency action plan (NEEAP)	The 3rd Energy Efficiency Action Plan was adopted in December 2016 and includes measures on supply side and end-use sectors covering the period until 2018. The 2020 energy efficiency target was set in the Programme of Implementation of Energy Strategy, which was adopted in November 2017. EEAP stipulates that the main reasons for low efficiency are outdated DH systems, heat plants and heat exchangers, as well as insufficient use of excess heat. Promotion of projects for reconstruction (rehabilitation) and modernisation of these systems was put forward by listing 8 of such projects. Related to efficient heating and cooling measures the following additional (new) measures for the support of DHS were stated: (1) Preparation of heating and cooling strategy with support for local planning (heat maps, etc.); (2) Stabile financing of the CHP support scheme; (3) EKO fund subsidies for sustainable development and increase of competitiveness of DHS (new connections, RES sources, excess heat, heat storages, etc.). http://www.mre.gov.rs/doc/efikasnost-izvori/efikasnost/Treci_akcioni_plan_za_energetsku_efikasnost_Republike_Srbije_za_period_do_2018_godine.pdf
National Renewable energy action plan (NREAP)	National renewable energy action plan of the Republic of Serbia was published by the Ministry of Energy, Development and Environmental Protections in June 2013, setting the RES targets until 2020, as well as the manners of their achievement. Among others, its aim is to enhance investments in the field of RES. The following activities are explicitly addressing DHS: (1) replacement of heating oil, coal and NG used for heating with biomass and other RES; (2) introduction of DHS based on the use of RES and CHP production; The development of distribution network for the connection of smaller electricity producers can be also treated as activity related to the previous one. Incentives ensured through the continuation of established support scheme for electricity generation from RES and CHP production with high efficiency are envisaged, as well as the preparation of guidelines for supporting the production of heat from RES at the local level, direct financial stimulations and corresponding taxation policy. The following overall national target is set: the share of RES should increase from 21.2 % in 2011 to 27.0 % in 2020. The 2016 energy statistics revealed that Serbia has reached only 20,9%, which is well below the 23,8% indicative trajectory, hence the country is at risk of not meeting the 27% renewable energy target in 2020. A target is also set for the heating and cooling sector: the increase of RES share from 1.059 ktoe in 2009 to 1.167 ktoe in 2020, which amounts to 10.2%. http://www.mre.gov.rs/doc/efikasnost-izvori/NREAP%20OF%20REPUBLIC%20OF%20SERBIA%2028_June_2013.pdf?uri=CELEX:32009L0028 (in Serbian)
GHG mitigation action plan	The GHG inventory was prepared according to the Tier 1 approach of the 2006 IPCC and for the years from 2010 until 2013. The First Biennial Update Report of the Republic of Serbia under the United Nations Framework Convention on Climate Change was published in February 2016 by the Ministry of Agriculture and Environmental Protection. Twelve Nationally Appropriate Mitigation Actions (NAMA) plans are overviewed, out of which 4 can be associated with DHS: one using solar energy for distribution of hot water for domestic use, one incorporating 1000 MW of small biomass boilers, one related to expansion of existing heating network, and one for introduction of system for metering consumption in DHS. http://www.klimatskepromene.rs/uploads/useruploads/Documents/E-version_FBUR-engleski-2016.pdf

SI Slovenia

National Energy Efficiency action plan (NEEAP)	Issued by the Ministry of Infrastructure in May 2015, it set Slovene 2020 national target for improving EE by 20 %. Measures to increase the efficiency of DHS are listed among the types of energy service and energy efficiency measures for achieving energy savings by liable entities (energy suppliers' obligations). The development of small DHS using wood biomass is encouraging. Amongst the main measures for promoting CHP, efficient DHC and other energy-efficient heating and cooling systems it is mentioned that improvements to DHS to be made by liable entities can also be included as eligible measures in terms of energy suppliers' obligations to achieve energy savings. There is also co-financing programme for the construction of DHS using wood biomass which enables the allocation of grants for the co-financing of projects for district heating using wood biomass (DHWB). Financial incentives are intended for investments in new DHWB systems and micro-systems, as well as the expansion of existing DHWB systems and the construction of new boiler rooms containing wood biomass boilers as a source for existing DH. The programme started in the framework of Operational Programme for Environmental and Transport Infrastructure Development 2007–2013 and is continued under the Operational Programme for the Implementation of European Cohesion Policy 2014–2020 (OP-EKP), which, besides 14 MEUR EU funds, ensured 2,5 MEUR for related investment activities. New additional measures for the support of DHS within measure for efficient heating and cooling encompass: • Preparation of Heating and cooling strategy with support for local planning (heat maps, etc.); • Stabile financing of the CHP support scheme; • EKO fund subsidies for sustainable development and increase of competitiveness of DHS (new connections, RES sources, excess heat, heat storages, etc.). The average annual losses at distribution in 2018 were estimated at 14,6 % of gross heat generated thus being 1,1% lower than in 2012. In general trends of reducing losses in DHS demonstrate positive impact of improvement measures.
National Renewable energy action plan (NREAP)	Slovene NREAP for the period 2010-2020 was published in July 2010 with an update dated of June 2017, but this renewal has not been officially accepted yet. The following major DHS related measures are defined: (1) As part of innovative systems for local energy supply subsidies for DHS using wood biomass and geothermal energy are defined where public tenders for financing DHWB and for promoting systems of DH using geothermal energy were envisaged. (2) As additional policies and measures (a) introduction of support scheme - system of feed-in incentives was accepted to hook up/produce heat from RES resulted in development of CHP systems and (b) Obligatory shares of RES in DHS shall be set in the Energy Act (Share_RES >=20 %; Share_RES + Share_CHP >= 80 %).

SI Slovenia

	NREAP promotes that the Rules on efficient energy use in buildings, setting out that connection to DHS operating on RES is one of means of gradual transition from fossil fuels to RES in heating all kinds of buildings. One of the guidelines (as part of the abovementioned Rules) promoted exclusive use of RES or CHP or district heating in all new buildings with offtake of more than 250 kW (from 2012 on). (3) Provision of urban planning guidelines for planning systems using RES in the built environment (by ministry responsible of the environment and spatial planning). The action plan also includes technical specifications for the required standards of quality for wood biomass boilers, which are part of DHS. The need for drawing up the Guidance for planning RES is set out. This guidance shall ensure that obligatory local energy concepts will enforce to incorporate the best combination of RES, high-efficiency technology and DHC in planning, designing, constructing and renewing industrial or residential areas. In order to promote DHC infrastructure development, NREAP envisaged sub-programme of the National Energy Programme, which would formulate, adopt and implement intensive development strategies for local energy, relying on high-efficiency CHP, RES and DHC systems. One of the operational objectives was the construction of new DHS, based exclusively on high-efficiency CHP or RES and waste heat from industrial processes from 2012 on.
GHG mitigation action plan	Operational programme of GHG emissions reduction till 2020 (*Operativni program ukrepov zmanjšanja emisij toplogrednih plinov do leta 2020*) which was published in December 2014 stresses the role of DHS in relation to air quality and reduction GHG emissions only in the following manner: (1) individual heating systems are not encouraged if they replace DHS; (2) possible prioritisation of DH in areas with an adopted decree on the air quality plan; (3) when designing incentives for the heating sector in buildings and settlements, DH has the highest priority order of heat supply according to the energy source.

UKR Ukraine

National Energy Efficiency action plan (NEEAP)	The goal of the NEEAP till 2020 is to achieve energy savings at the level of 9% from the average final energy consumption for the period 2005-2009. Amongst prescribed actions there is modernisation of heat supply systems. The average annual final energy consumption supplied by DHS in the period 2005-2009 was 15.9 mtoe. The action plan is aiming at introduction of 100% commercial metering for heat energy supply and introduction of stimulating tariff regulation (tariff incentives for the reduction of heat energy consumption). It is expected that in residential buildings sector the largest energy savings could be achieved by modernisation of heat supply and related systems (thermal insulation, boilers replacement, heat pumps), increasing the share of DH networks, as well as installation of hot water production equipment (with possible use of solar energy). The action plan also foresees the establishment of Energy Efficiency Fund as

UKR	Ukraine
	a transparent and stable tool for financing EE measures in residential and public buildings and heat supply systems facilities. http://zakon.rada.gov.ua/laws/show/1228-2015-%D1%80 (in Ukrainian)
National Renewable energy action plan (NREAP)	The NREAP for the period till 2020 exposes important role of biomass in heat energy generation balance, where the heat generated from biomass is expected to increase from 2.28 mtoe in 2014 to 5.0 mtoe in 2020. Besides, the action plan notes large reserves of thermal water in Chernigiv, Poltava, Kharkiv, Lugansk and Sumy regions, which could also be used for supply of DHS. http://zakon.rada.gov.ua/laws/show/902-2014-%D1%80 (in Ukrainian)
GHG mitigation action plan	In the currently accepted Concept of state policy implementation in the area of climate change for the period till 2030 there are no specific actions related to DHS.

C. Comprehensive assessment of the potential for the application of high-efficiency CHP and DHC

In order to promote cogeneration and DH in Europe, the EED (Art. 14) required each EU country to carry out a comprehensive assessment (CA) of the national potential of CHP and DHC as the main user of cogeneration. The first CA had to be done by December 2015. The outcome per EU countries has been presented on https://ec.europa.eu/energy/en/topics/energy-efficiency/cogeneration-heat-and-power.
There has been observed that DH shares of the heat supply and related RES shares have substantial variations across Europe. The importance of waste heat and cold, which can be integrated into DH networks, has been stressed in the recast of the Renewable Energy Directive (RED II). This requires EU member states to carry out an assessment of the use of waste heat and cold as part of the CA conducted under Art. 14 of the EED to guide the development of national measures.

The key highlights of country assessments are outlined below. CA was provided in all 5 EU member states which were covered with this review, but not in non-EU countries (SRB, UKR) as they were not committed to it. The potential of new DHS was assessed in all reviewed EU pilot countries, while the retrofit potential was only barely tackled and quantified. The results of the country-specific assessment are presented in very different ways and are difficult to compare. Besides, the results of the analysis in some countries are considered to be questionable or unrealistic either because of incomplete data or vague methodology. From the available data, it is actually impossible to estimate the quantity or share of heat and cold supply potential in DHC systems, hence more harmonised approach to the assessment and reporting would be highly desirable. Additional instructions on CA methodology might be needed.

AT Austria

Assessed potential of new DHS	On behalf of the Austrian Federal Ministry of Science and Economics (BMWFW) the comprehensive assessment was conducted by TUW and ECOFYS. Technical potentials for DH, CHP, waste heat, geothermal heat, solar thermal and DC and economic potentials of these technologies for regions with high technical DH potential have been analysed. The maximum annual technical potential of DHS (incl. CHP) is estimated at 120 TWh_{th} wherein the estimate of reduced technical potential reaches 42 TWh_{th}. Current heat demand for household heating and hot water preparation totals to 89 TWh_{th}, while heat production in DHS is 23,5 TWh_{th}. More than 10 TWh_{th} of this heat comes from biomass DHS and CHPs. The potential of district cooling is estimated at 0.3 TWh_{th} The analysed potential relates to the new DHS as well as the expansion of existing ones. https://ec.europa.eu/energy/sites/ener/files/documents/at_report_en.pdf
DHS retrofit potential	Retrofit potential of the DHS was not assessed.
Assessed CHP potential in DHS	The maximum technical potential for CHP is 57 TWh_{th} per year, while potential in the existing DHS equals to 10,2 TWh_{th}. The reduced technical potential (assuming connection rate of 45 % in areas with heat densities of >20 GWh/km^2) is assessed with 20 TWh_{th}. 11,4 TWh_{th} are currently produced in CHP plants with the following quantities according to the fuel: 5,5 TWh_{th} - gas CHP, 4,6 TWh_{th} - biomass CHPs, 1,3 TWh_{th} - oil and coal CHP.
Policy and newly proposed measures related to DHS and DHS retrofit	• Reductions in grid return-flow temperatures • Consumer-side efficiency measures such as cascading heat usage and/or increased use of panel heating • Keeping exhaust gas temperatures as low as possible (CHP systems)

CRO Croatia

Assessed potential of new DHS	The Programme of Exploiting Heating and Cooling Efficiency Potential for 2016-2030 was elaborated by the Ministry of the Economy in November 2015. In the first chapter, it outlines the development potential of DHC systems identifying 18 locations with the technical potential of 8.4 TWh of annual heat exploitation by 2030. DC potential was only mentioned as an additional possibility if DHS is already in operation and there is potential to use cogeneration units with absorption heat pumps. https://ec.europa.eu/energy/sites/ener/files/documents/croatia_report_eed_art_141update_en.pdf
DHS retrofit potential	In total, 15 DHSs were analysed but because of incomplete and limited data and of their questionable quality, resulting in unrealistic EE indicators, it is impossible to quantify energy savings. The potential for energy savings very likely exists but, given the ratio of the prices of thermal energy supplied and required investments, their economic viability can be questionable and needs more detailed investigation.

CRO	Croatia
Assessed CHP potential in DHS	The potential for additional (new) high-efficiency CHP in 2030 is presented in Chapter 9.2 of the Programme of Exploiting Heating and Cooling Efficiency Potential for 2016-2030. In the conservative scenario there are six potential locations (cities) for high-efficiency cogeneration identified with an estimated installed heat power of 956 MW, annual heat production of 1.53 TWh and electricity production of 2.40 TWh. Shares of consumers connected to high-efficient CHP vary depending on the location from 25 to 55%. The optimistic scenario (presented in chapter 9.3 and Table 53/Annex 14.1) recognises 18 potential locations for high-efficient CHP where estimated installed heat power in 2030 equals to 2.903 MW, annual heat production is estimated at 4.62 TWh and electricity production at 7.26 TWh. Shares of consumers connected to high-efficient CHP vary depending on the location from 30 to 80%.
Policy and newly proposed measures related to DHS and DHS retrofit	• Integration of new burners • Replacement of conventional boilers with cogeneration plants • Replacement of pipes in distribution networks • Construction of heat storages – buffers • Installation of variable speed pumps • Replacement of heat substations • Installation of thermoregulation valves in heat substations • Installation of regulating and measuring equipment in new buildings

Czech Republic

CZ	Czech Republic
Assessed potential of new DHS	The results of the assessment are presented in a document “Assessment of the potential for high-efficiency combined heat and power generation and efficient DHC for the Czech Republic” which was issued in December 2015. The evaluation of potential of new DHS was not assessed, only expansion of existing systems is expected. https://ec.europa.eu/energy/sites/ener/files/documents/cz_report_eed_art_141_en.pdf
DHS retrofit potential	In general, the most significant potential for reducing losses in mains is with upgrading DH network generation from steam to hot water or pre-insulated pipes (in total length of 1458 km, where 1129 km are used for building heat supply). The old steam networks are characterised by average annual losses five times higher than those of hot water or pre-insulated networks. The estimated length of steam DH networks being considered as urgent for reconstruction is 900 km, using the average for pro rata losses achieved by replacing steam mains of 5,7 GJ/m/annum, the expected overall annual energy savings can be quantified at 5,2 PJ. This would result in an increase of heat distribution efficiency of roughly 30%. The costs of the mentioned DH network upgrade can be estimated between 21 and 28 million CZK/km (0,8 to 1,1 MEUR/km), which totals at a level of 19 to 24 bn CZK (740 to 930 MEUR), for the whole steam network designated for urgent reconstruction.

CZ Czech Republic

Assessed CHP potential in DHS	The potential for developing high-efficiency CHP has been identified in particular for small and medium cogeneration units with power outputs at the level of up to 5 MWe, which are typically installed in DHS of smaller towns or companies. It is expected that the fuel structure in CHP-based power generation will, under the pressure of stricter and stricter emission limits, be switching from coal to natural gas, alternatively, according to local conditions, to biomass, biogas or other fuels. A growth in high-efficiency CHP can also be assumed in the development of the energy use from waste (incineration), but is dependent on stable economic stimuli for investors and source operators. For large sources, only limited growth potential of high-efficiency CHP was identified. Heat from large sources such as heat plants, factory power stations but also the majority of power stations is currently largely applied at the generation point, or is transferred to the consumer using a DHS. Gradual fuel switch (co-combustion of RES or alternative fuels) or an improvement in CHP parameters (to achieve greater efficiency or primary energy savings) is likely to take place in DHS with large sources. However, in large sources one should not ignore the risk of a possible reduction in electricity generation from high-efficiency CHP. Current trends in the energy markets (and their consequences in the form of a reduction in the wholesale price of electricity) may cause a slowdown in high-efficiency CHP electricity generation at large sources and a shift to a partially heat-plant operating regime. The majority of large heat sources use solid fossil fuels (coal). The retention of the existing level of electricity generation from high-efficiency CHP is therefore also threatened by tightening of environmental requirements and the expected growth in the cost of CO_2 permits.
Policy and newly proposed measures related to DHS and DHS retrofit	Proposed measures to support high-efficiency CHP and DHC: • Securing the continuation of operational support for high-efficiency CHP and heat from RES, compatible with EU public aid rules for new equipment commissioned 2016 onwards and legislatively anchoring the support scheme in an appropriate manner; • An increase in taxation of fossil fuel consumption in stationary sources excluding CHP in equipment not falling with the emissions trading system at a level matching the CO_2 emissions price from the expected permit price; • As part of the update to the National Smart Networks Action Plan, evaluate the options for providing support services at the distribution system level (voltage regulation, regulation of idle capacity, short-circuit contribution, blackstart, off-grid operations, etc.); • Include the primary energy factor for efficient heat supply networks in the energy efficiency evaluation for buildings (amendment to Decree No 78/2013); • Accelerate and simplify the permitting processes for high-efficiency CHP facilities and for the construction and reconstruction of heat networks; • Set motivational economic conditions for the energy use of the municipal waste remaining after the sorting of recyclable items. Link possible public support to the use of heat; • Securing corresponding funds to stimulate reconstruction and development of DHS after 2020 using inter alia some of the funds from selling GHG emission permits and other support mechanisms.

CZ Czech Republic

Other	**Energy Performance Report of the Heat sector in 2016** The Report on the Development of the Energy Sector in the Field of Production, Use and Distribution of Heat (*Zpráva o vývoji energetiky v oblasti tepla za rok 2016*) was prepared by the Ministry of Industry and Trade (MIT) on the basis of the instrument defined in the State Energy Concept (SEP). The report focuses on development, the main trends and changes in the heat sector in the period 2010-2016 and the expected outlook. The statistics published in this report are prepared in Eurostat methodology to ensure full compatibility of data with EC materials. https://www.mpo.cz/cz/energetika/strategicke-a-koncepcni-dokumenty/zprava-o-vyvoji-energetiky-v-oblasti-tepla-za-rok-2016--235225/ (in Czech)

LV Latvia

Assessed potential of new DHS	The potential was evaluated by PricewaterhouseCoopers SIA on behalf of the Ministry of the Economy and reported in a dedicated study (demanded by EU), which was published in February 2016. DH was characterised by (1) a high level of efficiency resulting from relatively high share of efficient cogeneration in Latvia (72.6 % of total produced heat), (2) high energy losses in the network, which lower its efficiency level and (3) by highly investment intensive infrastructure with high operation and maintenance costs. Overall, about 34% of heat demand is satisfied by DH. In accordance with the condition of a plot ratio larger than 0.3, nine Latvian cities and four suburban municipalities (of Riga) were identified and potentials (e.g. for connecting new consumers, building new infrastructure, heat recovery…) analysed. Heat consumption in the selected cities/municipalities account for about 48 % of the national heat consumed by DH. The highest potential for new DHS is in the household sector, however only limited interest from households and industries to connect was observed, since most of them prefer individual heating solutions for economic reasons. https://ec.europa.eu/energy/sites/ener/files/documents/Latvia_Art%2014_1assessment%20EN.pdf
DHS retrofit potential	Since 1998 the renovation and upgrading of DH systems has been ongoing. The aforementioned study notes that “from city development plans and heat network statistics it can be concluded that it is necessary to carry out the renovation of heat networks in order to reduce heat losses and thus heat tariffs as well”. Energy savings, which can be achieved by renovation of networks and production units are not quantified in the CA.
Assessed CHP potential in DHS	Almost three quarters of heat supplied to DH systems in Latvia is produced by CHP, in some cases these shares are approaching much higher figures, e.g. in Jelgava, with 97% of heat produced by CHP and 85% of RES. The initially mentioned analysis indicates that there is very limited and localised (e.g. in cities of Daugavpils, Liepāja and Jūrmala) potential for introduction of high efficiency cogeneration in DH but a more in-depth financial analysis of particular cases is needed. By implementing the cogeneration projects with identified potential, the share of cogeneration in DH could rise from the present 72.6 % to 75.7 % in 2020. The calculations were based on electricity and heat market prices. https://ec.europa.eu/energy/sites/ener/files/documents/lv_neeap_2017_en_0.pdf;
Policy and newly proposed	In order to realise the potential for DH, it is necessary to develop economic incentives for final consumers to ensure that the costs of DH do not exceed the costs of alternative individual heating. Such incentives mostly represent

LV Latvia

measures related to DHS and DHS retrofit	measures to achieve a reduction in the total heat tariff in the DH system; inter alia it is necessary to attract EU financial support for investments in establishing new regional DH networks and renovating the existing (old) networks in the municipalities where the existing or planned linear heat density of network exceeds 2 MWh/m. In addition, operation and maintenance processes of DH operators and the related costs should be reviewed and optimised. Faster implementation of EE improvement measures in the DH supply is hampered by lack of investments, limited borrowing capacity of municipalities and slow rate of capital turnover. Complex renovation of these systems may optimise the energy production process and reduce thermal losses in transmission systems. In the local territorial planning activities municipalities should take account of waste heat (e.g. from production processes), assess locations and capacities of the existing heat sources and analyse the possibility of connecting them to DH. The strategic policies should be adopted by the Ministry of the Economy in order to ensure uniform management process and an assessment of the results achieved.

SRB Serbia

Assessed potential of new DHS	Comprehensive assessment regarding Article 14 of the EED has not been done (Serbia is not a member of EU), as well as the potential of new DHS has not been explicitly assessed in any other document.
DHS retrofit potential	Data from the *Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030,* presented in 2015 reveal that financial funds necessary for the investments into systems for heat production and distribution by 2020 are estimated at 240 MEUR. The main share of this sum is dedicated to rehabilitation of distribution network (105 MEUR), followed by reconstruction, modernisation and construction of heat sources (90 MEUR) and rehabilitation of heating substations (45 MEUR). The rough estimate of further investments in these systems in the period 2020 – 2025 amounts to 130 MEUR and additional 180 MEUR is estimated in the period 2025 – 2030. http://www.mre.gov.rs/doc/efikasnost-izvori/23.06.02016%20energy%20sector%20development%20strategy%20of%20the%20republic%20of%20serbia.pdf
Assessed CHP potential in DHS	Assessment of CHP potential in DHS can be found in the *National renewable energy action plan of the Republic of Serbia* (issued in 2013) in the Table 9b where it is stated that biomass sourced heat from CHP plants is estimated at 45 ktoe and biogas (manure) sourced heat from CHP plants is estimated at 10 ktoe. Http://www.mre.gov.rs/doc/efikasnost-izvori/NREAP%20OF%20REPUBLIC%20OF%20SERBIA%2028_June_2013.pdf?Uri=CELEX:32009L0028
Policy and newly proposed measures related to DHS and DHS retrofit	There are no other measures proposed in addition to the existing ones defined in (1) Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030, (2) Decree on Establishment of Implementation Program of the Energy Sector Development Strategy of the Republic of Serbia for the period to 2025 year with projections to 2030 and (3) National renewable energy action plan of the Republic of Serbia. Presently, there are no specific nationwide incentive measures for heat production, regardless of fuel type.

SI Slovenia

Assessed potential of new DHS	The potential of new DHS was not assessed (only the expansion of existing DHS). The analysis was based on the calculation of linear heat density (LHD) and not on spatial analytics provided at an appropriate scale. Distribution system potential was assessed for all (91) DHS but was found that only 20 of them have LHD above 2.5 MWh/m, which was set as the limit for estimation of available DHS potential. The total heat potential for expanding existing DHSs is estimated at 800 GWh per year. https://ec.europa.eu/energy/sites/ener/files/documents/strokovne_podlage_porocilo-_24_en.pdf
DHS retrofit potential	Was not assessed.
Assessed CHP potential in DHS	The potential for additional high-efficiency cogeneration was estimated using the criterion of specific consumption amounting to 120 TJ/km^2 (330 MWh/ha). Results of this analysis indicate two locations, which are limited to the narrower areas of the cities of Ljubljana and Maribor. The heat supply potential that can be met by DHS in Ljubljana amounts to 370 GWh, while in Maribor this is 152 GWh. These figures are based on the projection of thermal energy consumption in 2035. Comparison of CA results with some other estimates (at the local level) shows that the methodology used to evaluate the DHC potential does not generate realistic results.
Policy and newly proposed measures related to DHS and DHS retrofit	The review of possibilities to increase EE of the existing infrastructure is limited to a few general notes on DHS state-of-art, not including any actual proposals of policies or measures.

UKR Ukraine

The Comprehensive assessment (CA) according to Article 14 of the EED has not been performed for Ukraine, while this task is obligatory only to EU member states.

D. Key support instruments for DHS operation and retrofitting

In order to encourage the implementation of activities introduced through action plans, it is essential to ensure a diverse set of effective support instruments.

The country review below provides an overview of financial and other supportive instruments that could enhance operation of DHS and/or its retrofit. It is indicated whether there is a specific support instrument available in each country, along with comments about some existing barriers or problems, links to information sources, etc. Effectiveness is marked with the following symbols: ☺ high, 😐 mean and ☹ poor (or not effective).

Investment subsidies for new DHS

Country	*Exists*	*Effective*	*Comment*
AT	Yes	☺	Environmental subsidies *Umweltförderung im Inland* in support of building new and expansion of existing RES DHS. Resources are limited and due to huge interest, additional resources will be provided in 2019. https://www.umweltfoerderung.at/betriebe/nahwaermeversorgung-auf-basis-erneuerbarer-energietraeger/navigator/waerme/neubau-und-ausbau-von-waermenetzen.html (in German) Use of Energy alternatives – Rural Development 14-20: subsidies for new and expansion of small-scale biomass DHS operated by farmers. https://www.umweltfoerderung.at/betriebe/umstieg-auf-energiealternativen-in-der-landwirtschaft/navigator/waerme/umstieg-auf-energiealternativen-in-der-landwirtschaft.html (in German)
CRO	No		
CZ	Yes	😐	Very complex requirements on applications, lengthy evaluation and approval process.
LV	No		An EE programme in the framework of the Operational Programme “Growth and Employment” is intended also for improving and modernising the DH systems but no subsidies are specifically focused on new DH. It is planned to develop a support programme for the centralised (district) cooling system in the framework of the programming period of the EU funds for 2021-2027. https://ec.europa.eu/energy/sites/ener/files/documents/ec_courtesy_translation_lv_necp.pdf
SRB	No		No subsidies are specifically focused on new DHS (only instruments quoted for “Investment subsidies for DHS retrofit”).
SI	Yes	☺	**Cohesion policy funds** – subsidies for new and expansion of existing RES DHS (limited resources, due to huge interest, additional resources will be provided in 2019) http://www.eu-skladi.si/
UKR	No		There are no (direct) investment subsidies for (construction of) new DHS.

Investment subsidies for DHS retrofit

Country	*Exists*	*Effective*	*Comment*
AT	Yes	☺	Environmental subsidies *Umweltförderung im Inland* aiming at optimization of DHS https://www.umweltfoerderung.at/betriebe/nahwaermeversorgung-auf-basis-erneuerbarer-energietraeger/navigator/waerme/optimierung-von-nahwaermeanlagen-1.html (in German)
CRO	Yes	😐	Cohesion policy funds – specific objective 4c3 - subsidies for increasing district heating energy efficiency – 80 MEUR for network reconstruction https://strukturnifondovi.hr/wp-content/uploads/2017/03/OPKK_eng-1.pdf (in Croatian)
CZ	Yes	😐	Very complex requirements on applications, lengthy evaluation and approval process.
LV	Yes	😐	EU funds and banks offer loans for improvement of DHS. Type of support: grant in tune of 30 to 40 % of eligible project costs (1st call in 2017, 2nd call in 2018); grant amount planned to be increased to 60% for the 3rd call (in plan by end of 2019). The total funding: 150 MEUR through co-financing by the CF of 60 MEUR. It will continue in the programming period of the EU funds from 2021 to 2027. Faster implementation of EE improvement measures in the DH supply is hampered by lack of investments, limited borrowing capacity of municipalities and slow rate of capital turnover.
SRB	Yes	☺	Fund for the EE improvement is intended for such purposes but designated to local self-government units only. The funding is managed through public calls on an annual basis. www.mre.gov.rs/javni-pozivi.php (in Serbian) Partial grant funding is possible when obtaining soft loans (see international financial organizations and banks listed under “Soft loans and other financing”). Subsidies in the form of grant funding may be obtained from the IPA projects (an EU Instrument for Pre-accession Assistance) related to EE and renewables. There are also national grants (e.g. Switzerland, Norway) where funding can be obtained for projects related to EE, use of RES and public (municipal) projects, i.e. projects for improving living conditions, but these funds are limited and available on occasional basis.
SI	No		**ECO fund** – subsidies planned (not yet available)
UKR	Yes	☺	State Regional Development Fund supports modernisation projects involving heat supply networks and boiler houses according to the proposals submitted by regional authorities. http://dfrr.minregion.gov.ua/ Investment subsidies (grants) for DHS retrofit are available by international financial organizations and cooperation agencies active in Ukraine, in particular E5P Fund and NEFCO. http://ukraine.e5p.eu/, https://www.nefco.org/

Investment subsidies for consumers

Country	*Exists*	*Effective*	*Comment*
AT	Yes	😐	Connection subsidies for companies: https://www.umweltfoerderung.at/betriebe.html (in German; DH listed inside "Wärme") Connection subsidies for private customers: http://www.wohnbau.steiermark.at/cms/beitrag/12637670/113383975/ (in German) Connection subsidies (switch from existing oil boiler): https://www.umweltfoerderung.at/index.php?id=577 (in German)
CRO	No		
CZ	No		
LV	No		Incentives are mostly aiming at reduction in the total heat tariff in the DH system.
SRB	No		
SI	Yes	😐	Ensured through Eco Fund programme, mainly for connection of new DH consumers.
UKR	Yes	☺	Subsidies for the purchase of EE equipment and materials for citizens are available within special state economic program on EE and development of energy generation from RES and alternative fuels (so-called "Warm Loans Program"). This programme stimulates individual households and home-owners' associations to reduce energy consumption in buildings and substitute NG with other energy sources. The normal reimbursement rate is between 35-40%, but can be increased up to 70% for individuals receiving social subsidies. The IQ Energy program, financed by EBRD, is also providing subsidies for consumers (targeting residential sector). The loans have been made as part of Ukraine Residential Energy Efficiency Financing Facility (UREEFF), otherwise known as IQ energy, designed to promote EE investments. http://www.iqenergy.org.ua/ (in Ukrainian) Energy Efficiency Fund is expected to start operation in 2019 and will support EE measures in buildings.

Soft loans and other financing

Country	*Exists*	*Effective*	*Comment*
AT	No		
CRO	No		
CZ	No		

Country	Exists	Effective	Comment
LV	Yes	😐	DHS may arrange the necessary co-financing in commercial banks, in Treasury (if it has municipal shares), but very often due to huge customer debt share their turnover is limited and therefore their financial needs can't be fully satisfied by banks/funds.
SRB	Yes	☺	Soft loans for (1) increasing EE and use of RES can be obtained by KfW (Kreditanstalt für Wiederaufbau), GGF (Green for Growth Fund), WEBSEFF (Western Balkans Sustainable Energy Financing Facility), EBRD (European Bank for Reconstruction and Development), WBIF (Western Balkans Investment Framework), (2) for use of RES by GEF (Global Environmental Facility) and (3) for projects related to climate change and biomass use by GEF (Global Environmental Facility) and IFC (International Finance Corporation.
SI	Yes	😐	Interest rates of soft loans offered by Eko Sklad (Eco Fund) are similar to the interest rates of commercial banks (e.g. DBS). www.ekosklad.si, www.dbs.si
UKR	Yes	😐	Available from international financial institutions active in Ukraine, including: (1) WorldBank, The District Heating Energy Efficiency Project (2014-2020), (2) European Bank for Reconstruction and Development (EBRD) and Clean Technology Fund (CTF), and (3) NEFCO. http://projects.worldbank.org/P132741/district-heating-energy-efficiency?lang=en https://www.ebrd.com/, https://www.nefco.org/

Tax incentives

Country	Exists	Effective	Comment
AT	No		
CRO	No		
CZ	Yes	☺	Reduced VAT rate of 15 % will be further decreased to 10 % effective 1 January 2020.
LV	Yes	😐	Taxation of electricity produced from RES or high-efficiency CHP is currently admitted as heavy burden to the economy, hence subsidised energy taxation system is under revision (will determine tax in tune of 15% from received renewable energy support).
SRB	No		
SI	No		
UKR	No		

Energy savings obligation scheme

Country	*Exists*	*Effective*	*Comment*
AT	Yes	😐	Only (a few) very large DHS are obliged to show annual savings. GHG saving is allocated to subsidy provider.
CRO	No		
CZ	No		
LV	Yes	☺	No previous experience in the implementation of the Energy Efficiency Obligation Scheme (EEOS) or its elements.
SRB	No		
SI	Yes	☺	DHS retrofit savings are eligible measure – incentive for retrofit implementation and potential additional financial resource for retrofit implementation.
UKR	No		

Support for electricity from CHP

Country	*Exists*	*Effective*	*Comment*
AT	Yes	😐	Feed-in tariffs only for small scale biomass CHP (<500 kW_{el}), the allocated budget is very limited. Currently there proceeds a political negotiation process about follow-up tariffs for existing large CHPs (>500 kW_{el}). Lots of them are expected to cease the operation.
CRO	Yes	😐	Defined according to the size of the cogeneration as referent price of electricity, depends on the date of the contract signature, since corrections lowering the FIT were introduced https://www.hrote.hr/poticajne-cijene (in Croatian)
CZ	Yes	☺	Support to new installations is only approved until the end of 2020 and applies solely to installations of up to 1 MW. Only very limited number of installations up to 2 MW can be supported.
LV	Yes	😐	The costs incurred in supporting the generation of electricity from RES or high-efficiency CHP are covered by all Latvian electricity end-users in proportion to their electricity consumption (the price includes mandatory procurement component).
SRB	Yes	☺	Feed-in tariffs are regulated by Decree on Incentive Measures for Electricity Generation from Renewable Energy Sources and High-Efficiency Cogeneration of Electricity and Heat and mainly depend on the type of RES technology. The validity of the Decree has been extended till end of 2019. http://www.mre.gov.rs/doc/efikasnost-izvori/Uredba%20o%20podsticajnim%20merama.pdf in Serbian)
SI	Yes	☺	

Country	Exists	Effective	Comment
UKR	Yes	☺	Green tariff for electricity generated from biomass (defined by Law on Alternative Energy Types) – will be applied till 2030, the height will be gradually reduced. The tariff increase (by 5 - 10%) is possible for power plants, which equipment is manufactured in Ukraine and exceeds 30% or 50% of CAPEX respectfully. The level of green tariff is adjusted to fluctuations of national currency exchange rate to Euro.

Obligatory share of RES or CHP in heat supply

Country	Exists	Comment
AT	No	
CRO	No	
CZ	No	
LV	No	Measures to promote the use of biomass in electricity and thermal energy generation as well as increase of RES installation by 30% are planned.
SRB	No	
SI	No	
UKR	No	National and regional development strategies and concepts include only specific goals with respect to RES share in heat supply.

Obligatory connection to DHS (e.g. for new buildings and neighbourhoods) / Fossil fuel boilers phase-out plans or bans

Country	Exists	Effective	Comment
AT	Yes	😐	Municipality can mandate the connection to DHS for new buildings, but it is rarely done. There are governmental plans for phasing out oil boilers: installation of new shall be banned by 2020; older than 25 years, should be banned by 2025.
CRO	No		
CZ	No		During the construction of new buildings or a major refurbishment of an existing building with an installed heat generation capacity above 200 kW, a feasibility study on alternative energy supply systems (including DH) needs to be provided.
LV	No		There are new measures foreseen in NECP regarding application of CO_2 Nature Resource Tax (in tune of 50%) to stationary heating equipment, installed/located in buildings with technical possibility to switch to DHS.

Country	Exists	Effective	Comment
SRB	No		
SI	Yes	😐	Municipality can mandate the connection to DHS (for new buildings) based on Energy Law and in connection with their local energy concept. In practice this is regulated by municipal decree on priority use of energy sources for heating. The conditions for connection are normally specified in the system operating instructions (issued by heat distributor). Wood biomass boilers and other RES based solutions are encouraged to phase-out fossil fuel boilers.
UKR	No		The owner of a building can submit application to receive technical conditions for the connection to DHS, but is not obliged to do so. If installation of modular boiler house or individual heating solutions are technically and economically feasible the owner can decide not to connect to a DHS. The cost of connection is covered by the investor.

Local / regional energy concepts

Country	Exists	Effective	Comment
AT	Yes	😐	A number of LECs exist, but most of them are not very effective.
CRO	Yes	☹	Several of them proposed construction of new DHS, retrofit of existing DHS and introduction of renewables but were not implemented by now.
CZ	Yes	☹	The quality of LECs is mixed but most importantly these documents cannot be effectively enforced in practice.
LV	Yes	😐	
SRB	Yes	😐	In SEAPs (or similar strategic documents), cities with DHS generally place district heating as principle mean of heating.
SI	Yes	😐	LEC is an obligatory document for all municipalities, actually all of them have it ready but an update period of the document is long (the average age of these documents is currently about 7-8 years). In practice LEC outlines existing demand and supply sources, but often does not provide analyses of potentials, strategies and conceptual development plans. The link with the municipal spatial plans and other acts of local communities is as a rule weak, hence implementation of planned measures in questionable or not even applicable.
UKR	Yes	😐	There is only limited information on the monitoring of SEAPs/SECAPs implementation and achieved results.

Heat maps

Country	Exists	Effective	Comment
AT	Yes	☺	http://www.austrian-heatmap.gv.at/das-projekt/

Country	Exists	Effective	Comment
CRO	Yes	😐	http://het.hr/gis-karta/
CZ	Yes	😐	Map exists within the Pan-European Thermal Atlas, developed as part of the Heat Roadmap Europe Project (HRE4). https://heatroadmap.eu/peta4/
LV	No		
SRB	No		
SI	Yes	😐	https://ceu.ijs.si/projekti/toplotna-karta-mom.html (only for Municipality of Maribor). National heatmap is under preparation (planned for the 1st half of 2020).
UKR	No		

Local planning tools and data

Country	Exists	Effective	Comment
AT	No		Mandatory planning tools do not exist.
CRO	No		DHS may use different planning tools on their initiative and cost.
CZ	No		There are no specific national tools for DHS planning available.
LV	Yes	😐	Planning tool is provided through partnership in the EU project THERMOS (a free on-line energy system mapping and modelling software is tailored to support local authorities and energy planners in their thermal network planning). Mandatory planning tools do not exist.
SRB	No		
SI	No		No tools for local (energy or DHS) planning exist. Data necessary or useful for strategic energy planning purposes and related policies and methodologies are being considered as part of the targeted development programme (CRP) at the Ministry of infrastructure. There is no national policy on data maintenance for the purpose of energy strategy development. Many useful data are considered private (or kept by utility companies as business secret) and not available for strategic planning purposes. Statistical data are normally reported to a national level, but not available at local level.
UKR	No		

E. Key legislative acts relevant for DHS operation and retrofitting

The role of key legislative acts and identified problems or barriers are briefly described in this section. Issues related to market regulation, price setting, taxes, heat measurements / allocation, heating metering and billing methods are tackled under the topic “Operation regulation”. Design and construction procedures for DHS refer to network extension, retrofit or construction of/connection to the new plant. Basic sustainability indicators like minimum shares of RES or CHP supply are stated in the row “Sustainability”. The topic “Customer protection and support for vulnerable customers” is aiming to address if (and how) fuel poverty has been integrated in DHS related strategies or plans.

Austria

AT *Act / Legal area*	***Key content relevant for DHS***
Energy law	Energy efficiency law (*Bundes-Energieeffizienzgesetz, EEffG*) defines that DHS (>10 MW_{th}) have to increase EE each year. Minimum RES shares are not required. The emissions law (*Emissionsgesetz-Luft 2018*) is enforcing existing DHS to reduce their emissions.
Operation regulation	There is no market regulation for DHS. Prices are set by the operators on the market, the inflation indexation applies. For heating metering there are some general laws on how this has to be implemented. If subsidies are obtained, DHS has to implement heat-metering for customers. *Comment*: Prices of different DH systems can be quite different.
Support – state aid	Environmental subsidies for (1) building new and expansion of existing renewable DHS (*Umweltförderung im Inland*) and (2) for installation of new and expansion of small-scale biomass DH systems operated by farmers (*Use of Energy alternatives* – Rural Development 14-20). Due to the undersized financial sources, a limited number of CHP plants has endorsed feed in tariff, the related waiting period for a new CHP can take 4 years or more.
Sustainability	There is no minimum RES share prescribed for the operation of DHS, however the use of RES and/or CO_2 reduction are prerequisites for use of subsidies.
Design and construction procedures for DHS	Heat and Cooling Pipeline Expansion Act (*Wärme- und Kälteleitungsausbaugesetz, WKLG*) provides legal basis for the network expansion. Building permit and plant operation permit are required, for large plants (>50 MW_{th}) an environmental impact assessment is required.
Customer protection and support for vulnerable customers (addressing	The Chamber of labour (*Arbeiterkammer, AK*) is in particular addressing the topics of fuel poverty. Other stakeholders in the system of “Social Partnership" (*Sozialpartnerschaft*) also play a

AT	*Act / Legal area*	***Key content relevant for DHS***
	fuel poverty)	decisive role in the regulation of wages and prices and are being involved in the development of new laws and strategies. *Comment*: The topic of fuel poverty is often used as an excuse why more RES is not fostered in DHS.

Croatia

CRO	*Act / Legal area*	***Key content relevant for DHS***
	Energy law	General rules necessary for all energy types such as defining measures for safe and reliable supply, energy-efficient transformation and consumption, common interest relations in the sector. Thermal Energy Market Act (*Zakon o tržištu toplinske energije*) defines the rules of district heating market in Croatia. https://mzoe.gov.hr/pristup-informacijama/propisi-i-medjunarodni-ugovori-2393/propisi-iz-podrucja-energetike/5192 (in Croatian)
	Operation regulation	The main regulatory documents: • General Terms and Conditions of Thermal Energy Supply, Delivery and Distribution • Rules on the method of cost allocation and billing for thermal energy supplied • Decree on the amount and method of payment of a concession fee for heat distribution and a concession fee for the construction of heat distribution energy facilities • The Methodology for determining tariff item amounts for heat generation and distribution Price is defined by Croatian Energy Regulatory Agency (HERA). *Comment*: Individual heat metering equipment is not installed in all buildings. Depending on the type of building and equipment the billing and metering can be done via measured heat consumption, heat allocators or by heated area.
	Support – state aid	No support for new DHSs. Operational programme Competitiveness and Cohesion 2014-2020 provides funds for the retrofit of existing networks. The legislative framework enables cogeneration plants to apply for feed-in premium or guaranteed purchase price for electricity production.
	Sustainability	There is no minimum RES share prescribed for the operation of DHS.
	Design and construction procedures for DHS	Building Act (*Zakon o gradnji*) and Law on Spatial Planning (*Zakon o prostornom uređenju*) form a relevant legislative framework for the design and construction of DHSs. The environmental impact assessment procedure, defined by the Law on Environmental Protection (*Zakon o zaštiti okoliša*), foresees preparation of environmental impact report, public consultations and issuing the related decision by an authorised state entity. The law applies to the planned activities, which could have a substantial impact on the environment, and impact assessment is obligatory for all power plants with the heat capacity of 10 MW and more.

CRO	*Act / Legal area*	***Key content relevant for DHS***
	Customer protection and support for vulnerable customers (addressing fuel poverty)	The by-law on energy poverty exists, but it is focused on electricity only (vulnerable customers receive 27 EUR per month to cover the electricity bill), other measures are in development phase.

Czech Republic

CZ	*Act / Legal area*	***Key content relevant for DHS***
	Energy law	Energy law (458/2000 Col.) lays down all basic conditions for operation of DH systems, licensing, customer rights, emergency procedures, heat metering a heat price regulation. Heat prices are regulated by Energy regulatory office based on justified cost and reasonable profit. Change of energy carrier (e.g. switching from steam to hot water) has to be announced to customers at least one year in advance by DHS operator. Customers need to adapt technology on their premises to this change at their own cost or quit heat supply contract. Disconnection from DH is possible with building permit, which can be obtained by customer if showing that local heating system is more economically viable. Costs of disconnection are at customer's expense. *Comment*: All the requirements apply to DHS only. There are no transparency requirements for companies offering local boilers or other equipment. Customer protection regarding informed choice of most economically suitable heating solution is almost non-existent.
	Operation regulation	Heat supply from DHS is the subject to heat price regulation by energy regulatory authority and is based on justified cost and reasonable profit. Operators of DHS with plants within EU ETS scheme, which have to buy emission allowances, are placed in a situation, which is less favourable than that of local heating users as there is no carbon tax imposed on. This will be partially rectified by decrease of VAT on heat from 15 to 10 % effective from 1 January 2020. DH companies are required to measure heat supplied to customers.
	Support – state aid	Support for electricity from high-efficiency CHP is embodied in Act No 165/2012 and the related Decree on electricity from high-efficiency CHP and electricity from secondary sources, laying down the quantity of electricity from CHP to which support relates. It is part of the support system for generation of electricity and heat from RES, high-efficiency CHP, secondary energy sources and individual electricity generation. The support is set annually by the Energy Regulatory Office. Operational support for heat from RES is provided through the green bonus. Its annual value (50 CZK/GJ) is defined in by the abovementioned act (Sect. 26), which also lays down that support for heat in the form of operational support within a single heat plant can be combined with the investment support for heat. Heat generated from supported biomass may according to Sect. 24 claim operational support; this biomass is the subject of electricity support under Sect. 4, or heat generated from bio-

CZ	Act / Legal area	Key content relevant for DHS
		liquids meeting the sustainability criteria set out by the implementing regulation in heat plants with a nominal heat capacity above 200 kW or heat generated from geothermal energy in facilities with a nominal heat capacity above 200 kW.
	Sustainability	Sustainable DHC is handled by Government Council for Sustainable Development, stakeholders are represented through the thematic Committees, e.g. Sustainable Energy Committee. The Technology Sustainable Energy Platform of the Czech Republic (TPUE) is an institutional tool for supporting activities related to research, development and implementation of technologies usable for sustainable development of production, transmission and consumption of modern forms of energy in the Czech Republic. http://tpue.cz/jacube/files/sva/sva.pdf (in Czech)
	Design and construction procedures for DHS	On behalf of Ministry of Industry and Trade (MPO) the analysis on diversification of DH systems and the way to their greater competitiveness was prepared. https://www.mpo-efekt.cz/upload/7799f3fd595eeee1fa66875530f33e8a/decentralizace.pdf (in Czech)
	Customer protection and support for vulnerable customers (addressing fuel poverty)	One of the competences of the Energy Regulatory Office (ERU) is protection of legitimate customers´ and consumers' interests in the energy industries, which is one of the elementary pillars of the Office strategies. A Code of Conduct for thermal energy suppliers was issued by ERU. https://www.eru.cz/documents/10540/462920/Vzorovy+eticky+kodex+pro+dodavatele+TE.pdf/8ff90b93-994a-4a0a-9d1d-3879f2be82c2 (in Czech)

Latvia

LV	Act / Legal area	Key content relevant for DHS
	Energy law	Energy law defines licencing, registering of energy supply operators and regulating their operation, heating and cooling systems. https://likumi.lv/doc.php?id=49833 (in Latvian) Energy Efficiency Law determines obligations (1) to carry out energy audits or to introduce EMS for large companies and large electricity consumers; (2) to introduce EE improvement measures; (3) to introduce EMS for national direct administration authorities, big cities and municipalities; (4) sets-up an EE obligation scheme for energy distributors and/or energy providers (EEOS); (5) defines the possibility of a voluntary agreement on improving EE. https://likumi.lv/doc.php?id=280932 (in Latvian)
	Operation regulation	In the heating sector, regulated services are the production of thermal energy, the transmission and distribution of thermal energy, as well as the trading of thermal energy (it is regulated by Public Utilities Commission). The heat supply service shall be regulated if the annual total amount of heat energy sold is higher than 5000 MWh. Smaller heating systems are not regulated (not to impose additional administrative burdens on

LV	*Act / Legal area*	***Key content relevant for DHS***
		heating operators and thus not to increase heating costs and tariffs). The trading of thermal energy is regulated up to the so-called "boundary of ownership" with the user, usually up to the point of heat pipeline entry to the building. The use of thermal energy in a building is not regulated service. Around 93% of the total volume of the heating market is considered as regulated service. Most of merchants (in total about 240) are also heat producers. Regulator determines the final heating tariffs for all 58 heating operators.
	Support – state aid	Financial sources for DH systems improvement are provided under the program "Growth and employment" (planning period 2014-2020) according to strategic support objective 4.3.1. For promotion of EE and the use of local RES the support is foreseen for the following activities: • reconstruction of DH systems heat sources (to increase EE and enable transition to the use of RES, covering purchase and installation of equipment) • reconstruction and building of heat energy transmission and distribution system (to reduce energy losses and use of fossil fuels, to decrease dependence of energy import, to increase efficiency of boiler houses using RES) • reconstruction of cogeneration stations • building and installation of heat energy storage equipment. A state support mechanism for the promotion of renewable energy introduced mandatory procurement and guaranteed fees for installed electrical capacity.
	Sustainability	Determined in NEEAP.
	Customer protection and support for vulnerable customers (addressing fuel poverty)	The definition of energy/fuel poverty has not been defined yet, (it is currently in the legislative process). An aid is intended for protected users (vulnerable, families with 3 or more kids, disabled persons), providing reduced fee for electricity consumed, distribution system services and mandatory procurement.

Serbia

SRB	*Act / Legal area*	***Key content relevant for DHS***
	Energy law	Energy Law (Official Gazette of the RS, No. 145/2014) sets economic, commercial and financial conditions for electricity generation from RES and CHP. Besides it defines government jurisdiction in adoption of a legal document, which regulates the energy licences in the heat (production, distribution, supply) sector and adoption of a methodology for setting price of heat supply to a final customer. It also sets that National Action Plan for the use of RES shall comprise measures necessary for the development of DHC infrastructure. https://www.aers.rs/FILES/Zakoni/Eng/EnergyLaw%20SG%20145-14.pdf

SRB *Act / Legal area*	***Key content relevant for DHS***
Operation regulation	Based on the Energy Law, the government adopts the methodology of forming the prices of heat supply to final customers. The energy entity performing the energy-related activity of heat supply determines the price, which must be approved by the local self-government unit. Decisions on and regulation of all other aspects regarding DH, including planning, choice of DHS entity performing production, distribution and supply of heat (e.g. public company, public-private partnership, concession), relationship between customers and DHS entity, etc. are passed on to the local self-government.
Support – state aid	The Energy Law sets that local self-government units are authorised to prescribe incentive measures and conditions for acquiring the status of a privileged heat producer and the criteria for the fulfilment of those conditions, as well as they shall determine the manner and procedure for acquiring such status. *Comment*: Nationwide obligatory incentive measures for heat production (either from heat plants or from CHP units) are insufficient.
Sustainability	NREAP has set targets for the share of RES which shall increase for 10% in the period from 2009 to 2020.
Design and construction procedures for DHS	The Law on Planning and Construction (*Zakon o planiranju i izgradnji*) (published in 2009, last amended in March 2019) defines overall procedure for construction and retrofit of all energy objects in Serbia. It defines which authority (Ministry in charge of construction, or the specified authority of the autonomous province, or local self-government unit) is competent for the issuing of technical requirements, construction permits, energy permits, and licences to operate. This mainly depends on the power plant level. https://www.paragraf.rs/propisi/zakon_o_planiranju_i_izgradnji.html (In Serbian) The Rulebook on Content, Method and Manner of Development and Performing Control of Technical Documentation According to Class and Intended Use of the Structure (*Pravilnik o sadržini, načinu i postupku izrade i način vršenja kontrole tehničke dokumentacije prema klasi i nameni objekata*) is the main legislation act, which defines content of the technical documents. Several other decrees, regulations and rulebooks regulate areas such as environmental protection, pre-feasibility and feasibility studies, various procedures and other. *Comment*: Procedure for obtaining all permits are relatively complex and time consuming.
Customer protection and support for vulnerable customers (addressing fuel poverty)	Energy Law stipulates that a lower income household may obtain a status of “an energy vulnerable customer” on the basis of the decision issued by a body in charge of social issues, but only related to the supply of certain amounts of electricity or NG and with a reduction of the monthly payment obligation.

Slovenia

SI	*Act / Legal area*	***Key content relevant for DHS***
	Energy law	The regulatory basis in the field of production and distribution of heat for DHC is set by Energy Law (*Energetski zakon*, EZ-1). It defines (1) terms DH and DC; (2) extent of protection (in terms of protected consumer re Regulation 2017/1938/EU) of DHS heat distributors; (3) obligations of heat distributors of public interest; (4) price regulation for the DHS heat supply; (5) rights for financial incentives and respected funds, (6) mandatory use of RES, CHP and excess heat in DHS with set minimum shares; (7) compulsory measurement of heat for an individual building connected to DHS. DHS is listed among alternative energy supply systems. EZ-1 sets (1) obligation to issue NREAP till 2020, which shall include the assessment of the necessary construction of a new DHC infrastructure, produced from RES; (2) the ministry responsible for energy, shall every five years prepare a comprehensive assessment of the possibilities for the use of high-efficiency CHP and efficient DHC; (3) guidelines for municipal spatial plans where the design of DHC systems is mandatory. http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6665 (in Slovene)
	Operation regulation	In accordance with the Energy Act (EZ-1), the price of heat for DH from distribution systems is regulated if (1) the distributor performs a public service or (2) a total heat power of connected devices to the distribution system exceeds 500 kW. EZ-1 stipulates that the DH heat price regulation is carried out on the basis of the methodology defined in the Act on the methodology for pricing of district heating heat (*Akt o metodologiji za oblikovanje cene toplote za daljinsko ogrevanje*), prescribed by the Energy Agency (*Agencija za energijo*). The methodology determines the method of setting the baseline price as the highest average price, on the basis of which the distributor and the regulated heat producer, in accordance with the criteria and mechanism set out in the new methodology, form heat prices for DH. The baseline price of heat is determined on the basis of the eligible costs (that are necessary for the performance of the distribution activity) and consists of fixed and variable parts. The final amount to pay for the heat supplied from DHS consists of (1) heat price (fixed part - accounting power; variable part – delivered heat), (2) contributions (for support of the production of electricity from RES and CHP; Energy Efficiency contribution) and (3) VAT. EZ-1 defines that measurement of heat for an individual building connected to DHS is compulsory.
	Support – state aid	In 2002, a system of guaranteed prices (‘feed-in’ tariffs) was introduced. In 2009 it was upgraded, and in 2010 a new programme provided more funds to accelerate the achievement of objectives in the field of RES and high-efficiency CHP. Until

SI	*Act / Legal area*	***Key content relevant for DHS***
		2015, there was aid in the form of 'feed-in' tariffs (stimulated or guaranteed prices) and operational aid. The duration of aid for promoting efficiency in heating and cooling using CHP was limited to 10 years and for RES to 15 years. The Operational programme for the implementation of European cohesion policy (OP EKP 2014–2020) provides that, when granting incentives for heating of buildings and residential areas, priority is given to heat systems using RES and high-efficiency CHP.
	Sustainability	Energy law, Art 322 defines that DHC systems must be efficient in such a way that heat distributors provide heat (at the annual level) from at least one of the following sources: (1) min 50% of the heat produced directly or indirectly from RES or excess heat; (2) min 75% of the heat from CHP or (3) min 50% of the combination of heat from (1) and (2).
	Design and construction procedures for DHS	Following EZ-1, Art 463, the Government, by decree, determines the types of maintenance work for the public benefit of facilities, installations and networks required for the transmission and distribution of heat and the manner of their implementation, in accordance with the law governing the construction of facilities.
	Customer protection and support for vulnerable customers (addressing fuel poverty)	Energy poverty has been addressed with some instruments (including incentives) but none was related to DHS.

Ukraine

UKR	*Act / Legal area*	***Key content relevant for DHS***
	Energy law	Ukraine does not have a general energy law but specific, sectoral laws which govern electricity generation, heat energy supply, and use of alternative fuels.
	Law on Heat Supply	The Law governs the operation of heat energy market participants, including tariffs establishment mechanisms. Tariffs, which should cover economically justified expenses for production, distribution and supply of heat, are approved by National Commission on State Regulation of Energy and Utilities Sectors (if DHS' heat supply volume exceeds 145 thousand Gkal and if more than 90% of heat energy supplied is metered) or by relevant local authorities in accordance with the responsibilities established by the law. Since 2017, the tariffs for companies, generating heat energy from alternative energy sources (including CHP), for the needs of organizations and institutions financed by state or local budgets, as well for the needs of residential sector, are established at the level of 90% of the normal tariffs (for the heat generated by NG), independently of production costs to incentivize heat energy generation from RES. http://zakon.rada.gov.ua/laws/show/v0308874-17 (in Ukrainian)

UKR *Act / Legal area*	***Key content relevant for DHS***
Operation regulation	The *Law on commercial metering of heat energy and water supply* establishes provisions on metering equipment maintenance and billing. It prohibits connection of buildings to external engineering infrastructure (incl. heat supply systems) without installation of commercial metering units in line with the requirements of the Law. http://zakon.rada.gov.ua/laws/show/2119-19 (in Ukrainian) There are cases of multi-apartment buildings where large number of apartments disconnected from DHS, having installed individual NG fired boilers. In these cases, the heating cost for the remaining DH consumers, based on metered heat, strongly increased. Often in such cases heat meters are not used, but consumption is billed per square meter norms.
Support – state aid	According to Article 8 of the *Law on Heat Supply* state support and incentives are provided in line with the amount of funds approved in the state budget of Ukraine and relevant local budgets for a specific year, as well as funds for the scientific and experimental works on the improvement of heat supply systems and energy savings.
Sustainability	Environmental taxes for air emissions, including the CO_2 tax are defined with the Tax code of Ukraine. CO_2 tax was established (2019) at the level of UAH 10 (EUR 0.3) per tonne and has limited impact on DHS investment decisions due to its low cost-level. There is no legal requirement for the minimum share of RES or CHP supply.
Design and construction procedures for DHS	The *Law on Regulation of Urban Construction Activities* governs the aspects related to territorial planning, design documentation development and review, construction permits and commissioning. The permits and the respective permitting procedures for construction works, including connection of the facility to the engineering infrastructure systems depending on the consequence class (CC) of the construction facility. Determination of CC is based on criteria defined by law and national construction standards, and may be low, medium or significant. http://zakon.rada.gov.ua/laws/show/3038-17 (in Ukrainian) The environmental impact assessment procedure was introduced by *the Law on Environmental Impact Assessment* in December 2017, foresees preparation of environmental impact report, public consultations and issuing the related decision by authorized state entity. The law is applicable to the planned activities, which could have substantial impact on the environment, impact assessment is obligatory for all power plants with the heat capacity of 50 MW and more. http://zakon.rada.gov.ua/laws/show/2059-19 (in Ukrainian)
Customer protection and support for vulnerable customers (addressing fuel poverty)	*Law on Housing and Utilities Services* defines that Cabinet of Ministers is responsible for (1) definition of an upper limit of expenses on utilities' services for citizens, which in accordance with the law have the right for the reduction of payment or

UKR	*Act / Legal area*	***Key content relevant for DHS***
		related subsidies and (2) approving the procedure for the provision of subsidies for the payment for housing and utilities services. http://zakon.rada.gov.ua/laws/show/2189-19 (in Ukrainian) (1) The level of subsidy is defined for each household and for each utility service, including heat supply. The expenses limit on utilities services depends on the income level of the household and is defined in accordance with the procedure established by the Cabinet of Ministers. Typically, households pay up to 10-15% of their income for utilities, while the additional costs are covered by subsidies. http://zakon.rada.gov.ua/laws/show/1156-98-%D0%BF (in Ukrainian) (2) The procedure for obtaining the subsidies: http://zakon.rada.gov.ua/laws/show/329-2018-%D0%BF (in Ukrainian)

Retrofitting of DHS – review of key barriers, opportunities and support instruments

Introduction

Centralized heat supply is considered worldwide as one of the most effective, economic and ecological methods of heating. Nearly 50 % of final energy demand is used in the EU for heating and cooling purposes. The European Parliament considers district heating and cooling as one of the pillars of European energy strategy based on reducing energy consumption and greenhouse gas emissions and developing renewable energy sources. The European Parliament has stressed the importance of district heating networks as an alternative to more polluting individual heating systems. According to the EP, these networks represent a particularly efficient and cost-effective means of sustainable heat and cooling supply that uses renewable energy, recovered heat and cold, and stores excess electricity at a time of lower consumption, giving the grid a flexibility. However, most district heating networks in Central and Eastern Europe urgently need modernisation to improve energy efficiency. As fossil fuels are still the predominant sources of energy, interventions are even more urgent. Many Central and Eastern European DH operators are faced with inadequate maintenance, high customer heating costs, and limited control options for users, thus undermining the district heating image. As a result, a significant number of customers disconnect from DHSs and install individual heating sources.

KeepWarm project is analysing situations specific to seven project participating countries (Austria, Croatia, Czech Republic, Latvia, Serbia, Slovenia and Ukraine), investigating weaknesses and propose solutions which will become input to strategies and action plans, leading to enhancement of DHS retrofit plans at national and regional levels. Each country has its own specific conditions and policies to adapt to, the obstacles it faces and the opportunities that may be exploited. Within WP5, T5.2, and based on a targeted survey of individual DHSs, an overview of barriers, opportunities and stakeholders for each participating country was prepared, resulting in proposed solutions to mitigate or overcome obstacles, exploitation of opportunities for DH development and set-up of proper communication between involved national stakeholders to ensure improvement of DHS and breakthrough of DHC services.

The following review consists of 3 parts, each addressing all 7 pilot countries: (1) an overview of DHS context and market specifics, (2) detailed information on the key obstacles that hinder modernisation and retrofit of DHSs, enhanced by proposals on how to overcome barriers; and (3) an overview of opportunities, support measures and stakeholders in the process of modernisation of the DHSs.

The overview of DHS context

Austria

Heat and hot water generation represent nearly 27 % of the final energy consumption. District heating covers one fifth of the total heat demand. On average, in the last five years, approximately two-thirds of the heat supplied to DH networks was produced in highly efficient cogeneration plants. According to Statistics Austria, 28 % of the inhabited dwellings are supplied with DH. The trench length of DH pipeline systems is about five thousand kilometers. The annual growth rate for DH systems is about 5% and is one of the highest among EU countries. Combustible renewables (mainly solid biomass) have considerable shares. The trend towards the use of more renewable fuels, which started in the 80s, has continued dynamically during the last ten years. Today, approximately half of the fuel used in DH is renewable (waste, biomass and other renewables) more than 90% of heat generated in DH is using CO_2-neutral or low CO_2 primary energy.

Croatia

There has been no expansion of DH in the last fifteen years in Croatia and there is a considerable need for refurbishment of existing networks in order to increase customer confidence, EE and profitability. Natural gas is the most dominant energy source for space heating and domestic hot water preparation, it is also the main competitor of DH. Electricity heating can be found in the southern, coastal region, where NG or DH networks do not exist. DH networks exist in larger continental cities and with the local heat market share between 15 and 40 %. As regards to renewable energy, wood is the main heating source. Decentralised and small-scale CHPs are seldom found and their market share is very low. The existing DHSs in Croatia require substantial investments for their revitalisation and modernisation aiming at increase the reliability and security of heat supply. A lack of energy planning is also significant obstacle to the new development and DHS modernisation.

Czech Republic

The Czech Republic has traditionally a high share of district heating, where DH serves about 41 % of households, hence it can be considered as highly developed. Despite that, there is still considerable space for improvement in terms of distribution network, length and technology efficiency. The country is struggling with pollution from local sources, notably domestic heating systems, the air quality in certain regions and cities remains unsatisfactory. Therefore, extensive measures, to address these problems, are needed and DH systems can be a part of the solution particularly in urban areas. The DH networks reach a length of about 7700 kilometres. Due to the fact that almost 15 % of those networks are still the steam pipe and of the 2nd DH generation, there is a great potential for heat savings in the heat distribution. Generally, the most significant potential for reducing losses in distribution is an upgrade to the later (e.g. 3rd) generation of DH networks.

Latvia

District heating is an important segment of the Latvian heat supply, covering about 40 % to 70 % of the total heating demand in the largest cities, respectively about 30 % of total heat demand in the residential sector. Riga, the county capital with a population of nearly 700 thousand, plays an important role in the DH market, ensuring around 50 % of the total DH share. DH systems are mainly owned by local municipalities and in some cases by private companies. An improvement of EE in DHS has been delayed due to limited investments and capacity of local governments to obtain funding as well as the slow capital turnover rate. NG is still the main fuel used, however, the share of biomass is increasing.

Serbia

District heating is considered as reliable and safe manner of heat supply, both in the eyes of the state and of the citizens (consumers). It is used by about a quarter of the population. Primary energy sources for heat production in DH plants are currently natural gas (78 %), heavy oil (13 %) and coal (9 %). DH utility companies receive significant support from the state and municipalities since they represent an important energy stability factor countrywide. Due to the increase in the price of NG, which is predominantly used in DH, heat prices have increased in the last few years. This has significantly reduced the competitiveness of DH on the energy market. Heat pumps using geothermal energy are becoming more and more a competitor of DH in multi-family buildings. A significant competition between DH and NG can be observed, although the connection to the DHS is still very common in the situations where both networks are available.

Slovenia

Five years ago, Slovenia encountered a strong growth in the use of heat pumps, geothermal and solar sources to the detriment of the number of households using DH. Since 2017, the trend has reversed. Although the predominant source (> 50 %) used to satisfy heat demand in the residential sector is renewable energy (mainly wood biomass) the importance of DH for heat supply is still growing. Currently, DH satisfies about 9 % of heat demand in the residential sector. The bright side of DH policy is that the support schemes for heat pumps are not assigned to the end customer in case its location is near DHS. The primary energy source of DH production is coal (56 % in 2017), followed by NG (26 %), the share of RES reaches almost 13 %. Larger urban areas have the potential to use excess heat or provide heat from waste and large-scale heat pumps in combination with other RES. The Energy Law, by which the Directive 2012/27/EU has been implemented, supports the development of DH systems producing heat mainly from RES, CHP or waste heat.

Ukraine

Ukraine has a quite developed district heating infrastructure in all major urban settlements. The share of citizens served by DH in Ukraine is 40 %. As a rule, DH systems are managed by municipal DH companies that provide heat to private and public clients under the

supervision of either local municipalities or the National Commission for State Energy and Public Utilities Regulation. Natural gas still remains the dominant fuel in the DH sector, while the use of biomass for heating is growing, following the lifting of (previously subsidized) NG prices to market levels. Local municipalities often subsidize their DH companies' operational activities, while considerable investment into modernisation projects are executed with the active participation of international financial institutions.

Key barriers for DHS retrofitting and possible solutions

Interviewees – the representatives of DHS operators – were asked about the barriers to systems' development that they currently face and to give some hints on potential solutions. Their responses partly differ by specifics of countries involved, however it became rather clear that the key is to create goodwill, cooperation and trust among municipality, developer and (large-scale) building owners, because these are the stakeholders that usually make the decision to develop a DH. The existing natural gas networks and favourable gas prices make a challenging environment for the out roll of renewables in the heating sector. A negative public image among customers about DH which was mostly created by mismanagement of the older DHSs is also an important barrier, but educating customers and public about the modern, energy efficient and cleaner DH solutions can make perception of these systems more positive. The lack of knowledge and expertise in DHS development was focused as well. All in all, the financial component seems the crucial limiting factor for DH retrofit, which makes public involvement necessary for further development of systems. Specifics of country responses are presented below.

Austria

The DH companies address the following main barriers to expansion and modernisation of district heating: high investment costs, strict regulations for emissions and competition with other heating alternatives, especially heat pumps and backup sources such as tiled and wood boilers. Low heat consumption in new or refurbished buildings is making competition even harder. Operators also consider the process of obtaining subsidies and permitting procedures very difficult, time-consuming and complex. Restrictions of the authorities might change the economy of the project to a negative level. Negative impact have also NGOs, which defame DH due to wood burning. The proposed solutions encompass simplification of support processes, restriction of subsidies for heat pumps when DH is available, definition of economically meaningful emission limits and guarantee of long-term legal security. Operators would appreciate greater support and cooperation with municipalities.

At the organisational level, operators see shortcomings in the capacity of qualified personnel and a motivation of teams for implementation of planned changes or improvements. A greater focus on education, organizing educational programs and trainings is being proposed. External key barriers include uncertain economic situation on

the global energy market, the lack of clear and stable framework conditions and the reduced investment intentions of DH companies (until 2025).

Croatia

The project pilot DHS companies have analysed barriers in various functional areas that limit the successful process of upgrading these systems. They state that the main obstacle in the modernisation process is insufficient knowledge of new DHS related technologies, which presupposes the establishment of training courses for the relevant staff. Since DH system in Croatia is a part of a wider business system (National company HEP Group), there are no major financial constraints on modernisation project realisation. DHSs are obliged to follow the Public Procurement Act, which in some cases, can extend the planned time for implementation of a project. Besides, the existing Law on the Market of heating energy introduces several arrangements, which hinder the development of DHS – i.e. the ownership of heat substations has been transferred to end customers, as well as boiler stations in smaller DHS. During the project implementation, it is necessary to anticipate a sufficiently long deadline for the public procurement procedure, as well as thorough preparation of project is vital to avoid complaints. It would be beneficial to modify the Thermal Energy Market Act in order to make DH operators interested in investing, modernising and expanding existing DH systems. The act defines that DHS has preference over other means of heating, but this is often neglected in municipal development plans, which makes significant obstacles for DHS development. More communication efforts or even workshops targeting representatives of the local and regional governments is needed, all in order to present the benefits of DHS for both, local and regional community, thus enabling DHS to become one of the cornerstones of the municipal development.

Given the current legislation, a real thermal energy market is not yet developed, suppliers do not have their supply area and are not competitors, while other fuels, primarily NG, induce highly unfair competition in terms of price. Amendments to the legal regulation, which regulates the thermal energy market and the regulation of tariff models for fuel that compete with DHS is needed to put in order the conditions. Given the poor representation of DHS, there is often lack of interest by general public and media, which consequently means that the politics is not sufficiently devoted to solving problems in the thermal sector. DHS operators consider as necessary to ensure popularisation of DH systems through promotional campaigns in order to attract the general public and trigger policy-making plans favourable to DH.

Currently, there is a good structure of human resources within the systems, which is one of the prerequisites for the realisation of larger number of projects. Because of permanent development of new technologies, it is vital to provide regular trainings and continuously improve the knowledge. DHSs are trying to maintain the existing good human resource situation and increase the level of knowledge and its implementation in practice.

A cooperation between DHS and local/regional authorities is often weak. There are numerous cases where public/regional authorities are direct competitors since they may hold ownership of a gas company or other energy company. Awareness of the DH benefits for local and regional society should be increased.

Czech Republic

A large share of heat generation is based on fossil fuels. The main objectives of the national heating policy include the promotion of biomass use, as well as other renewable and secondary sources and the maximum use of waste in combination with other fuels. Currently there is only 8 % of heat produced from RES. Biomass is the most convenient substitute for fossil fuels for heat generation, but according to predictions, the country biomass potential will be insufficient in 2-3 years. The solution is to find another kind of renewable source for heat generation. Another obstacle to the implementation of modernisation projects is the high complexity of documentation requirements to obtain subsidies. Competent authorities should reduce these requirements to speed up the approval and allocation process for new projects. Related to this is the length of approval processes for new construction and accessibility of private land for pipelines. It is necessary to adjust the legislation concerning building and construction activities. This is also related to the efforts of NGOs fighting against large-scale energy facilities and networks.

Customers exert increasing pressure on DH systems due to user comfort hence DH companies are forced to improve services for end users (e.g. energy management activities). DHSs are faced with high competition from local heat solutions (outside the EU ETS system). Promotion campaigns and marketing activities are therefore essential for the DH sector, helping to inform the public and make the right decisions. The solution is to reduce the competition disadvantage of the DH systems (e.g. by introducing stimulatory taxation).

Ensuring skilled workforce is a major problem from the DHS internal perspective, even more as interest in technical education is decreasing. It is necessary to promote the technical education of the younger generations. There is high uncertainty about national and EU future environmental and energy policies in the area of the management and it causes wrong choices in management strategies focusing on short term projects only. The solution is to increase legislation certainty, as stable legislation is crucial particularly for infrastructural projects (like DHS).

Latvia

In the process of DHS modernisation, companies face various types of barriers from different points of view. The DH infrastructure is poorly maintained and obsolete. Country isn't densely populated, which makes DH systems less applicable or more expensive to build infrastructure. Poor building heating systems affect the quality of heating, so customers are frustrated. The cost of heating with wood logs is competitive to DHS, what makes difficult new (or existing) end consumers to connect (or stay connected) to DHS. Individual heating systems are the main competitor of DHS.

More regular maintenance and survey of networks is indispensable. Installation of multiple and smaller boiler houses is required. It is necessary to optimize and automate DHS networks and reduce heating losses. The cities' population is decreasing as well as the number of DHS users is declining. DHS operators state that they suffer from lack of funding

for the development of new connections. They expect to solve this problem by using EU funds and more state aid, hence they are in favour of connecting policies support, grants, loans and other financial (aid) instruments. Utility companies appraise that lower costs for the heating (lower tariffs) will stimulate people to think about connecting to DHS.

Also mentioned as barrier in view of DH utilities is the lengthy regulatory authority approval process. They propose to develop a more efficient process for the operation of the heat-regulator authority. General public (existing and potential consumers) is not acquainted with the distribution, charging and other principles of thermal energy supply, hence awareness raising and informing the public has to be improved. DHS operators would prefer advanced cooperation with the municipalities regarding issues related to the ownership of heat networks. In the area of human resources DHS companies face a shortage of professionals, therefore much more effort has to be put in trainings at various educational levels (vocational, on-the-job) and creation of pools of DH experts.

Serbia

The modernisation processes are often hindered by insufficient technical capacity of staff. There are individual projects carried out, however general political consensus for the implementation of major projects is missing. Heavy oil-fired boilers which are still very common, are outdated (over 30, even 40 years old), likewise the distribution networks. In order to enable a switch to biomass or other RES, specific knowledge and skills are needed. Regarding the use of biomass, regulation on land ownership makes the situation even more difficult, besides DHS utility, companies consider also how to resolve the exploitation of biomass in mountainous terrains. These barriers can be mitigated by achieving consensus on important infrastructural issues and coordination in drafting planning documents.

Low financial potential and limited access to funds for investing, operational losses for may DHS business and the impossibility of taking loans are the next major obstacles. The absence of subsidies and the current low end-user price of DH heat seriously endangers the process of modernisation. Often DHS services are owned by municipalities and are monopolistic. As public service, the prices and tariffs are strictly controlled, moreover the DH heat prices are a "social category" and often do not cover the costs of operation. More active role of the operators, better communication and cooperation with the banks and appropriate state authorities is required. DH utilities propose implementation of mandatory charge for consumption. For many customers, lower price of individual heating is often the driver to get disconnected from DHS. By increasing EE of DHS and insulation of the buildings, this problem is much less noticeable. The public does not have relevant information about DHS operation, sufficient knowledge on EE and the environmental impact of different types of heating, which are also reasons why DH does not seem to be attractive. A challenge to raise the awareness in collaboration between DHS and municipalities is to be take also by media.

DHS operators complain about the discriminatory behaviour of the state gas company Srbijagas, what leads to the customer disconnections from the DH network. Operators believe that the situation can be settled if all parties comply with existing laws and in

accordance with the Energy Act and EU legislation, the status of Srbijagas monopoly is abolished. The same market principles shall apply to electricity and thermal energy sector. Local and national authorities play an important role in the process of upgrading the heating system. Better support and cooperation among these authorities is required.

The modernisation process in Serbia is accompanied by a lack of professional staff and experts in new heating technologies. It is necessary to hire experts and educate existing employees.

Slovenia

Various technical solutions and specifics of Slovene DH systems make difficult to find a complex and unified approach for their retrofit. Public procurement rules in supply of equipment are estimated to be inappropriate, so the modification of these procedures is necessary. Competent authorities should also reduce administrative burdens.

According to the DHS utilities, problems in the financial area as for example bankability of the new investments, low profitability, uncertain cash flow due to changing heating seasons, high (operational and fixed) costs and increasing energy sales price are hampering the process of modernisation. State guarantees are proposed as possible solution. In the context of new investments, DH systems face bureaucratic obstacles at all levels of the project. Hiring a legal or administrative consultant would additionally increase the investment costs. The national heating market is characterized by rather fluctuating prices for end customers, where prices are changing several times during the heating season. DHS utilities would prefer stricter approach of the Slovenian Energy Agency. DHS operators face high pressure of other energy suppliers (mainly natural gas and individual heat pumps) and promotion of natural gas and related investments with strong politics support at municipal level. DH utility companies are in favour of a concession contract that guarantees business stability. The solution could be modification of local legislation where municipal decrees and spatial plans can support DH as the priority-heating source in densely populated areas. Not only the public, even end users are poorly familiar of potentially negative environmental impact of individual heating devices (e.g. wood-fired boilers), hence promotion campaigns should be intensified. DH system operators stress the lack of strategic decisions and long-term plans, which have to be decided by DHS owners (mainly municipalities). Improvements can be achieved by targeted awareness campaigns and provision of national heating and cooling strategy. Close cooperation between municipalities and local energy stakeholders is necessary.

Ukraine

Financial and organizational matters together with technological issues are the major barriers of DH sector in Ukraine. Technological improvements aim to balance current reduced heat loads with existing heat generation and transmission facilities, further centralise DH and upgrade technological equipment, introducing, where feasible, biomass and other renewables. No doubt, the scale of related investment in throughout the country shall be significantly increased to ensure mid- and long-term reliability of heat supply.

Ukraine has significant biomass resources, both wood and agricultural, which make biomass the major competitor of NG. There is already legislation in place imposing specific tariffs for biomass-based electricity and heat. The latter constitutes 90% of the NG-based heat tariff. Dozens of large biomass boilers and CHPs are under development, a few of such projects have already been built and put in operation, demonstrating the feasibility and reliability of such activities in Ukraine. Further spread of biomass usage in the sector greatly depends on the success in dealing with sustainable biomass growth and logistics as well as market-based regulation of biomass prices, aiming to stabilise the price of this fuel considering seasonal and geographical discrepancies.

Heat tariffs, which constitute the financial base of DHS companies, are torn between the need to cover all expenses of DH operators and the capacity of clients, particularly individual households, to sustain the prices. In the result, DHS companies' tariffs for heat rarely include all expenses required for the operation and development of DHS companies. In addition, there have often been considerable time gaps between the dates of official increase of NG and electricity prices and the actual reflection of these changes in the tariffs. Hence, many companies have significant debts before Naftogaz of Ukraine – the state NG supply company. The solution here may be found in improving the tariff establishment procedure to get the NG/other fuels/electricity price fluctuations automatically reflected in the tariffs, which, in turn, must be economically viable. At the same time, the cooperation of Ukrainian DHS companies with Naftogaz shall be better balanced to allow proper management of the debt and its reduction in a near future.

DHS companies remain the actual monopolies on heat supply at major urban settlements. Limited competition results in sector's inefficiency and prevents new players and investments from entering the DH sector. Introduction of heat market in the country, based on the competitive access to the heat transmission grid, shall provide significant impetus for DHS development and modernisation across country.

Human resources and organisational capacities of the DH sector ought to be as well improved. On-going and coming introduction of modern heat generation and transmission equipment requires a new level of professionalism and skills of the key DHS personnel, supported by regular trainings and education. The staff shall be appropriately paid and motivated to be able to execute EE and renewable energy projects in the sector.

Thus, the successful transition toward efficient DH in Ukraine requires smart modernisation of DHS facilities, related significant investment as well as capacity development and the introduction of needed competition in the sector. A number of ongoing DHS modernisation projects demonstrate the feasibility of successful DHS reform with the support from the EU and international financial institutions. Much more shall be done to spread these successes everywhere in the country.

Opportunities and support instruments for successful retrofitting of DHS

A reflection on possible supportive actions stated below is a generalised country specific view provided by interviewed DHS operators. The majority expects that the national DHC strategy and improved related regulation shall assign DH the leading role in making sustainable heat supply in urban areas. Particularly local, municipal authorities play one of the major roles in facilitating the development of DHS by integrating them into spatial development plans while at the same time they need to mediate communication between stakeholders. Care should be taken to strengthen relevant skills and raise knowledge among decision makers.

The conversion to lower-temperature generations of DHS is rather straightforward in terms of technologies, much more complex is the strategic planning that would create the conditions for stable operation of the systems. One of the distinct advantages that other heating solutions do not have is the possibility of integrating different (local) energy sources, especially RES and excess heat.

Due to the large-scale and long-term investments, it is necessary to develop targeted financial mechanisms and business models which will support stable development of the DHS. Public and EU funding is inevitable to accelerate renovations.

Much also remains to be done in promoting and raising awareness of DH benefits for sustainable community development.

Austria

A number of support instruments, including incentives and subsidies have been established to promote development of DH systems, aiming to meet the energy policy targets. Heating and Cooling Network Expansion Act (*Wärme- und Kälteleitungsbaugesetz*) provides a framework for increasing the DHC infrastructure in Austria. It addresses security of energy supplies, balanced energy mix, the reduction of primary energy usage, cost effective reduction of emissions, use of waste heat and increase of local/regional heat supply.

The upcoming 2030 Austrian energy strategy is expected to drive things forward, with DH in one of the most important roles in the national heat policy. Positive aspects in the process of development and modernisation of DHS can be considered subsidies for investment costs (up to 35-50%), standards as an integrative basis for building and operating DH plants, use of regional resources (biomass), new solutions for DHC networks, creation of new jobs and many others.

Croatia

The main opportunity for the development of DH is related to improvement of EE and an increase in reliability and security of supply of DHSs implementing improved technologies such as CHP, biomass and incineration plants, the replacement of old network pipelines

with pre-insulated pipes and the improved regulation at all levels (including demand-side management).

Given the present situation and forecasts of economic and demographic growth, by 2020, Croatia is expected to set-up the basic preconditions for the development of DH, which comprises of the completion of related legislative framework, the establishment of energy planning as well as general energy management (as a result of increasing energy prices and environmental costs). The connection of smaller boilers to the larger system and integration of as many renewables as possible in the existing DHS is a great opportunity for DH systems. To further modernise existing heat production facilities, new end-customers can be connected. Since DHSs are part of a large business system, their financial stability is rather secure. The DH supply areas are located primarily in urban settlements of large and medium-sized cities, which sometimes poses a problem for performing modernisation and other constructional works on DH systems. Very demanding may also be short deadlines for major interventions due to interruptions of heat supply.

Legal regulations regarding the thermal energy market should change to allow greater investments and interventions in DHS. The regulatory impact on the possibilities of reconstruction and modernisation is high. Due to unresolved property rights and the relationship between local government and DH systems, administration and bureaucracy negatively affects the implementation of development projects. Often, political representation is unsatisfactory interested in DH or in heating sector in general, which can be an overriding circumstance when adopting development plans for modernisation. Currently, there are not many public appearances or marketing activities aiming at popularisation of DHS, hence its public image is based on end-consumers (dis)satisfaction with the provided service. This has an important impact, as the public is not adequately acquainted with the benefits of DHS and its improvement.

Increased level of knowledge of designers and planners, as well as higher number of professional trainings and events on contemporary technologies, technical solutions and their implementation in DHS is prerequisite for DH progress. Awareness raising activities on DHS benefits and targeted open dialogue with local and regional authorities is essential to communicate DH advantages and encourage decision-makers at the local level. DHSs strive for an advanced, modern national energy strategy that would properly consider the benefits of DHS and encourage their sustainable development. Prerequisites for successful implementation of modernisation projects are mutual interest and cooperation of DHS operators and relevant regional and national authorities, reliability of supply and cooperative communication amongst all stakeholders.

Czech Republic

Modernisation is focused on an upgrade of DH networks, namely conversion of steam network to hot water, construction of hot and warm water pipelines, fuel optimization, heat losses reduction, modernisation of operations, as well as on the increase of efficiency and security of heat supply. DHSs can use subsidy schemes for modernisation of DH systems. Possible participation of consumers in DH utilities, also as their shareholders, offers new opportunity for stable business models. Stable heat price is a solid basis for DHC project

developments.

State Energy Policy, approved by the government, in principle supports DH, however development of national DHC strategy is vital for sustainable growth of the heat sector. It is necessary to ensure stable legislative and regulatory framework. In addition, the participation in the development of new EU legislation would also be beneficial.

In order to successfully implement modernisation projects, it is necessary to ensure cooperation of DH utility companies with local and regional authorities, and to raise public awareness of district heating supply.

Latvia

DH utility companies estimate that there exists considerable potential for modernisation in the heat generation process and technologies. Access to projects, supported by EU funds would contribute to the modernisation of existing DH systems. The regional authorities also need a long-term or at least mid-term strategic plan regarding municipality development, which impacts the DHS planning. A support fund for modernisation of obsolete DH systems should be established at national level. Trainings on preparation and funding of projects are essential.

DHS operators perceive that the greatest influence on implementation of the modernisation process have local, regional and state authorities, which determine the rules and policies for the energy sector. On the other hand, they also guarantee official basis for fair approach to all stakeholders.

Serbia

In the view of DHS operators, the current situation in the Serbian heat market is very inconvenient in particular due to outdated facilities, facing excessive energy consumption and non-economic heating prices; this often results in DH business balance losses. Despite the fact that some specific loan programmes exist, access to investment funds or subsidies is very limited, moreover many municipalities do not have appropriate capacities (competent personnel). DH operators rely on state aid.

All stakeholders consider modernisation as essential. The main DH systems' energy source potential is biomass from the area. In case biomass projects are implemented, this will be a major step towards reduction of fossil fuels use and environmental protection. Increasing EE through modernisation of DHS and home insulation would help to improve the situation.

The role of the state authority is essential particularly in the implementation of energy policies and assumed obligations, implementation of the national energy strategy and provision of adequate state funds for energy efficiency.

Slovenia

DH system operators consider modernisation of DHS as an opportunity to improve the environment and increase efficiency as well as contribute to primary energy saving. As the

most vital they appraise modernisation of pipelines, substations and boiler houses, where more efficient technologies shall ensure reduction of heat losses and cut in operational and maintenance. DHS operators expect that successful modernisation will reflect in an adequate and stable cash-flow, clear and open relations to energy suppliers and their first level equipment suppliers. Digitalization and modernisation of the reporting system has an important impact too. Working with local decision makers and public officers can be a good opportunity for influencing energy politics. The media can enable both, positive and negative effects on DHS modernisation, it depends on how they inform; in general, they offer good opportunity to promote benefits of DH and present the new investments, including retrofits.

Ukraine

DHS operators envisage good opportunities for successful retrofitting and extension of heat distribution networks, switch from 4-pipe to 2-pipe heat supply systems, introduction of burners with low emissions, construction of biomass-based CHP and introduction of RES (mainly biomass). From a financial perspective, success depends on the (1) introduction of economically viable tariffs bearing all the costs associated with heat energy generation, (2) timely and regular payment of DH services, (3) access to finance and (4) restructuring of debts. The prerequisites for successful implementation of DHS retrofitting projects are as follows: (1) raising professional level of subcontractors, (2) timely completion of design and construction works, (3) formation of project management unit/team.

At the local level, (1) evolvement of the local DH development plan at all city levels can be a strategic starting point, (2) gaining support from local authorities, followed by (3) creation of specific task forces and (4) attraction of financial support. From the regional point of view, it is important to (1) get financing from regional budgets by proper communication with regional authorities and program, (2) make projects' approval procedures less complicated, (3) attract investors in DH and (4) establish exchange of experience within a region. On the national and European level, the following seems to be of utmost importance: (1) to adopt national DHC strategy, (2) obtain funding at national and EU levels, (3) learn the best practices and (4) take part in demonstration projects.

Key stakeholders and their roles in the processes related to retrofitting of DHS

The development of a sustainable DH systems depends on the cooperation of many stakeholders. Their impact in the process of DHS modernisation can be twofold - positive and/or negative. Various expectations and values of individual stakeholders make value chain fragmented, which results in an increase of costs and total risk, the latter particularly due to many complicated agreements, which are required among them. The following table indicates the main stakeholder groups and their key positive/negative role(s) indicated by interviewed DHS in the participating countries. Although the listed roles are not ultimate, but mainly indicative, it can be concluded that proper involvement of stakeholders

(particularly the key ones which make the decision to connect to a DHS, such as large-scale building owners, developers and municipalities) and communication among them in stages is the prerequisite for success.

1. Local and regional stakeholders

1.1 Owners and operators of DHS

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	All owners work together. Efficiency gains, high security of supply.	Discouraged by high investment costs.
CRO	Positive examples of practice are being applied through conversation and cooperation with other DHS operators.	-
CZ	DHSs are interested in investing and operating equipment that is efficient, modern and environmentally friendly, retaining existing customers or acquiring new ones.	Inactivity of DHSs with obsolete equipment or installations, which do not have enough funds to upgrade.
LV	In general willingness to modernise DHS. Participation in DH association, which gives motivation for modernisation, possibilities to see best examples/practices in modernisation, thus having up-to-date information on developments in the DH sector.	Future insecurity in case of municipal DHS, because of ongoing administrative reforms. Lack of finance due to restrictions imposed by the Ministry of Finance to limit loans for municipalities.
SI	Seeking for advanced and efficient technologies. High interest in reduction of losses. Willing to cooperate and exchange good practices and experiences with other DHS.	Primary focus on sustainability and convenience, but energy costs are mainly of prime importance for customer's decisions on heating alternatives. Monopolistic position of DHS operator (no room for competition as the owner of the network is normally also responsible for heat delivery). Business models are often inflexible (e.g. do not sell heat as service but as an energy unit).
SRB	Understanding the need for modernisation and providing security and energy independence. Resolved land ownership issues.	Lack of funding.
UKR	Interested in renovation of DHSs and increased capacity of their employees.	Monopoly within a particular city, which limits the access of private companies to DHS modernisation projects.

1.2 Suppliers of RES

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Long term secure supply of RES. Stable fuel/energy prices on a long term.	Afraid of lower fuel demand after DHS optimisation.
CRO	High interest in cooperation.	A small number of suppliers on the market.
CZ	The number of RES suppliers is growing. Increased demand for RES by DHS.	The volume of biomass is limited, its price is expected to rise. There is limited space for solar thermal fields. Exploitation of geothermal energy is still associated with high costs.
LV	Stable biomass supply.	Fluctuation in biomass prices, depending also on weather conditions.
SI	Stimulation of the local economy and the creation of employment opportunities.	Underdeveloped market with low number of suppliers.
SRB	Promotion of RES and adequate price policy.	Underdeveloped market.

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
UKR	Suppliers of biomass provide resources for the development of DH, foreseeing biomass use for heat energy generation.	High and volatile prices of biomass during a heating season. Poor biomass quality. Fuel supply not reliable. No possibility to conclude long-term fuel purchase agreements with secured prices and supply volumes. Non-transparent market conditions.

1.3 Suppliers of excess heat

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	*(Remark: No data available.)*	
CRO	-	*(Remark: No experiences.)*
CZ	Good opportunities for the use of surplus heat from industry. Possibilities for excess heat supply are being analysed by stakeholders.	Lack of coordination among stakeholders. Related projects are typically very complex from organizational point of view.
LV	*(Remark: No data available.)*	
SI	In principle, a low-cost heating source. Availability throughout the country.	No adapted (heat) market models on the supply side. Image of unreliable heat source (possible interruption due to termination of business).
SRB	-	*(Remark: No experiences.)*
UKR	Relatively affordable energy source that could be integrated into DHSs.	Technical difficulty to get the heat into DH system. Lack of incentives/support instruments to cooperate with DHSs.

1.4 Technology suppliers

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Generating local added value and secure jobs. Work with local suppliers.	-
CRO	Good knowledge and presentation of the latest technologies that can be implemented in DHS.	-
CZ	Follow global trends and keep high level of knowledge.	The latest technologies are hardly affordable due to high prices. Lack of experts.
LV	Provider of support and information (to DHS).	Often too expensive technologies (implementation in DHS is economically questionable).
SI	Support the increase of DHS flexibility (in terms of the generation and distribution of heat, but also in the integration with other energy sectors)	Innovative character of the solutions may be riskier and more expensive to exploit. Besides there is lack of funding for research and development in efficient and low-carbon heating technologies.
SRB	Transfer of new technology trends to DH systems.	Very limited number of domestic suppliers. Lack of competition and service support.
UKR	Provision of modern and efficient technologies. Timely implementation of contracted projects. Availability of suppliers for different technologies is leading to market competition and price optimization. Transfer of expertise and increase of capacity of DHS employees through trainings and consultations.	Lack of reliable and publicly available data on suppliers and their products/services. Absence of long-term warranty of the installed equipment.

1.5 Suppliers of fossil fuels

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Have no impact as there is no demand for fossil fuels.	-
CRO	Safe and timely delivery of fossil fuels (for DHS boilers).	Unstable fuel prices.
CZ	There are restrictions set for coal mining. Fuel prices are rising.	The price of coal is still lower than other fuels. Easy access to fossil fuels due to large number of fossil sources.
LV	Stable fuel supply, important particularly for NG fired CHP plants.	Fuel price fluctuations.
SI	Stable fuel supply (NG, coal).	Maintaining competitive prices against other fuels or heat sources.
SRB	Stable fuel supply.	Large variations in prices, unfavourable payment terms, and a monopolistic position.
UKR	Stable and reliable supply of NG under regulated prices.	Supports the increase of NG prices to market levels and enforces strict contractual arrangements due to monopoly on regulated gas market.

1.6 Customers, end-users and customer organizations

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Consumers require high (improved) security of supply, which puts efficient DH ahead of other heating means.	-
CRO	In communication with end-users, valuable information is provided, which helps developing new DH services.	Sometimes, the expectations and demands of end-users cannot be met due to the market situation.
CZ	Customers have a high awareness of individual technologies and environmental impact, they support the use of RES.	Customers are focused on price, followed by service and comfort.
LV	Interest in energy efficiency measures in order to decrease own heating costs.	Insufficient resources to invest or cover the costs.
SI	Customers are prepared to contribute to energy savings, environmental/climate protection and sustainability, however this mostly concerns efficiency measures that also lead to cost savings.	In the case of dwellings, the end user does not make the decision to connect to a DHS, but this was usually decided in the construction phase (e.g. by municipality).
SRB	Demand for increasing the quality of heating systems.	Lower prices are demanded. Insufficient financial resources for initial (connection) expenses.
UKR	Attractive when co-financing of energy efficiency projects within the multi-apartment buildings exists. control over the quality of works/services; participation in public hearings regarding heat energy tariffs establishment and DHS investment programs.	Delays in payments for the consumed heat. Disconnection from the DHSs and switch to alternative heat supply options (e.g. individual natural gas or electric boilers, etc.).

1.7 Local governments, policy-makers and municipal authorities

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Very supportive to DHS and their customers.	-

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
CRO	-	Low interest in DHS.
CZ	Municipalities are often the owners of DHS and are interested in enabling heating services at affordable prices. Seeking for environment friendly technologies.	Inefficient cooperation with DHSs.
LV	Interested in energy efficiency measures in order to decrease maintenance costs of buildings, including heating expenses.	Limited ability to invest and weak attraction of funding.
SI	Normally in collaboration with the municipality, developer or housing company makes the decision to connect buildings to the DHS, sometimes municipality obligates the connection to the DH by municipal building regulations. Municipalities are major driving force behind the demand for DH. Have a critical role to play in promoting, convening, providing early development capital and potentially investing long term in DHS.	DH related benefits of CO_2 (GHG) reduction and particulate matters' (air quality) emissions, and decrease of primary energy (in comparison to e.g. individual gas fired or biomass boilers) are not valued financially. This means that public involvement may be necessary for the deployment, modernisation and long-term development of DHS.
SRB	Understand the need of modernisation and providing security and energy independence.	Lack of funding.
UKR	Municipalities provide operational and financial support (subsidies, funds for municipal/regional EE programmes, guarantees, etc) to owners and operators of DHSs. Contribute to political support at the national level.	Political influences and conflicts potentially blocking DH strategies and modernisation projects. Weak communication with other stakeholders.

1.8 Regulatory and energy agencies

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Important for consulting.	
CRO	Recognize and consider the opinion of the DHS. Cooperative with DHSs. Solid level of knowledge.	Slow reactions to market changes and sometimes misleading directions.
CZ	Cooperative with DHSs. Elaborate various expert analyses, concepts, projects. Stand up for modernisation of the DH sector.	High consultancy costs.
LV	*(Remark: No data available.)*	
SI	Help to evaluate and promote benefits of DH compared to other means of heating.	Not proactive.
SRB	*(Remark: No data available.)*	
UKR	In support of project development process. Assist to attract financial resources.	Insufficient level of expertise and capacities to provide effective support.

1.9 Spatial planning offices, technical planning authorities

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Crucial for good planning. Assist in utilisation of local resources.	-
CRO	Good cooperation in the process of obtaining a permit (for reconstruction, operation…).	Poor accuracy (or absence) of installation maps/plans of do not ensure reliable foundation for planning of reconstruction and modernisation.

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
CZ	Readiness to cooperate with DHSs in finding solutions.	-
LV	*(Remark: No data available.)*	
SI	High impact on promotion of DH in areas with high heat demand density.	Spatial and development plans are often not communicated to DHS operators/suppliers so the commitment of all involved parties is not assured.
SRB	Ensure harmonisation of planning acts of all utility/infrastructure companies.	Lack of promptness and consistency in planning acts create problems in the development of DHS.
UKR	Familiarity with technical issues. Keeping control over the quality of technical documentation/works.	Municipal zoning requirements for the compulsory connection to DHSs not evolved. Causing delays in provision of needed documents.

1.10 Financial institutions, banks

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Provide loans for investments (as part of their regular business).	-
CRO	Cooperative in project financing.	-
CZ	Financial institutions appraise the DH sector, promote modernisation and create acceptable offers for DHSs.	Available funds (e.g. subsidies) remain only partly used.
LV	Commercial banks offer targeted loans.	Interest rates are too high (thus making loans unattractive).
SI	Targeted loans stimulate renovation of DH substations and connection to DHS. Can help to find innovative solutions to make sure good projects can be financed.	Absence of funding programmes adapted to DH projects. Larger total financing risk due to involvement of more stakeholders, which raises interest rates and shortens amortisation periods for loans.
SRB	Readiness for financial support.	Project financing is not applicable, particularly due to absence of guarantee funds and unfavourable credit conditions.
UKR	*(Remark: In Ukraine not applicable on local and regional levels.)*	

1.11 Private investors

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	*(Remark: No data available.)*	
CRO	Good response in terms of connecting new buildings or facilities to DHS.	-
CZ	Ability to invest.	Primarily focused on immediate profit. They may have unrealistic demands.
LV	Willing to cooperate.	Want to have profit – therefore their services are expensive for DHS.
SI	New real estate development projects have an important effect on the financial returns of a DH.	Investments are particularly risky for private companies, e.g. in case of economic crisis which may halt construction projects.
SRB	-	-

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
UKR	Provide additional financial sources and capacities. Mainly in support of RES use projects.	Reduced control over municipal DHS assets.

2. National and EU stakeholders

2.1 Central government, policy-makers and state authorities

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Enforce legislation which is aiming at reduced emissions. Provide effective subsidies.	Stimulating CO_2 taxation not yet elaborated.
CRO	Defining a national policy that allows the expansion of heat services and enables possibilities of co-financing specific projects.	Slow response in case of preparation and implementation of projects for which co-financing is possible.
CZ	Make the effort to maintain regulatory support for the development of DH systems.	Ambiguous rules and legislation, lengthy approval processes.
LV	Supportive in implementation of EU and national binding acts and policy documents.	-
SI	Developing long-term state energy and climate policies which favour DH.	Insufficient resources (human, knowledge) hinder preparation of the national Heating and Cooling Strategy and related action plan.
SRB	Many strategic documents favour DH as a key area for increasing the energy efficiency at various levels.	Action plans and measures are not effectively implemented.
UKR	Provision of state guarantees for attracting financial support and ensuring effective cooperation with international financial institutions (e.g. World Bank, EBRD, EIB, etc.). Development and enforcement of national policies and instruments (e.g. tariff systems), which support DH.	National strategy on the development of DH sector is not available. Long legislative procedures. Low priority of DH in the political agenda.

2.2 State regulatory office

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	*(Remark: No data available.)*	
CRO	Timely adoption of all necessary acts, which regulate the heating services.	Poor consideration of the DHS operators' positions.
CZ	Regulatory authority has positive attitude towards the interest of final consumers.	Poor consideration of the DHS sector economy. Insufficient stimulation of CHP and RES usage.
LV	Supportive.	Excessively strict rules for setting up new DHS heating tariffs, which does not allow to partially cover the costs of DHS improvements.
SI	-	The eligible costs of a distributor or a regulated heat producer are not sufficient to support ambitious renovation plans.
SRB	*(Remark: No data available.)*	
UKR	Provision of timely regulatory information, guidelines and consultations. Organization and execution of stakeholders' consultation processes.	Heat tariffs do not allow sufficient investments in modernisation and operational expenses (e g. to employ highly qualified staff and ensure reliable service of

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
		existing infrastructure) since they are regulated at inadequate levels. Delays in heat tariff adjustments (e.g. after increasing other fuel prices or costs).

2.3 State financial authorities

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	*(Remark: No data available.)*	
CRO	Great support in project financing.	-
CZ	Supporting the modernisation of the DH system, e.g. by reducing taxation of heat.	They should be more supportive of maximum drawing of subsidies.
LV	-	Imposed restrictions for municipalities to take out the loans hinder projects of DH systems which are (co-) financed by municipal capital.
SI	*(Remark: No data available.)*	
SRB	*(Remark: No data available.)*	
UKR	Provide targeted financial resources for DH modernisation and energy efficiency improvements in buildings.	Administrative procedures are complicated.

2.4 Environmental NGOs

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Demand the reduction of emissions.	Oppose the use of biomass for heating.
CRO	*(Remark: No data available.)*	
CZ	Strive for awareness raising about the climate change and protection of environment.	Often prone to uncompromising positions and strict attitudes e.g. to environmental protection or energy related issues.
LV	Active sectoral organisations (e.g. Association of heating companies) have strong voice and ability to participate in a dialogue with the Government.	-
SI	By following the work of the Government and participating in the decision-making processes, the sustainable development, climate change and energy related issues become more transparent.	Achieving of reasonable trade-off can be very difficult.
SRB	Launching initiatives and debates. Raising awareness of environmental protection and climate change.	Negative campaigns of particular interest groups. Criticism in media without clear arguments and competences.
UKR	Follow the environmental impact of DHSs operation. Participate in public consultations during environmental impact assessment procedures for large-scale DH projects. Awareness rising activities on the importance of EE, energy savings and reduction of emissions.	Misuse of public consultation mechanisms (e.g. public hearings) for blocking potential DH projects due to political or other reasons.

2.5 Academic sphere, scientific and research community

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	Technical/expert assistance in DHS optimisation and development.	-
CRO	High level of cooperation on development and research projects.	-
CZ	Knowledge transfer and advisory support.	Theoretical approach does not always evolve into robust, practical solutions. Lack of actual, operational experience.
LV	Capability (having knowledge) and willingness to participate in development / optimisation / modernisation projects.	-
SI	Involved in research (e.g. H2020) projects, paving implementation of new technologies in demonstration projects.	Lack of project-implementation oriented cooperation with DH systems.
SRB	One of the main promotors of new technologies, implementation of EE measures and exploitation of RES.	-
UKR	Provide high level of expertise in the optimization of DHS operation.	Lack of effective (e.g. project based) cooperation with DHSs.

2.6 General public

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	*(Remark: No data available.)*	
CRO	*(Remark: No data available.)*	
CZ	DH is gaining favour if associated with environmental protection.	Conservative attitude towards DHS.
LV	Interested in implementation of EE measures.	Cost reduction is highly valued, other benefits of DH are not in focus.
SI	Demand to reach targets on EE, increase of RES and reduction of GHG/PM emissions.	Difficult to change the way of thinking / attitude. Can be easily misled (e.g. by media, influencers).
SRB	Demand for clean environment. Launching initiatives and debates, targeting sustainable energy and climate issues.	-
UKR	Participation in public consultations with DHSs operators.	Sometimes, nonconstructive interference in (public) discussions on energy/climate strategies (thus hindering new projects).

2.7 Media and social platforms

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
AT	An important channel to help rising positive image of DH.	Opponents of using RES have uneven space in media.
CRO	Inform public on success stories. A great opportunity to improve cooperation and an enormous room for progress.	Mostly negative end-consumer stories are being published. Lack of interest in transmitting news about completed projects, as well as positive stories from end-consumers.
CZ	Share positive image about the status and	Powerful tool to create unfavourable public opinion, damage the reputation of DHS operators or exaggerate

	Positive role in the process of DHS modernisation	Negative role in the process of DHS modernisation
	importance of the DH sector.	individual cases.
LV	*(Remark: No data available.)*	
SI	Some media have very competent journalists, enabling fair informing the public. Targeted communication of DH related content.	Unattractive topic for the majority of audiences. Good (positive) stories only seldom find place in media.
SRB	Enable positive influence on the general public.	Deficient or biased reporting, often as a result of incompetent journalists.
UKR	Quick dissemination of information. Effective communication with customers and other audiences, inter alia, through social media.	Occasionally excessive critics (especially regarding prices of executed works) which tend to be generalized.

Conclusions and further steps

This review of DH regulatory framework and barriers for retrofitting of these systems is solid basis for the development or upgrade of action plans for retrofitting of DHS. This is the core activity of project task T5.3, which is focused on preparation of action plans at national or regional level. The review of stakeholders and their existing impact in the process of DHS modernisations will be a particularly useful starting point in clarifying their roles and their relationships in the new plans. This document will serve as an input for discussions with relevant stakeholders on the expert meetings in all participating pilot countries, which will generate new ideas (measures and activities) and guidance to be included in the final versions of DHS retrofitting action plans. The task T5.4 will be another step further towards more active support for the renewal of DHS. Activities and measures for DHS retrofit generated in T5.3 will be integrated in SECAPs on the municipal or regional level, the next revision of Comprehensive Assessment for CHP and DHS (expected by end of 2020) and NECPs.