SimTerm2022 PROCEEDINGS

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ENERGY EFFICIENCY ECONOMY ECOLOGY

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Recommended actions aiming at DHS development and refurbishment

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Abstract: Strategic energy settings, along with the current geopolitical situation and growing energy uncertainty, greatly emphasize the necessity of revitalizing the district heating system (DHS) in Serbia. The upcoming winter will also highlight the need for this due to increasingly obvious climate change and the region's worrisome environmental state in recent years regarding air pollution. This paper aims to make some recommendations on the DHS revitalization to the national government and local authorities. The paper will present the current state of the district heating system in Serbia, its key participants and stakeholders, then key challenges of DHS retrofitting and development and recommended actions aiming at DHS development and refurbishment. These recommendations stemmed from the Keep Warm project - "Improving the performance of district heating systems in Central and Eastern Europe" in which the project leader in Serbia was the Institute VINČA, Laboratory for Thermal Engineering and Energy.

Keywords: DHS, RES, energetic efficiency, action plan

1. Introduction

The Serbian district heating sector has developed an infrastructure supplying 48,92% of urban households [1], with the possibility of expansion into densely populated areas and plenty of room for improvement. In Serbian strategic documents, the following aspects are stressed regarding the district heating systems (DHS): modernization and enlargement of the existing DHSs to increase energy efficiency in generation, transport, distribution and heat use, reduction of the share of liquid fuel and coal and higher use of RES, and combined production of electricity and heat [2-6]. Additionally, National Sustainable Development Strategy [3] recognizes that the production of heat has the highest potential for the increase of energy efficiency (> 50%) compared with any other energy activity. Unfortunately, there are no goals (defined quantitatively) or specific plans for the DHS sector regarding modernization.

District heating, particularly ones based on renewables, strongly depends on local conditions, so actions are primarily taken at local and regional levels. Local authorities are uniquely positioned to advance DHSs through their roles as planners and regulators, facilitators of finance, role models and advocates, large consumers of energy, and providers of infrastructure and services. To use local sources, municipalities, energy utilities, and the industry must collaborate across sectors. Actions that cannot be properly addressed locally/regionally are to be handled at a wider governmental level. To address the barriers and realise the opportunities provided by DH, there is a need to create a concrete Action plan. This plan should outline the concrete actions that the government must take in collaboration with the wider public sector, business, industry, community representatives, and other stakeholders to encourage confidence in the public sector's ability to advance projects, the private sector's willingness to invest, and consumers' eagerness to connect.

Aside from the significant cost savings for heating and cooling buildings connected to district energy systems as a major opportunity, other benefits of district energy include further cost savings from mitigating air pollution and the associated government costs for health and productivity impacts. District energy also has a significant positive impact on local economies through the creation of jobs in planning, construction, and operation.

2. Key participants and stakeholders

Key participants and stakeholders in the process of modernization of the DH sector are presented in Table 1. with the roles they have and the positive and negative aspects of their actions in that process.

Table 1. Key participants and stakeholders

Group	Role in process of DHS modernisation
Local and regional stakeholders	
Owners and operators of DHS	DHSs are owned by municipalities (local self-government units, LSGU), and operated by specially established municipal enterprises - Public companies, PE or public utility companies, PUC. Positive: interested in renovation of DHSs and increased capacity of DHSs employees; provide financial support to DHS; execute modernisation projects improving the efficiency and reliability of heat supply; resolved land ownership issues. Negative: DHS operators usually have a monopoly within a particular city, which limits the access of private companies to DHS modernization projects. Lack of funding.
Suppliers of fossil fuels	The main supplier of: natural gas for DHSs is the Srbijagas, public gas company fuel oil for DHSs is the Naftna Industrija Srbije (NIS) coal - Elektroprivreda Srbije (EPS) and smaller state-owned coal mines Positive: ensures a stable and reliable supply. Negative: Large variations in prices, unfavorable payment terms, and a monopolistic position. Since 2022, poor management of energy entities (EPS) and a large increase in fuel prices due to an unfavorable geopolitical situation, endangered the security of supply
Suppliers of RES	The main stakeholders are the state forestry enterprise, JP Srbijašume, and private suppliers of biomass. Positive: provide biomass resources for DHS modernization projects foreseeing biomass use for heat energy generation. Negative: Underdeveloped market with a low number of suppliers; lack of biomass fuel standards and poor quality of the fuel (high water content); not reliable fuel supply with a low possibility to conclude long-term fuel purchase agreements with secured prices and supply volumes; non-transparent market conditions and lack of RES stock exchanges.
Suppliers of excess heat	Potential stakeholders include EPS (power plants) and industrial enterprises producing excess heat. Such energy sources are mostly not used, except for: Thermal Power Plants (TPP) Nikola Tesla A for DH of Obrenovac TPP Kostolac A for DH of Požarevac and Kostolac (steam units for coal) TPP Kolubara A for DH of Lazarevac Positive: relatively affordable energy source that could be integrated into DHSs. Negative: technical difficulty to get the heat into the DH system; lack of incentives to cooperate with DHS.
Technology suppliers	Positive: provision of modern and efficient technologies; timely execution of contracts; transfer of expertise and increased capacity of DHS employees due to trainings and consultations within the scope of technology supply contracts. Negative: A very limited number of domestic suppliers. Lack of competition and service support. Lack of reliable and publicly available data on suppliers and their products (comparison of technical characteristics and price information); often lack of spare parts and service of the installed equipment (non-availability of long-term warranty); quick depreciation of the equipment.
Customers, end-users and customer organizations	Positive: provision of feedback on the reliability and quality of heat supply; co-financing of energy efficiency projects within the multi-apartment buildings; control over the quality of works/services; participation in public hearings regarding heat energy tariffs establishment and DHS investment programs. Negative: Insufficient financial resources for initial (connection) expenses, absence of timely payments for the heat energy consumed (fortunately, minor to total consumption); disconnection from the DHSs and switch to alternative heat supply options (e.g. individual boilers, boiler houses, heat pumps…).

Group	Role in process of DHS modernisation
Local governments, policy-makers and municipal authorities	Positive: support of activities and DHS modernization projects execution; financial support of DHSs modernization via direct subsidies to municipal enterprises operating DHSs or financing municipal/regional energy efficiency programs; provision of municipal guarantees for attracting finance from international financial institutions and other international donors; political support of DHS modernization on a national level. Negative: Experience shows that their motivation and interest in participating in changes are not always high, which is certainly because heat production and distribution are just one of the many activities that local governments are engaged in, and that it is not always their priority. Political influences and conflicts potentially block the support of DHSs modernization projects; difficulties with local city council members' communication.
Regulatory and energy agencies	Positive: support of the project development process and attracting financial resources for DHSs modernization projects. Negative: not a sufficient expertise and capacities level to effectively support modernization projects.
Spatial planning offices, technical planning authorities	Positive: general good understanding of technical issues; provision of necessary conclusions; keeping control over technical documentation/work quality. Ensure harmonisation of planning acts of all utility/infrastructure companies. Negative: the complicity of technical conditions receipt and other procedures; delay in the provision of needed documents; lack of municipal zoning requirements for the compulsory connection to DHSs.
Financial institutions, banks	Not applicable at local and regional levels. The banking sector, which operates on a commercial basis, public funds - the Public Investment Management Office of the Government of the Republic of Serbia (PIMO) Positive: professional expertise in creating/ implementing projects and in designing specific financial support measures. Negative: unfavourable credit conditions.
Private investors	Positive: provide additional financial instruments and capacities for DHSs modernization projects, in particular, RES use projects. Negative: losing control over municipal DHS assets
National stakeholders	
The central government, policy-makers and state authorities	Positive: providing state guarantees for attracting financial support and ensuring effective cooperation with international financial institutions (WorldBank, EBRD, KfW, etc.); developing and enforcing national policies supporting DHSs modernization projects (e.g. special tariffs for heat energy from alternative energy sources, green tariffs for renewable electricity, etc.); developing long-term state policy priorities in the area of district heating. Negative: lack of the national strategy for the DH sector development; long processes for the adoption of regulatory documents; a low priority of the DH sector in the political agenda.
State regulatory office	The main stakeholder is the Energy Agency of the Republic of Serbia Positive: provision of timely regulatory information, guidelines and consultations; control over the compliance with relevant licensing conditions and other regulatory requirements; organization and execution of stakeholders' consultation processes; participation in the policymaking process. Negative: complicated procedures in dealing with DH companies.
State financial authorities	The main stakeholders in the group are the Development Fund of the Republic of Serbia, the Budget Fund for Improving Energy Efficiency and the Directorate for Capital investments of AP Vojvodina and state-owned banks. Positive: provision of financial resources for DHSs modernization projects and energy efficiency improvements in buildings. Negative: too complicated procedures in dealing with DH companies.

Group	Role in process of DHS modernisation
Academic, scientific and research community	Positive: provision of scientific knowledge on the optimization of boilers and system operation. Negative: lack of effective cooperation between the scientific institutions and DHSs.
General public	Positive: provision of feedback on the reliability and quality of heat energy supply; participation in public consultations with DHSs operators. Negative: sometimes, disruptive interference in DH operations, not professional feedback, creation of hurdles especially to new projects.
Environmental NGOs	Positive: providing new ideas; control over the environmental impact of DHSs operation, including participation in public consultations during environmental impact assessment procedures for large-scale DHSs modernization projects; conducting awareness-raising activities on the importance of energy efficiency improvements, energy savings, and reduction of greenhouse gas emissions. Negative: using public consultation mechanisms/ hearings, for blocking potential DHSs modernization projects due to political or other reasons.
Media and social platforms	Positive: high speed and effectiveness of information distribution; effective communication with customers, inter alia, through social media. Negative: sometimes, too many critics, especially regarding the prices of executed works.
Others, Financial institutions, banks.	Positive: provision of loans and grants for DHSs modernization projects; provision of technical assistance for forming project implementation units, preparation of feasibility studies and/or securing effective procurement process; enforcing competitive tendering procedures and quality control procedures under international requirements. Negative: strict requirements and high cost of finance.

3. Key challenges of DHS retrofitting and development

The following points highlight the current assessment of the state of the DHS in Serbia.

A. *Dominant representation of fossil fuels*

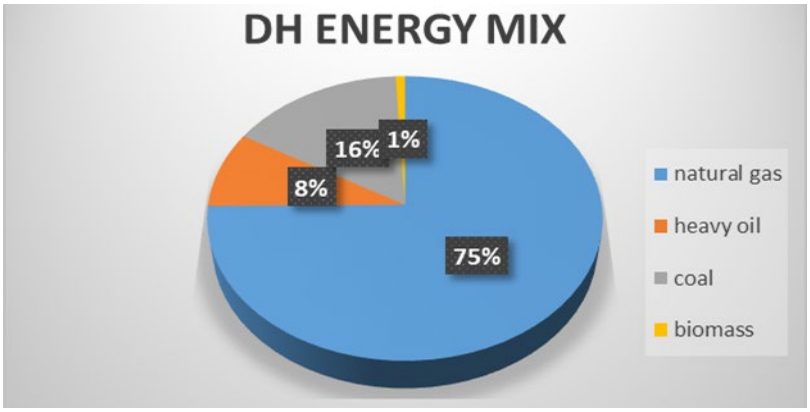

Figure 1. Serbian DH energy mix

Practically only fossil fuels are used in DH plants for heat production (fig.1), gas being the predominant fuel with a share of 74,87%, followed by heavy oil with 8,65% and coal with 15,66 % [1].

B. *Significant age of the system*

The average age of DH heat plants is 28 years, of the distribution networks 22 (7 - 48) years and heat transfer stations 14 years [1].

- The present problems of the production system are the technological obsolescence of the system's most important elements, low degree of automation, insufficient energy efficiency, and emission of pollutants from plants that use fuel oil and coal.

- The distribution systems problems are losses due to dilapidated pipelines, poor and/or damaged thermal insulation, and hydraulically unbalanced network. The heat losses in the distribution grid, observed individually are 7-30%. The average value of these losses for DHS as a whole is 12% [1].
- The indirect system of heat transfer stations is mostly used.
- Local systems of regulation, control and monitoring of processes prevail, but they are mostly outdated and insufficient.

Notwithstanding the above, the degree of efficiency of heat sources for the sector as a whole, in 2020, was 89.59% [1]. Namely, the overall statistics are dominated by DHS of large cities such as Belgrade, Novi Sad, which have, to a large extent, modernized their systems and mainly use natural gas as an energy source in boilers which are highly efficient with good process automation.

C. *The charge of delivered heat per unit area of heated space prevails*

Although the relevant Ministry of Energy has passed a methodology for determining the price of supplying the end customer with thermal energy [7], DH systems generally (with a few exceptions) charge per unit area of housing/ business space. Sustainable switching to billing by heat consumption is one of the key challenges. The burden of modernization of DHS with the liberalization of the fuel market, in this case, is borne by the owners of apartments of the lowest thermal class (buildings without or poor thermal insulation) which leads to problems of service billing and a dramatic increase in the demand for disconnection from the DHS. Fixed costs, in this case, are redistributed to the remaining customers and the price of the heating service rises. Higher prices demotivate the remaining customers, etc., so that DH becomes unattractive, and cannot provide efficient operation and current business. The only way to overcome this problem is to raise the energy efficiency of buildings, before or together with the introduction of billing with consumption by subsidizing works on thermal - insulation and/or thermal - regulation. Precisely for this purpose, the Ministry of Mining and Energy, through the Decree [8], issued a public call for the approval of subsidies for the replacement of carpentry, and the installation of insulation [9]. This action is being implemented in the Belgrade municipality of Palilula and will be continued in the following period in other municipalities as well.

D. *Operate in conditions of unfavorable energy price parity*

Before the current global political situation and energy uncertainty, the DH sector was operating in conditions of unfavorable energy price parity, and above all the ratio of electricity and fuel prices. Namely, electricity in Serbia was produced from domestic energy sources - coal and hydro energy. For both, only the ore rent of 3% was paid, so electricity, unencumbered by the CO2 emissions tax, had a low price. On the other hand, DHSs largely use imported gas and fuel oil, so the price of district heating is formed based on the price of these energy sources. In that way, the end customer who pays for heating services even outside the heating season was in a less favorable position than the one who used cheap electricity only in the heating season. Also, the use of heat pumps for heating buildings is becoming more and more attractive, so this option is preferable to building investors than DHS. The next heating season will bring new conditions that can only be evaluated once the heating season starts. These conditions include the increase in power prices due to the importation of coal and electricity and the increase in natural gas prices as the main DHS energy source.

E. *Deficiency of professional staff*

The migration of skilled labor is a problem in all sectors of the economy, even here. Therefore, the expertise of staff and organizational capacity in the DH sector should be improved. The introduction of modern equipment for heat production and transfer requires a new level of professionalism and skills of key DHS staff with the support of regular training and education. Staff must also be financially motivated to implement energy efficiency and renewable energy projects in the district heating sector.

F. *Duality of the service of production, distribution and supply of thermal energy*

According to the Law on Communal Activities [10], heating is a communal service (the activity of general interest), and according to the Law on Energy [4] is an energy activity. Local self-government units, LSGU, establish public companies (PEs) and entrust them with the service of heating the population. PEs build and maintain the infrastructure from their revenues, by charging for the heating service. Therefore, the competent LSGU bodies, have the final decision on the method of determining the price and approve / or not the price of heat energy proposed by the DHS.

Private sector participation in the provision of heating services is limited. This creates some problems in the inclusion of alternative heat producers, which could affect the market and possibly focus more quickly on RES. One solution is public-private partnerships (PPPs), which are allowed by law. On the other hand,

commodification and privatisation (at least in part) of the communal sector, including heating, if not carefully regulated can lead to an increase in service prices (similarly to under ***C***).

Taking the above stated the DHS operators in Serbia are facing the following *challenges* regarding decarbonization and their revitalization and modernization:

a) Improvement of the energy efficiency of the connected buildings to reduce the heating load;
b) Replacement of old equipment with new and more efficient one;
c) Rehabilitation and replacement of critical sections of heat distribution systems;
d) Introduction and use of new technological solutions for DH sub-systems, lower temperatures of hot water, heat storage, and more flexible DHS operation time;
e) Integration of more RES and industrial waste heat sources in the system;
f) Implementation of modern process regulation, control and monitoring systems, both for heat production and heat distribution;
g) Achieving adequate energy source mix to ensure reliable delivery of heat to consumers;
h) Maintaining and securing profitability despite the decreasing heat demand of connected buildings and the competition from other individual household heating solutions;
i) Improvement of a legal framework for systematic decarbonization of DH networks and the introduction of incentives for heat production from RES;
j) Adjustment of state pricing policy so that social considerations are not as dominant as presently are.
k) Permanent education of the DHS staff to apply new technologies and operation methods.

These challenges are strongly interconnected and to be properly addressed cooperation and coordination of many stakeholders and at many levels must be present. So the following *key success factors*, as drivers to high quality, efficient and sustainable DHS, are considered the most relevant:

1. The coherent national policy and regulatory environment providing stable ground and incentives for the DHS development (by setting ambitious CO_2 targets, establishing specific fiscal measures promoting the use of renewable energy, proper parity of fuel prices and energy sources, etc.).
2. Direct or indirect subsidies (e.g. investment grants, support schemes for heat production using RES, access to competitive debt funding, fossil fuel taxes...) and/or dedicated financial instruments can enhance the competitiveness of DHS. Relevant tax incentives (increased taxes on electricity and fossil fuels) are essential to promote EE and support the energy transition.
3. Coherent urban municipal (local) heat supply planning, supported by the promotion of DHS as part of municipal energy supply and climate strategy, where heat planning is integrated into their urban development projects.
4. Alignment of interests through cooperation and efficient communication between the national (public authorities, regulating bodies) and local actors (municipal authorities, DH company, final users), all aiming at good quality service and sustainable and cost-efficient heat and cold supply[6].
5. Competitive DH prices compared to the alternative energy solutions available in the market. This price competitiveness can be enhanced through optimized system design, through competitive procedures for the market, or by allowing competition between different heat/cold supply solutions.
6. A flexible production that allows better cost-efficiencies (mainly through dynamic optimization of the supply) can be achieved through a diversified and complementary energy mix.
7. Transparency of the prices, comparison at the national level through benchmarking and clear visibility of future prices have a positive impact on a client's choice of DH systems. Transparency is a necessity to gain the trust of all stakeholders and consumers in particular.

4. Principles of Action plan creation

The DH systems Action Plan is the key document that provides an overview of the actions needed to make district heating solutions more sustainable. It defines concrete measures that will support the transition and long-term environmental and energy-related strategies into action. As circumstances change, this document shall be considered as a living document, particularly as ongoing actions provide results and experience which may be useful input for future revisions of the plan.

This document is intended to serve as a list of solutions/actions/activities which will enhance the elaboration of local or regional action plans for heating (and cooling) and their integration into wider policy development. The areas of recommendation are structured as:
(1) Heating (and Cooling) visions, strategies and plans (tab.2);
(2) Supporting actions and expert guidance (tab.3);
(3) Planning and regulation (tab.4);
(4) Funding (tab.5).

Table2. (1) Heating (and Cooling) visions, strategies and plans

No.	Action	Timing	Responsible stakeholder
1.1	Formulation of a clear vision (*where do we want to go?*). This implies setting up strategies and elaborated Action plans (*How do we get there?*) for Heating and Cooling. At least the period till 2030 shall be covered, if possible with a view until 2050. For each measure or action, it is important to set the responsible body, the timing (start-end, major milestones), the cost estimation and financing/source as well as the indicators for monitoring. *In preparation*: MME has started drafting the Integrated Energy and Climate Plan of the RS (NECP), which should cover the period from 2021 to 2030, including projections until 2050, to ensure compliance with long-term goals at the level of the European Union (EU). The drafting has kicked off after the adoption of three energy laws [2,3,6] which are expected to initiate the energy transition in Serbia. Part of this plan will also apply to DHS.	2021-	Ministry of Mining and Energy (MME) Ministry of Construction, Transport and Infrastructure (MCTI)
1.2	Setting targets and road maps for upgrading insulation of the public sector buildings, as well as for incentive and support actions for individual and commercial housing owners. The public sector should include both the national, regional and local levels. Planning should consider a period of at least up to 2030. *In realization*: The Ministry of Mining and Energy launched the National Program for Energy Rehabilitation of Residential Buildings, Family Houses and Apartments in 2021 [11], which is implemented by local self-government units. The goal of the Program of Energy Rehabilitation Measures for Residential Buildings, Family Houses and Apartments is to improve energy efficiency in the housing sector and increase the use of RES in households on the territory of the Republic of Serbia.	2021-	MME MCTI, Municipalities
1.3	Creation of Heat maps. This action will be a part of a (national) Heating and Cooling Strategy support programme to support national strategies and targets and help local authorities identify the source of both heat supply and demand and identify if the circumstances are appropriate for potential DH projects (construction, extension, refurbishment). It is necessary to pass a Law on Thermal Energy or the Law on the Operation of DHS, to enable the thermal energy market.	2020-2022	MME MCTI Municipalities/ Local self-government units
1.4	Evaluation of (shallow) geothermal energy(GTE) potential. This action will be a part of a (national) Heating and Cooling Strategy support programme to support national strategies and targets. The Law on Mining should be amended so that in the administrative sense, it is easier to use GTE, especially its use with heat pumps. (Remark: Pilot sites need to be identified and relevant demonstration projects have to be selected and implemented.) *Note*: According to the Energy Development Strategy of the Republic of Serbia to 2025 with projections to 2030 [2] the geothermal potential is estimated at 0.18 Mtoe per year or 3.2% of the total available potential of RES. According to [12], 66 projects in Serbia deal with	2020-2022	MME MCTI Municipalities /Local self-government units The University of Belgrade Faculty of Mining and Geology and Institute of Geology

No.	Action	Timing	Responsible stakeholder
	the direct use of GTE for various purposes. It is estimated that there are 1005 geothermal heat pump units; their utilization varies between 10 kW and 40 kW with 2860 full load hours annually.		
1.5	Selection and examination of long-term heat storage sites. Heat storage is one of the key elements for the decarbonization of heating networks. This action should be carried out at the municipal level, but motivation and guidance should come from national bodies.	2021-2022	MME Municipalities /Local self-government units
1.6	Evaluation of industrial/commercial waste heat potential that may be used in DH, along with promotional, incentive and support measures for such usage. The establishment of a (national) waste heat register is recommended.	2021-2022	MME MCTI Municipalities /Local self-government units

Table 3. (2) Supporting actions and expert guidance

No.	Action	Timing	Responsible stakeholder
2.1	Establishment of a body that coordinates support for DH development. The coordination body shall have the following roles: (1) Strategic planning, (2) Knowledge and best practice sharing (technical, financial, and project development aspects), (3) Identification of collaborative opportunities, (4) Leading the Heat mapping initiative, (5) Identification of funding opportunities and financial support, (6) Technical advice and support.	2020-2021	MME MCTI Ministry of Environmental Protection Business Association of Heating Plants of Serbia (TOPS)
2.2	Establishment of a national support programme at the national level for the development of the DH sector, with access to the Budget Fund for Energy Efficiency Improvement. The intention is to assist the local authorities to develop a strategic approach to DH and support the use of the relevant tools (e.g. heat mapping). This can include the creation of a permanent expert team or service supporting DH development and co-ordinating exchange and sharing of good practice for a period of 5 years, reflecting the long development cycles of district heating projects and their implementation in practice.	2021-2022	MME MCTI TOPS Public Investment Management Office (PIMO)
2.3	Evaluation of the potential for integration of large-scale heat pump applications in conjunction with DH. This action will be a part of a (national) Heating and Cooling Strategy support programme to support national strategies and targets. Analysis of possible full/partial exemption from network charges, as well as other specific incentive measures, should be incorporated.	2020-2021	MME MCTI Ministry of Finance
2.4	Improvement of the legal framework related to the protection of consumer interests and transparency. The intention is to achieve a high level of customer acceptance which is a prerequisite for further development and expansion of DH.	2020-2022	MME Energy Agency
2.5	Introduction of tax incentives for district heating to foster the conversion of fossil individual heaters. A VAT exemption on grid connection costs and heat prices of renewable DH gives an advantage against fossil options.	2021-2024	MME Ministry of Environmental Protection Ministry of Finance Energy Agency

No.	Action	Timing	Responsible stakeholder
2.6	Introduction of tax exemptions and tax-free allowances on investments to support further development, building and optimization of DHS.	2021-2030	MME Ministry of Finance Energy Agency
2.7	Capacity-building (training and education) and awareness-raising campaigns. Apart from training and teaching specific groups and categories of individuals, the intention is to bring together various stakeholders – from city officials to real estate developers, local legal experts and business owners – to learn from each other.	2020-2030	MME MCTI Standing Conference of Towns and Municipalities TOPS
2.8	Awareness-raising through promotional campaigns. The main intention is to attract the general public and trigger policy-making plans favorable to DH.	2020-2030	MCTI Energy Agency

Table 4. (3) Planning and regulation

No.	Action	Timing	Responsible stakeholder
3.1	Adoption of guidelines on both national and local aspects of planning for district heating. Local authorities should designate areas based on heat maps where district heating would be the presumption for new developments or refurbishments. These local heat planning processes should be used to examine the potential for expanding the heating networks and converting the heating networks to renewable energies. Development plans should consider the benefit of allocating and co-locating heat supply and demand and should support heat networks where they are possible, particularly if they implement renewables.	2021-2022	MCTI Municipalities Energy Agency Energy Management System (SEM)
3.2	Adoption of methods of support to the municipalities in heat planning. The main goal is to ensure the involvement of central services in various ways, in particular by helping with the procurement of funds, guidelines for municipal heat planning, training and the creation of inter-municipal data, e.g. “waste heat register” (industry and trade), possible areas for large open-space solar thermal systems, the potential for geothermal energy, building and energy-related data.	2020-2030	MCTI MME Municipalities
3.3	Ensuring that producers of significant amounts of heat regularly investigate options for capture and use of their waste heat and facilitate the supply of waste heat to a network where this is economically viable. This shall apply to all electricity generation and industrial plants, which need to be required to carry out a cost-benefit analysis on heat use. DH networks will also need to carry out a cost-benefit analysis where potential industrial/commercial heat sources are available.	2021-2030	MCTI Municipalities
3.4	Specific trainings on district heating planning issues for planning practitioners and various stakeholders. These trainings are significantly more advanced than before mentioned capacity-building efforts and awareness campaigns. This is especially in the case when targeted are planning practitioners in which case even certificates may be foreseen.	2021-(2030)	MCTI MME TOPS
3.5	Introduction of carbon pricing in Serbia. This legislation should cover the whole energy sector but our interest is focused on the heating/cooling sector. The proper definition/setting of a CO_2 tax on fossil fuels for individual heating would make heating solutions based on fossil fuels considerably less attractive and would thereby increase the	2021-2022	MME Ministry of Environmental Protection Ministry of Finance Energy Agency

No.	Action	Timing	Responsible stakeholder
	attractiveness of renewables. If carbon taxes are specified for each sector separately, the heating/cooling sector should be in the privileged group.		

Table 5. (4) Funding

No.	Action	Timing	Responsible stakeholder
4.1	Support activities for the development of new business models for the delivery, refurbishment and financing of heat networks. One possible business model is ESCO, which can be developed as a not-for-profit Energy Service Company which can tackle fuel poverty, cut carbon emissions and create new jobs. New models should be investigated such as modified ESCO models in which the DHS itself finances individual households in their activities to improve the energy efficiency of their buildings. Public-private partnership (PPP) arrangements should also be investigated. The Law on Efficient Use of Energy [6] regulates the implementation of public-private partnership, ie the ESCO mechanism. The amendments to this law prescribe the form of the energy service contract.	2020-2022	MCTI MME Ministry of Finance Towns and Municipalities/Local authorities DHS
4.2	Provision of necessary funding for the sustainable retrofitting of DH systems aiming at increased efficiency and competitiveness (optimization of operation, expansion of networks, increasing the use of RES and excess heat, promotion of CHP in DH systems, etc.).	2020-2022 (2030)	MCTI MME Energy Agency Public Investment Management Office Ministry of European Integrations
4.3	Securing an incentive framework that supports investments in climate-neutral heat, allowing adequate (quantitatively limited) support for the remaining heat generated by CHP that can't be ensured by RES or waste heat in a short term, and other.	2020-2030	MCTI Energy Agency Ministry of European Integrations
4.4	Establishing a co-financing programme (financial incentives) for investments in new DH using wood biomass (DHWB) systems and microsystems, as well as the expansion of existing DHWB systems and the construction of new boiler rooms containing wood biomass boilers or solar systems as a source for existing DH.	2020-2030	MME MCTI PIMO

5. Conclusion

As DHS plays a crucial role in securing energy needs, improving the efficiency and sustainability of DH systems operation has to be addressed systematically. This document contains a proposal for the following key directions:

- Heating visions, strategies and plans: measures to enhance the role of district heating modernisation priorities in the national, regional and local development planning process;
- Supporting measures and technical guidance: measures and actions to strengthen institutional capacity of state authorities, technical, organisational and financial capacity of DH operators, as well as legal framework improvement and awareness rising;
- Planning and regulation: measures to address legal and regulatory barriers for DH modernisation projects, as well as create additional incentives for improving energy efficiency and use of renewable energy sources;
- Financing measures to assist DH operators in attracting financial resources for DH modernisation projects and provision of targeted financial support.

The proposals presented in this document are expected to serve as a basis for further stakeholder consultation activities regarding the development of energy systems in the country, in particular district heating sector modernisation and adoption of relevant state support measures.

In the end, it is important to point out once again that the action plan for the revitalization of the DHS was created as one of the results of the KeepWarm initiative, and in the midst of the COVID pandemic. It certainly slowed down its consideration and eventual implementation. However, the current geopolitical situation has brought a handful of new problems the most notable of which is the sudden rise in prices of all energy products. Prices in Europe are reaching new record highs and are more than ten times higher than they were before the crisis caused by the war in Ukraine. Under these circumstances, the energy stability of the country is greatly affected by the effective and sustainable functioning of the district heating system, so the time is right for the action plan presented in the paper.

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