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FEASIBILITY STUDY ON EXPANDING AND IMPROVING THE DISTRICT HEATING SYSTEM IN THE CANTON OF SARAJEVO

SUMMARY

Sarajevo, 2019.

This publication has been issued within the Project "Improving Air Quality in Bosnia and Herzegovina through Promotion of Renewable Energy Sources and Improvements in District Heating" funded by the Italian Ministry of Environment, Land and Sea Protection, implemented by the United Nations Development Programme (UNDP).

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1 INTRODUCTION

The "Feasibility Study on expanding and improving the district heating system in Sarajevo Canton" (hereinafter "the Study") was developed in the framework of the Project "Improving Air Quality in Bosnia and Herzegovina through Promotion of Renewable Energy Sources and Improvements in District Heating". The Project was funded by the Italian Ministry of Environment, Land and Sea Protection, and implemented by the United Nations Development Programme (UNDP).

The Study was conducted in accordance with the strategic documents of Sarajevo Canton ("SC") and seeks to contribute to the achievement of environmental goals defined in the Cantonal Environmental Action Plan. The overall goal of the Study is to provide support to SC to take action on mitigating air pollution in the Canton through promotion and utilization of renewable energy sources and improvements in access to district heating. The Study addresses priority measures identified in the key Cantonal strategic documents. The ultimate output of the activity is a list of bankable subprojects for the improvement and expansion of the service area. These subprojects were presented in the short-term priority investment programme. The Study also contributes to identification of a possible interconnection and expansion of the service area through an analysis of the entire heat supply chain, including production, distribution and end use.

The main analyses covered by the Study include:

- Socio-economic analysis of the current situation of the district heating system in SC
- Legal and institutional analysis of the district heating sector
- Analysis of companies for production and distribution of heat energy in SC
- Technical analysis of the district heating system in SC
- Proposed improvements of the legal and institutional framework, enhanced efficiency of the system and reduced adverse effects on the environment
- Development of scenarios for an improved and expanded district heating system
- Financial, environmental and social analysis of proposed scenarios
- Development of a concept design for an optimum scenario
- Development of a short-term and long-term investment programme.

The Study was conducted in consultation with stakeholders as follows:

1. The first two-day stakeholder workshop held on **9 and 10 July 2018**
2. Presentation of scenario analysis in SC on **23 October 2018**
3. The second stakeholder workshop held on **5 November 2018**.
4. A stakeholder meeting to present the results on the development of the Feasibility Study on the expansion and upgrade of the district heating system in SC on **16 January 2018**.

2 CURRENT STATE OF THE HEATING SYSTEM IN SARAJEVO CANTON

The systems of heat production and distribution in the Sarajevo Canton can be classified into three groups, based on the source and means of distribution:

- The District Heating System (DHS) managed by both public and private companies engaged in heat production and distribution: Cantonal Public Utility Company (KJPK) Toplane-Sarajevo d.o.o. Sarajevo, BAGS Energotehnika d.d. Vogošća, and UNIS Energetika d.o.o. Sarajevo.
- Central boiler rooms not owned by any of the distributors and which produce heat from natural gas, electricity, and liquid and solid fuels. A significant number of public institutions and buildings as well as commercial structures are thus supplied with heat. This group also includes a number of newly built residential buildings with major heat consumption.
- Individual stoves which use gas, coal, firewood, pellets and electricity. This group includes individual houses as well as residential buildings which are not connected to DHS operated by one of the distributors.

Gas is currently the primary fuel in the district heating system of SC. As DHS mainly covers residential buildings, this heating system is mostly used in three urban municipalities (Novi Grad Sarajevo, Novo Sarajevo and Centar Sarajevo).

In the overall energy consumption in SC, gas accounts for 53.2% (with 29.7% used in the DHS), followed by firewood with 17.5%, coal lignite with 13.05%, brown coal with 7.7%, electricity with 6.0%, fuel oil with 1.6%, and pellets/briquettes with 0.95%.

3 ANALYSIS OF POTENTIALS FOR IMPROVING THE DISTRICT HEATING SYSTEM

3.1 Long-term strategy – technical scenarios for the future district heating system

The analysis of the current situation of the DHS in SC suggests that upgrading, expansion, and establishment of a sustainable DHS is necessary. The Study proposes three possible scenarios. **Expansion of the DHS** has been discussed for all three scenarios in the same manner. More specifically, the discussions focused on exploring the possibility of expanding the DHS in residential areas which are currently not covered, and of connecting buildings to the existing system. The DHS expansion is included in all the proposed scenarios, while buildings considered for future expansion are identical in all three scenarios per the Municipalities in SC.

Scenario 1

- Enhanced efficacy and environmental performance of the current DHS in SC;
- Expansion of the DHS in SC;
- Natural gas.

Scenario 1 includes the expansion and improvement of the current DHS in the SC without transitioning to a different fuel, i.e. with natural gas remaining the main fuel. The analysis of the possibility of DHS expansion coversall the municipalities in Canton with a special focus on the areas of Hrasnica, Ilidža and Vogošća. This effort will particularly target public buildings which are not connected to the system and which use heavy fuel oil, coal and fuel oil as the main fuel for heating because the replacement of such fuels will reduce adverse effects on the environment.

Scenario 2

- Enhanced efficacy and environmental performance of the current DHS in SC;
- Expansion of the DHS in SC;
- Natural gas + renewable energy sources (biomass, geothermal energy).

Scenario 2 includes the expansion and improvement of the current DHS in SC, as in Scenario 1, including a transition to biomass in the areas of Hrasnica, Vogošća i Ilijaš. The analysis of a possible use of biomass contributes to an increased share of renewable energy sources and ensures security of energy supply. The technical potential (potential of biomass for district heating) in SC amounts to 144,729 tonnes annually, 2,074,772 GJ annually, and/or 576,325 MWh[1] annually. As for geothermal potentials in the area of Ilidža, their exploration suggests that the available information and literature on these potentials are not sufficient so as to allow the Consultant to take them into account, and include them in the present scenarios. The present boreholes (6 boreholes) were drilled in the period 1964-1986 and the water temperature varies between 30°C and 58°C. There is also borehole IB-10 drilled in 2004 with the intention to go as deep as 1500 + 20%. Drilling works stopped at the depth of 1100 m and the temperature measured was 20°C. In the area of Ilidža, geothermal energy is currently used for heating of a hotel and pool complex through boreholes IB-1 and IB-2. There are plans to build a geothermal power plant which could provide heat for certain residential neighbourhoods in the vicinity, but no activities have been launched to implement this project and there is no information when such activities could start. While solar energy has a huge potential for production of heat, it has been used to a very limited extent, and has not been used in DHS at all. It would make sense to use this energy in the district heating systems, if it would also be used to supply sanitary hot water, or if the systems would have a seasonal energy storage function. Seasonal energy storage would again make the whole system more expensive. It is therefore not expected that solar energy will be used in the SC district heating systems in the near future. Accordingly, solar energy has not been taken into account in the analysis of the scenarios as one of the potential RES.

Scenario 3

- Reconstruction and adaptation of the system so as to be able use hot water from Thermal Power Plant (TPP) Kakanj
- DHS expansion in SC;
- Hot water from TPP Kakanj.

Scenario 3 includes the proposed expansions from Scenarios 1 and 2, and a replacement of the heat source. Hot water from TPP Kakanj has been considered as a new source of heat. An analysis of the heat

[1] Study on renewable energy sources focusing on biomass, geothermal and solar energy in Bosnia and Herzegovina, 2019

sources, i.e. of potentials and capacities of the current blocks of TPP Kakanj, and planned new blocks for delivery of heat to the DHS in SC suggests that, in the best-case scenario, it would be possible to obtain 600 MW of heat from the current blocks in TPP Kakanj.[2]. This would imply a reduction of electrical power by 136 MW. However, taking into account the recommendation to size plants to cover base loads in designing the district heating system of about 70% of the total assessed consumption, the required power that needs to be provided from the TPP Kakanj should be about 300-330MW, taking into account the expansion of DHS.

3.2 Analysis of possibility of providing heating in areas with individual houses in Sarajevo Canton

The basic goal of the analysis is to examine the technical and financial feasibility of providing heating to buildings in the outskirts of SC as a potential measure to address the air quality issue in SC. The analysis of the possibility of connecting individual houses to DHS in SC comprises 4 steps, as follows:

1. Zoning of the areas/neighbourhoods dominated by individual houses;
2. Identification of areas for a detailed analysis based on selected criteria;
3. Household survey;
4. Feasibility analysis for selected pilot areas.

Out of 49 settlements in 9 municipalities in SC with a total population of 162,230, 5 of them meet the criteria for the analysis of a possible connection of buildings to the DHS according to the Guidance of the Energy Efficiency Directive 2012/27/ EU.

A household survey aimed at testing the willingness of occupants of buildings in the 5 selected neighbourhoods was conducted on a sample of 83 households. The results of the survey suggest that 50% of the occupants of buildings (as high as 82% in Butmir) are willing to be connected to the DHS, provided that the costs of such heating are lower than the price they currently pay for heat supply. Respondents in all neighbourhoods, with the exception of respondents in the settlement of Stup I, expect 24-hour heat supply and do not expect increased costs. Between 17-40% occupants of buildings in all neighbourhoods are not willing to pay the costs of connection. About 10% of inhabitants of the neighbourhoods Stup I and Pofalići I and II are willing to accept such transition unconditionally.

Based on the criteria and results of the survey, two pilot areas were identified for a detailed analysis: Stup II situated in a plain area, and Velešići, an urbanised hillside neighbourhood, where no major obstacles in construction works or property legal challenges are expected.
The results of the analysis suggest that it is not rational to connect the hillside neighbourhood Velešići to the system in SC, while an analysis conducted for the plain area of the settlement Stup II shows a 21-year return on investment period and potentials to consider DHS expansion. However, the analysis also shows that the priority for individual houses is to implement energy efficiency measures before considering their connection to DHS.
Given that Canton cannot directly contribute to increasing the income of households in SC, it is necessary to define programs which will result in reduced heat demand in both individual houses and residential buildings, and lead to an increased use of environmentally friendly fuels (such as gas and others). Such a

[2] Feasibility Study of heat supply from TPP Kakanj to/in Sarajevo, 2016

program could include the subsidised implementation of energy efficiency measures in individual houses and buildings with imposing an obligation for these households to start using natural gas for heating.

4 ANALYSIS OF PROPOSED SCENARIOS

The analysis of the scenarios began with the identification of quantitative technical, financial and environmental indicators, and the indicators were evaluated for each of the three proposed scenarios of upgrading and expanding the district heating system in SC (***Table 1***)

Table 1: Results of the technical, financial and environmental analysis of proposed scenarios

Aspect	Criteria	Unit	Scenario 1	Scenario 2	Scenario 3
Technical	New users	MWh	132.765	132.765	132.765
	System efficacy	%	>90	>90	>90
	Share of renewable energy sources	%	0	13,6	0
Economic	IRR-Internal Rate of Return	%	10,7	7,7	4,9
	NPV-Net Present Value	BAM	35.210.695	19.869.606	-3.753.446
	Investment costs Sarajevo Canton	BAM	146.612.129	171.568.799	175.273.836
	Investment costs TPP Kakanj				193.031.999
	Total investment costs		146.612.129	171.568.799	368.305.835
	Investment Return Period	year	13	14	14.5
Environmental	Reduction of CO_2eq eq emissions	%	8	10	-8[3]
	Reduction of SO_2 emissions	%	14	14	-5
	Reduction of NO_2 emissions	%	10	10	-4
	Reduction of PM_{10}	%	10	10	-5

A previously conducted Feasibility Study for providing heat from TPP Kakanj to/in Sarajevo also considered the possibility of including Breza, Visoko, Ilijaš, Vogošća, and Sarajevo. In Breza, Visoko, Ilijaš and Vogošća, the population primarily uses coal in individual stoves, and based on the Feasibility Study, transitioning to heat energy from Kakanj would ultimately reduce the consumption of coal. According to the mentioned Study, the total reduction of emissions in 2023 would be: SO_2 by 4%, NOx by 4,3%, PM_{10} by 5%, and CO_2 by 8%.

If we consider Scenario 3 from the point of view of the energy balance which will change after transitioning to heat supply from the TPP and reduce consumption of coal, fuel oil and gas in SC, this will result in reduction of SO_2 emissions by 13%, PM_{10} by 7% and CO_2eq emissions by 28%. However, to produce the required quantity of hot water for supply of SC, TPP Kakanj must increase its coal consumption by some 115.000 t/year. Emissions generated in Kakanj will add to the balance of emissions in SC, increasing the emissions as follows: SO_2 by 5%, NOx by 4%, PM_{10} by 5%, and CO_2 by 8%.

In order to select the optimum scenario, the selected indicators were evaluated on a scale from 0 to 5. The results of the evaluation indicate that scenario 2 has the highest score. It increases the share of

[3] Implementation of the Scenario 3 in the Sarajevo Canton would involve a major reduction of CO_2eq emissions (28%), however, CO_2eq emissions would increase around the site of PTT, more specifically in Kakanj, and it is not justified to view these emissions separately. Overall emissions would increase by 8%.

renewable energy sources by 13.6%. The contribution of this scenario to reduction of CO_2 emissions is larger than Scenario 1. Based on the selected criteria, Scenario 3 is the most unfavourable one.

On 16 January 2019, a stakeholder meeting was held in the conference room of the Government of the Canton to present the results of the Feasibility Study of expanding and improving the DHS in SC. The meeting was attended by the Prime Minister of the Canton, representatives of UNDP, Ministry of Utilities and Infrastructure of SC, Ministry of Spatial Planning, Construction and Environment of SC, Ministry of Economy of SC, Institute of Development Planning of SC, Cantonal public utility companies "Toplane-Sarajevo", "Sarajevogas", and the company "Bags Energotehnika".
The purpose of the meeting was to inform the stakeholders in SC of detailed strategic scenarios for expanding and improving the DHS, and to select the optimum scenario for which a concept design will be developed. Conclusions of the meeting and information on the development of the Study were discussed at the session of the Cantonal Government. The Cantonal Government selected **Scenario 2 as the optimal scenario for which a concept design will be developed.**

5 DESCRIPTION OF THE SELECTED SCENARIO

The selected scenario implies the modernization of existing boiler rooms, including the replacement and installation of new gas fuelled boilers. In addition, installation of biomass and/or chip wood fuelled boilers has also been considered. Such new wood biomass boiler rooms should be set up in municipalities outside the City of Sarajevo; more specifically, one boiler room in each Vogošća, Ilijaš and Ilidža (in the neighbourhood of Hrasnica). The new wood biomass boiler rooms would have sufficient capacity to meet the heat demand in the municipalities of Vogošća and Ilijaš, and the neighbourhood Hrasnica.

Table 2: Buildings which will be covered by the district heating system expansion in Sarajevo Canton

Municipality	Buildings considered for connection to DHS	Currently used fuels
Stari Grad	Healthcare Center Stari Grad, Museum of Sarajevo, Kosta Herman Villa (Institute for the Protection of Cultural and Historical and Natural Heritage CS + Museums of Sarajevo), Gazi Husrev-beg Medrese, Secondary School for Tourism, Primary School "Mladen Pozajić" Music Academy, Central School for Music, Municipality of Stari Grad, Public Health Institute of Sarajevo Canton, Institute for Special Education "Mjedenica".	Natural gas , electricity and fuel oil
Centar Sarajevo	Faculty of Architecture, Faculty of Civil Engineering, Faculty of Sports, Faculty of Philosophy, Faculty of Medicine, Faculty of Pedagogy, Dental Medicine Faculty, Gymnasium „Obala", Catholic School Centre „Sv. Josip", First Gymnasium, Secondary School of Mechanics, Secondary School of Metal Professionals, Vascular Surgery, Historical Archives, Institute of History, Institute for Research of Crimes Against Humanity and International Law, Institute for Language, National Theatre of Sarajevo + Sarajevo Philharmonic, Police Station Center, Youth Theatre, Presidency of Bosnia and Herzegovina, Parliament of BiH,	Natural gas, fuel oil, electricity, coal and pellets

Municipality	Buildings considered for connection to DHS	Currently used fuels
	National Museum, Historical Museum, Department for Planning the Development of Canton Sarajevo, Department for Health Care of MUP Sarajevo Canton Sarajevo, Department for Health Care of Women and Maternity of Canton Sarajevo + residential buildings.	
Novo Sarajevo	Faculty of Mechanical Engineering, Faculty of Math and Sciences, Secondary Schools (for Economy, Electrical Energy Engineering, Secondary School for Environment and Wood Design, Secondary School for Transport and Communications, Third Gymnasium), Primary Schools (Grbavica I, Velešićki heroji), Police Station, Institute for Genetic Engineering and Biotechnology, Traffic Unit of the Ministry of Internal Affairs of SC + residential buildings.	Natural gas, electricity, fuel oil, brown coal, firewood
Novi Grad Sarajevo	Community Health Centre, Centre for Blind Children and Children with Impaired Vision, Primary School Skender Kulenović, Culture Centre, Sports Hall Dobrinja, Stadium Otoka, Olympic Pool Complex Otoka, Gerontology Centre, Kindergarten "Dječiji grad", Primary School "Aleksa Šantić", Primary School "Ćamil Sijarić" + residential buildings.	Natural gas, electricity, fuel oil, pellet
Ilidža	Community Health Centre Ilidža, Outpatient Clinic Hrasnica, Outpatient Clinic Hrasnica II, Local Community Office Hrasnica II, Primary Schools (Second, Third and Fourth Primary School), Municipality Building Ilidža, Police Station Ilidža + residential buildings.	Natural gas and fuel oil
Vogošća	Community Health Centre Vogošća, Primary Music School, Primary School Zahid Baručija + residential buildings.	Fuel oil, natural gas and electricity
Ilijaš	Cultural and Sports Centre, Radio Ilijaš, Sports Hall, Music School 1 + residential buildings.	Natural gas
Hadžići	Residental buildings	Firewood and natural gas

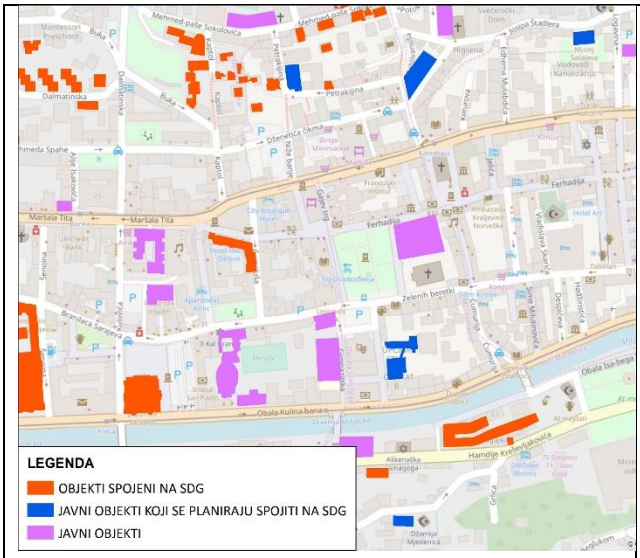

***Figure 1**: Map of proposed expansion of the district heating system for the municipality Stari Grad*

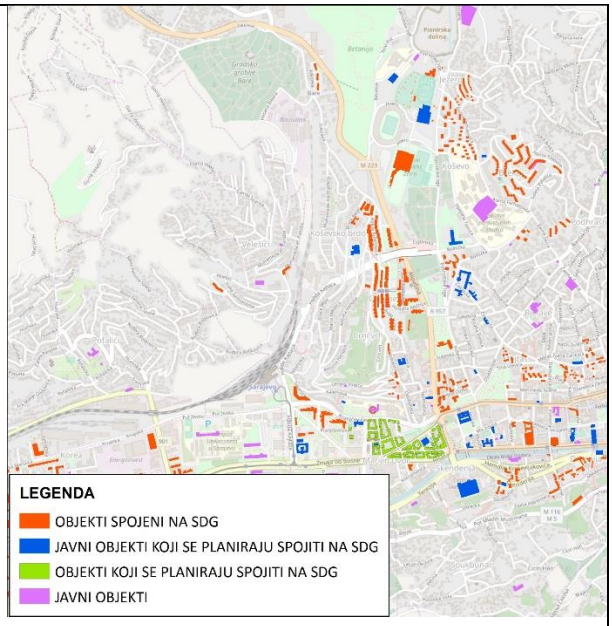

***Figure 2**: Map of proposed expansion of the district heating system for the municipality Centar Sarajevo*

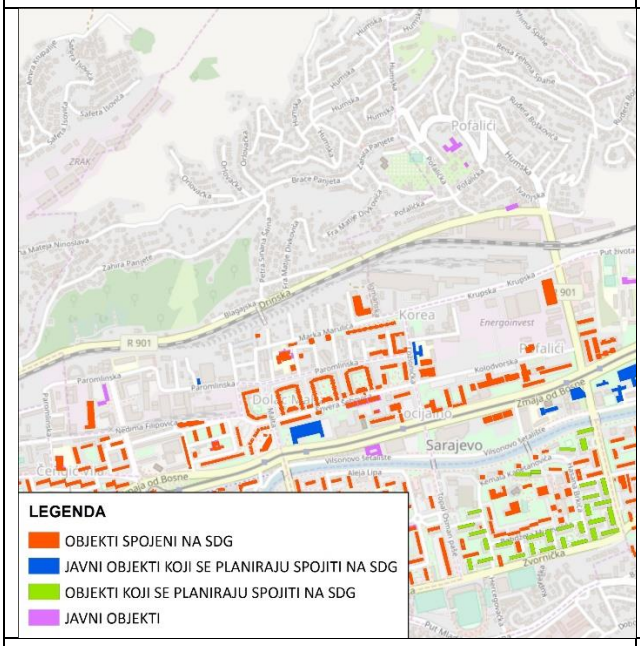

***Figure 3**: Map of proposed expansion of the district heating system for the municipality Novo Sarajevo*

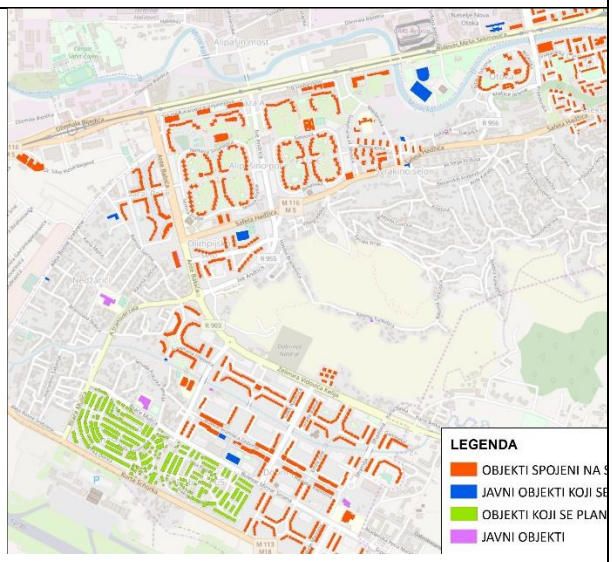

***Figure 4**: Map of proposed expansion of the district heating system for the municipality Novi Grad Sarajevo*

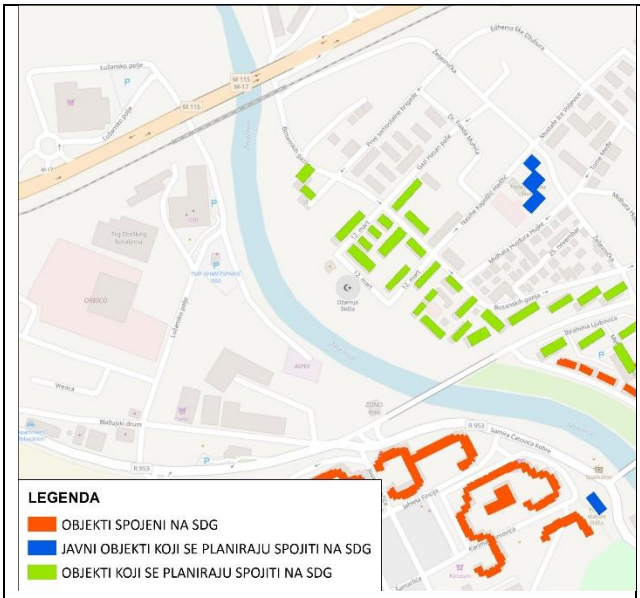

Figure 5: Map of proposed expansion of the district heating system for the municipality Ilidža

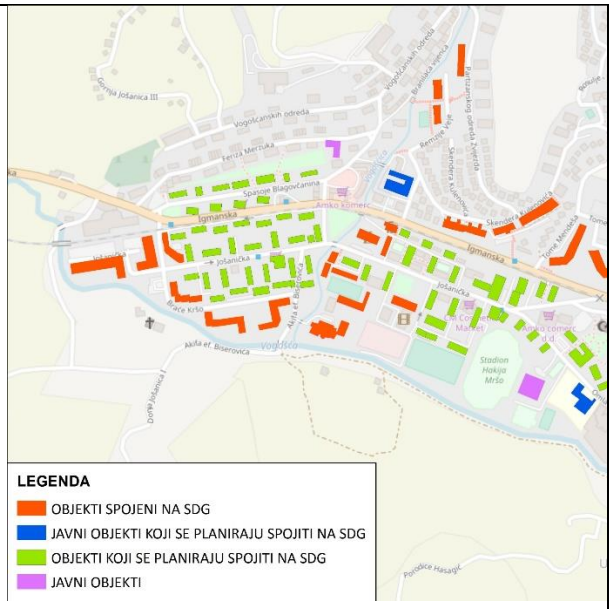

Figure 6: Map of proposed expansion of the district heating system for the municipality Vogošća

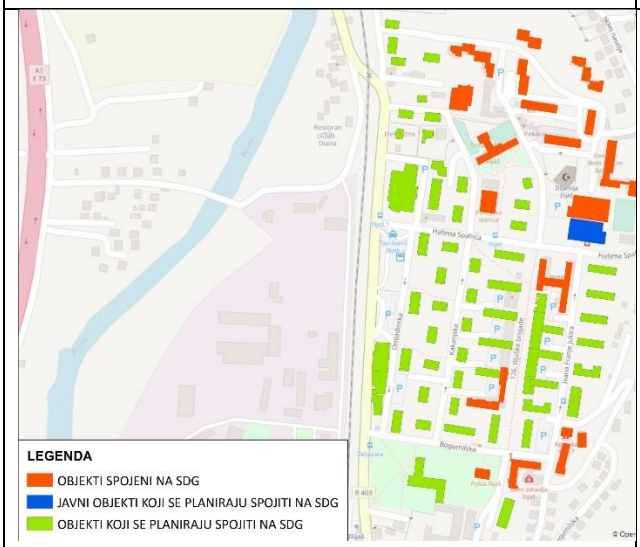

Figure 7: Map of proposed expansion of the district heating system for the municipality of Ilijaš

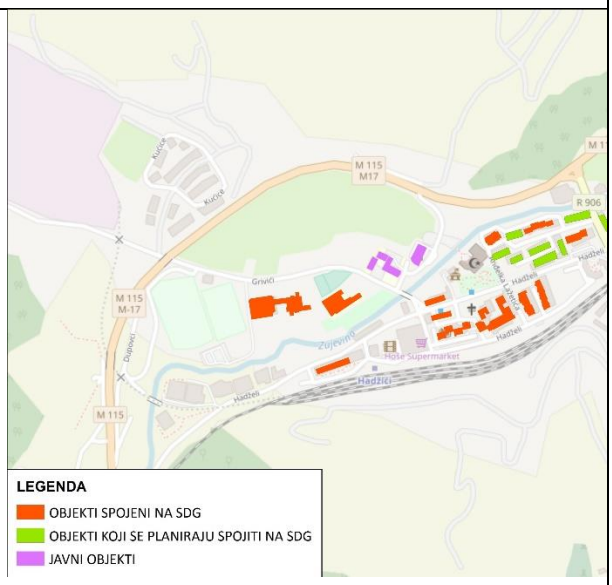

Figure 8: Map of buildings that need to be connected to the district heating system (buildings marked red already have central boiler rooms)

Due to the current state of the boiler rooms which mainly use natural gas, the modernization of these boiler rooms is planned, including the replacement of boilers with new higher efficiency boilers. The

boilers which use heavy fuel oil with low efficiency will be replaced with new gas fuelled boilers. Biomass boiler rooms in the area of the municipalities Ilidža, Vogošća, and Ilijaš (***Table 3***) is planned as well.

Table 3: Overview of current and planned capacity of boiler rooms in selected scenario

Municipality	Unit Place	Existing boiler rooms	New boiler rooms	New boiler rooms (biomass)
Stari Grad	MW	-	3	-
Centar Sarajevo	MW	84	116	-
Novo Sarajevo	MW	204	158	-
Novi Grad Sarajevo	MW	167.8	210	-
Ilidža	MW	31.5	31	13
Vogošća	MW	92,4	-	14
Ilijaš	MW	12	-	14
Hadžići	MW	5.3	7.6	-

The total heated surface area after the implementation of the selected scenario will be 4,825,113 m^2. Taking into account the expansion of the DHS, the selected scenario envisages the installation of new gas fuelled boilers with a total capacity of 260 MW and biomass fuelled boilers with a capacity of 41 MW.

Table 4: Technical criteria for selected Scenario

Technical criteria	Unit Place	Scenario 2
Heat demand – current consumers	MWh	418,194
Heat demand – new consumers	MWh	132,765
Total heated area– current situation	m^2	3,560,375
Total heated area– after expansion	m^2	4,825,113
Total new boilers – gas	MW	260
Total new boilers – wood biomass	MW	41
Total amount of fuel required	MWh	655,448
Supply of heat energy	MWh	549,375
Share of renewable energy sources	%	13.62

Measures aimed at improving DHS in SC also include improvement measures for three companies engaged in heat production and distribution: Cantonal Public Utility Company (KJPK) Toplane Sarajevo d.o.o. Sarajevo, BAGS Energotehnika d.d. Vogošća, and UNIS Energetika d.o.o. Sarajevo, including:

Measures aimed at improving DHS operated by KJPK Toplane-Sarajevo d.o.o:

- Integration of boiler rooms (closing of small capacity boiler rooms);
- Reconstruction and improve of the system:
    - Replacement of boilers and burners;
    - Replacement of the existing pumps in boiler rooms and substations with frequency regulated pumps;

  - Reconstruction of distribution networks;
  - Reconstruction of heat substations;
  - Extension of SCADA system;
  - Automatic hydraulic optimisation of plant operation;
  - Construction of a heat energy buffer;
  - Change of heating curve - reduced temperature of water in forward line

- Improved measurement system and implementation of individual meters - billing based on actual heat consumption
- Transition to an around the clock heating regime
- Reconnection of disconnected consumers to DHS;

Measures aimed at improving DHS operated by BAGS Energotehnika d.d., Vogošća:

- Reconstruction of worn-out network and boiler rooms (huge energy losses);
- Reducing temperature level and replacing heat carriers, transition from steam to hot water;
- The system uses steam boilers, and this requires reconstruction and transition to hot water boilers;
- Improved measurement system and implementation of individual meters - billing based on actual heat consumption
- Reconnection of disconnected consumers to DHS;

Measures aimed at improving DHS operated by UNIS Energetika d.o.o.:

- Replacement of boiler and burner;
- Replacement of the existing pumps in the boiler room and substations with frequency regulated pumps;
- Reconstruction of distribution networks;

Priority investment plan

The priority investment plan is oriented towards maximization of operational cost savings and improved efficiency of the heat production and distribution companies in SC, as well as priority measures, which are applicable (in accordance with the conclusions of the baseline study) for the considered period of three to five years. The short-term investment plan includes legal, institutional, technical and environmental and health and safety measures.

Expansion of the DHS in the considered period is focused towards connection of the public and residential buildings in system area to boiler houses which have sufficient capacity to cover heat demand, as well as modernization of some boiler houses based on the current state of equipment. In addition, it is planned to install a new boiler house in Bistrik in Stari Grad municipality in order to enable the connection of public buildings to the DHS, as well as a new boiler house in the University of Sarajevo Campus located in Novo Sarajevo municipality in order to enable the connection of public and residential buildings in Centar Sarajevo and Novo Sarajevo municipalities. Furthermore, a new biomass based boiler house is envisaged

in Hrasnica in Ilidža municipality, complete with primary and secondary networks to connect new users to the DHS, as well as replacement of the existing heavy fuel oil boilers with biomass based boilers in Vogošća municipality including network extension.

The implementation schedule of the short-term investment plan is provided in the table below.

Table 5: Implementation schedule of the short-term priority investment plan

		2020	2021	2022	2023	2024	TOTAL
KJKP Toplane - Sarajevo including UNIS Energetika							
Modernisation and installation of new boilers	BAM	3,270,148	5,558,469	4,091,596	3,275,306	3,275,306	19,470,826
DHS exapansion (installation of new primary and secondary networks and connection of new users)	BAM	13,362,525	13,362,525	12,962,352	7,826,007	7,826,007	55,339,416
Other expenses	BAM	1,663,267	1,892,099	1,705,395	1,110,131	1,110,131	7,481,024
TOTAL	**BAM**	**18,295,940**	**20,813,093**	**18,759,344**	**12,211,444**	**12,211,444**	**82,291,265**
BAGS Energotehnika							
Modernisation and installation of new boilers	BAM	1,232,173	3,696,519	3,285,794	0	0	8,214,486
DHS expansion (installation of new primary and secondary networks and connection of new users)	BAM	1,262,499	3,156,248	1,893,749	0	0	6,312,496
Other expenses	BAM	249,467	685,277	517,954	0	0	1,452,698
TOTAL	**BAM**	**2,744,139**	**7,538,043**	**5,697,498**	**0**	**0**	**15,979,680**
Short-term priority investment plan							
Modernisation and installation of new boilers	BAM	4,502,321	9,254,988	7,377,391	3,275,306	3,275,306	27,685,312
DHS expansion (installation of new primary and secondary networks and connection of new users)	BAM	14,625,024	16,518,773	14,856,101	7,826,007	7,826,007	61,651,912
Other expenses	BAM	1,912,734	2,577,376	2,223,349	1,110,131	1,110,131	8,933,722
TOTAL	**BAM**	**21,040,079**	**28,351,136**	**24,456,841**	**12,211,444**	**12,211,444**	**98,270,945**

Results of the financial analysis

The financial analysis was conducted from the point of view of the companies KJKP Toplane-Sarajevo d.o.o. Sarajevo and BAGS Energotehnika d.d. Vogosca, which are engaged in heat production and distribution in SC. The financial analysis included projections of balance sheet, income statement and cash flow statement for both of the mentioned companies for the period 2019-2039, all based on planned investments and expected operating expenses and revenues. Based on the balance sheet, income statement and cash flow statement, key performance indicators for these companies were calculated and are presented in the following tables.

Table 6. Key performance indicators for KJKP Toplane-Sarajevo d.o.o. Sarajevo

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
DSCR	-	-	-	7.63	6.26	5.67	4.45	1.79	1.04	0.91	0.72	0.53	0.45	0.42	0.41	0.45	0.49	0.53	0.57	0.68	0.84	1.03	1.22	1.45
Current Ratio	1.66	1.96	1.84	3.39	3.98	4.71	4.52	4.22	3.97	3.87	3.73	3.60	3.26	2.98	2.78	2.61	2.47	2.33	2.37	2.53	2.81	3.14	3.61	4.23
T.L. / T. N. W.	23.90	17.85	19.49	9.23	7.92	7.52	7.61	7.50	7.42	7.13	7.38	7.59	7.50	7.04	6.33	5.52	4.70	3.95	3.27	2.69	2.23	1.86	1.56	1.32
T.L /EBITDA	12.48	11.80	11.18	23.68	42.45	37.48	39.11	33.63	32.75	27.22	29.41	27.87	25.71	23.52	22.23	20.85	19.43	18.01	16.57	15.20	14.02	12.99	12.08	11.28
Return on Equity (ROE)	0.99	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Return on sales (ROS)	0.20	0.19	0.20	0.09	0.06	0.07	0.07	0.09	0.09	0.11	0.11	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Return on assets (ROA)	0.01	0.02	0.03	0.05	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04
Net margin	0.03	0.04	0.08	0.11	0.08	0.06	0.04	0.03	0.02	0.03	0.02	0.01	0.01	0.01	0.02	0.03	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.11

Table 7. Key performance indicators for BAGS Energotehnika d.d. Vogosca

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
DSCR	-	-	-	0.34	-0.16	-1.30	0.85	0.12	0.17	0.27	0.38	0.47	0.54	0.61	0.67	0.73	0.78	0.83	0.87	1.09	2.64	-	-	-
Current Ratio	0.16	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.13	0.19	0.25	0.31	0.37	0.43	0.50	0.60	0.88	1.44	2.02	2.61	3.19
T.L. / T. N. W.	1.59	2.27	2.08	1.53	2.20	5.46	6.52	6.43	5.82	5.02	4.20	3.41	2.71	2.12	1.64	1.24	0.92	0.67	0.46	0.31	0.24	0.22	0.20	0.18
T.L /EBITDA	23.09	1.111.16	24.78	33.77	-50.93	-24.24	15.07	14.44	13.34	12.26	11.26	10.27	9.27	8.27	7.27	6.27	5.27	4.27	3.27	2.44	2.09	2.09	2.09	2.09
Return on Equity (ROE)	0.03	0.00	0.02	0.02	-0.06	-0.35	0.08	-0.02	0.02	0.05	0.08	0.11	0.13	0.15	0.17	0.18	0.20	0.21	0.22	0.23	0.24	0.25	0.25	0.26
Return on sales (ROS)	0.13	0.00	0.12	0.08	-0.07	-0.24	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Return on assets (ROA)	0.01	0.00	0.01	0.01	-0.02	-0.05	0.01	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.07	0.08	0.08	0.07	0.07	0.07
Net margin	0.05	0.00	0.03	0.03	-0.08	-0.35	0.10	-0.03	0.02	0.06	0.10	0.13	0.17	0.19	0.22	0.25	0.27	0.29	0.31	0.33	0.34	0.36	0.37	0.38