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Energy Saving Group

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Investment Plan for DHC Senta

Rehabilitation of District Heating Systems in Serbia – Phase V

Investment Plan for DHC Senta

Ministry of Mining and Energy, REPUBLIC OF SERBIA and KfW, GERMANY

Contact

Fichtner GmbH & Co. KG
Sarweystrasse 3
70191 Stuttgart
Germany

www.fichtner.de

Wolfgang Schroeder
+49 711 8995 295
+49 163 8995 800
Wolfgang.Schroeder@fichtner.de
Fichtner GmbH & Co. KG

Contact

Bojana Opacic
+381 11 4066 711
+381 62 105 11 88
Bojana.Opacic@esg.co.rs
Energy Saving Group, ltd

Document approval

	Name	Signature	Position	Date
Prepared by:	Wolfgang Schroeder		Fichtner Project Manager	22.02.2021
Prepared by:	Bojana Opacic		ESG Project Manager	22.02.2021
Checked by:	Karl Joachim Linder		Fichtner Project Director	22.02.2021

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Acronyms and Abbreviations

BH	Boiler House
BLS	Building level Substations
BR	Boiler Room (in small sized island networks)
CBB	Consumption based billing
CD	Conceptual Design (IDR Idejno resenje) according to TOR, Inventory DH Phs V.xlsx
CEMS	Computerised Emission Monitoring System
COD	Construction Design / Detailed Design (PZI Projekat za izvodjenje) according to TOR, Inventory DH Phs V.xlsx
DCP	Design for Construction Permit (PGD Projekat za gradjevinsku dozvolu) according to TOR, Inventory DH Phs V.xlsx
DH	District heating
DH Program	KfW's financed Program "Rehabilitation of District Heating Systems in Serbia"
DHC	District Heating Company, see also Toplana
DHW	Domestic hot water
Din	Serbian Dinar
DIN	German Industrial Norm / Standard
DN	Nominal diameter of pipelines
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EN	European Norm / Standard
ESHS	Environmental, Social, Health and Safety
ESIA	Environmental & Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
FC	Frequency control
FS	Feasibility study
GWh / MWh	Giga watt hour / megawatt hour
h	Hour
HE	Heat exchanger
HFO	Heavy fuel oil (mazut)
HoB	Heat only boiler
HM	Heat meter
KfW	Kreditanstalt für Wiederaufbau
kW	Kilowatt
LC	Location Conditions
LFO	Light fuel oil (Diesel)
m	meter
MoME	Ministry of Mining and Energy of the Republic of Serbia
O&M	Operation and Maintenance
PD	Preliminary design (IDP Idejni Projekat) according to TOR, Inventory DH Phs V.xlsx
PPR	Project Planning Report
Project	Rehabilitation of District Heating Systems in Serbia – Phase V
Pr.	Investment Item / Project
SCADA	System for Computerized Automation and Data Acquisition
TC	Temperature control
Toplana	District Heating Company
TR	Technical Requirements

1 Description of the current DH System

1.1 Heat Production

DHC Senta has a new boiler house with a total capacity of 14 MW (2 x 7 MW), which uses natural gas as fuel. The boiler house started operation in January 2019. Heat production in the last year was about 17,000 MWh.

Table 1-1: Details of the boiler house

Boiler station	Boiler type and manufacturer	Burner	Year of commissioning	Network Regime [°C]	Available installed Capacity [MW]		Calculated peak load per boiler station [MW]
BH Senta	BOSCH	Weishaupt G70/2-A	2019	80/60	7	14	10
	BOSCH	Weishaupt G70/2-A	2019	80/60	7		
					Total:	**14**	**10**

Although the efficiency of the new gas-fired boilers is about 95%, the energy efficiency in the first heating season was 85.5% only, which indicates a long period of part load operation.

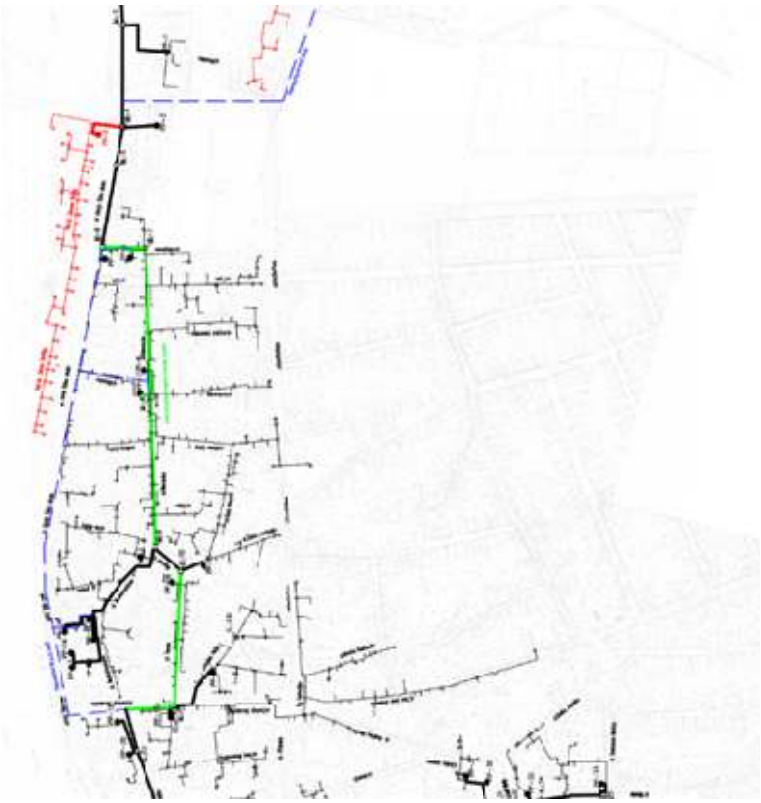
The regarded DH systems have excess capacity in the range of 4 MW.

Heat Production is not part of this Rehabilitation Project.

1.2 Heat Distribution Network

The total length of the network is about 30 km (7.8 km of primary network and 22.2 km of secondary network), which are older than 40 years. Some of them are pre-insulated, others are insulated by mineral wool and bitumen mixture, but a part of them are without any insulation. Old pipes are buried in concrete channels mostly, at the depth of about 1m. Due to frequent interventions, the pipelines of the existing network are causing troubles. Heat loses in the season 2019/2020 amounted to 22%, resulting from the age of the network and the lack of insulation.

Figure 1-1: DH system of Senta



1.3 Heating Substations

The boiler house in Senta is new, but other parts of the district heating system are rather old.

The total number of heating substations is 52 and the total number of installed heat meters (calorimeters) is 614.

The main issue with regard to heat distribution and heat supply to the customers is the fact, that the circulating hot water of the primary network is passing through the boilers as well as through the radiators of the customers in one circulation loop without interposing of any kind of heat exchanger. The function of the substations is just pressure control and heat metering. Moreover, the average age of these substations is 40 years.

Therefore, the DHC Senta plans to install heat exchangers in heat substations in the buildings of the customers.

2 Investment Proposals of the Toplana

2.1 Heat Production

Heat Production is not part of this Rehabilitation Project.

2.2 Heat Distribution Network

The DHC intends to replace some 9,655 m of pipes with an average diameter of 100 mm to reduce the high heat and water losses. According to the information obtained, 100% of the networks are in a poor technical condition. This is indicated by high network losses: usually 20 - 22% heat losses per season, of which about 70% are assumed to be pipeline related and 30% are substation related.

The distribution network rehabilitation consists of two sub-projects:

- network parts in the settlement of "Pesak" and
- network parts in other parts of Senta.

Project 1.1 – Network rehabilitation in the settlement of "Pesak".

DHC Senta has Location requirements, Preliminary Design and Approval of works for reconstruction of the old network and for construction of new network parts in the settlement of "Pesak".

The length of pipes that should be replaced is 2,084 m, while the length of the new pipes that should be installed is 988m, and in total it amounts to 3,072 m of pipes **(Table 2-1**).

Table 2-1 presents information about the section, DN, length, unit price and total price for project network reconstruction in settlement of "Pesak".

Table 2-1: Replacement of pipes per section in settlement of "Pesak"

No. section	DN	Pipe length [m]	Unit price, [EUR]	Total, [EUR]
SETTLEMENT PESAK				
The structure of the network of the primary substation PP-2, Kej dr Z. Đinđića br.26 - REPLACEMENT				
1	40	360	57	20,444
2	50	342	72	24,607
3	65	126	86	10,835
4	80	84	110	9,200
5	100	276	159	43,866
6	125	456	199	90,891
7	150	320	252	80,564
8	200	120	327	39,188
The structure of the network of the primary substation PP-2, Kej dr Z. Đinđića br.26 - NEW NETWORK				
1	40	300	57	17,037
2	50	16	72	1,151
3	65	96	86	8,255
4	80	228	110	24,972

No. section	DN	Pipe length [m]	Unit price, [EUR]	Total, [EUR]
SETTLEMENT PESAK				
5	100	348	159	55,309
TOTAL		**3,072**		**426,320**

Prices without VAT

Project 1.2 - Network rehabilitation in other parts of Senta.

The Conceptual Design for project rehabilitation of network in the "other parts of Senta" is not yet ready but will be provided by the DHC for tendering purposes.

The total length of pipes (not traces) foreseen for replacement is 2,123.4 m. The length of pipes for new network sections is about 4,460 m.

For these network sections, the DHC prepared a list of diameter and length of pipes (Table 2-2). The unit prices are taken from the design for the network in the settlement Pesak.

Table 2-2: List of pipes for installation in other parts in Senta

No. section	DN mm	Pipe length [m]	Unit price, [EUR]	Total, [EUR]
REHABILITATION OF NETWORK IN OTHER PARTS OF SENTA				
Network of the primary substation PP-38, Zlatna greda br.6 - REPLACMENT				
	25	230.4	45	10,368
	32	32	50	1,600
	40	98.4	57	5,609
	50	99.6	72	7,171
	65	283.4	86	24,372
	80	252.4	110	27,764
	100	142.6	159	22,673
	125	400.4	199	79,680
	150	421.4	252	106,193
	175	38.8	290	11,252
	200	124	327	40,548
Network to the Hospital, Karađorđeva br.64 - NEW NETWORK				
	50	540	72	38,880
	125	740	199	147,260
	150	560	252	141,120
Relocation of the network from Nemanjina street to the street Donja Tisina Obala - NEW NETWORK				
	50	20	72	1,440
	65	100	86	8,600
	100	620	159	98,580
	300	1880	490	996,400
			Total	**1,694,310**

The Preliminary Design defines costs of 426,320 EUR for reconstruction of the network in the settlement of "Pesak".

Based on the prices from the design, the costs for new pipelines and for rehabilitation of existing pipelines in other parts of Senta would amount to 1 694 310 EUR.

Therefore, the total costs for this project of rehabilitation of the distribution network would cost about 2,125,000 million EUR, as it was initially estimated by DHC.

2.3 Heating Substations

The DHC intends to replace 25 old primary heat substations (without heat exchangers) with 105 new compact substations equipped with heat exchangers and with SCADA system. All equipment should be delivered as compact substations with ready-to-install electric power, pipe connection and measurement, control and regulation equipment (SCADA system). Temperature regime of the heat substations would be 80/60 for primary and 70/50 for secondary loop.

Same as for the rehabilitation of the network, this project consists of two sub-projects:

- installation of substations in the settlement of "Pesak" and
- installation of substations in other parts of Senta.

Project 2.1 – Substations in settlement of "Pesak".

DHC Senta has prepared Preliminary Design and obtained Approval of works to replace 1 old primary substation with 35 new compact substations equipped with heat exchanger, heat metering and SCADA system in the settlement of "Pesak (**Table 2-3)**.

Table 2-3 presents the power range, number of units, unit price and total price for project replacement of substation in the settlement of "Pesak. Total installed capacity in these substations will be 3.86 MW.

Table 2-3: Replacement of substations in the settlement of "Pesak (Data from Preliminary Design).

Heat power	Number of units	Unit price, [EUR]	Total, [EUR]
80 kW	22	7,100	156,200
120 kW	4	7,400	29,600
180 kW	9	7,600	68,400
	35		**254,200**

Prices without VAT

Project 2.2 – Substations in other parts of Senta.

DHC Senta will provide Conceptual Design to replace 24 old primary substations with 70 new compact substations equipped with heat exchangers and with SCADA system in the other parts of Senta.

All technical characteristics of the substation should be defined in the Conceptual Design. The Conceptual Design for project rehabilitation of substation in the "other part of Senta" is not ready. Designer House who will prepare Conceptual Design has not chosen yet.

DHC initially estimated the total costs for heat substations at 450,000 EUR. But, since the Preliminary Design defines costs of 254,200 EUR for installation of 35 heat substations, then installation of 105 heat substations of similar capacities would cost about 750,000 EUR without VAT.

It is necessary to note, that the prices given in the table above are pretty high for heat substations of that capacity.

2.4 SCADA

DHC Senta has not installed SCADA system until now. They would like to install a central SCADA system, control, regulation and monitoring equipment in the boiler house and each substation planned for reconstruction.

The DHC initially estimated cost amounts to 120,000 EUR., which are deemed being too low.

More detailed investigations define a sum of 240,000 EUR, considering the effort according section 3.3. with supply and services for

- SCADA main System (hardware & software)
- Civil works for control room preparation inside the existing boiler house
- Data transfer via communication links
- Settlement metering software

Remark: The control and monitoring equipment for the new heat substations are covered in prices of the above-mentioned compact stations.

2.5 Miscellaneous

There is no other equipment planned with this rehabilitation Project.

3 Technical Assessment and Development of Alternatives

3.1 Heat Distribution Network

Based on the information received, 100% of the heat distribution pipelines are in a poor technical condition. This poor condition of distribution network result in high heat and water losses throughout the network as well as high repair and maintenance cost.

Considering the overall age and condition of the system, replacing of old pipes will increase reliability and improve heat and water losses significantly.

The Consultant proposes to follow the approach of the DHC regarding the pipelines to be replaced.

The conceptual design for network rehabilitation in "Other parts of Senta" has not been finalized yet. It is planned to replace a total of length of 2,124.4 m and to install new pipes at a length of 4,460 m.

As the installation conditions in the town as well as the local conditions of the networks are different for each DHCs, it is not possible to define unit prices for pipelines, which may be valid for all DHCs. Main differences result from pipelines laid under roads and/or walkways as well as under bridges or in the green field on ground. More detailed information will be available during detail design. However, the consultant agrees with the assumption by the DHC, that the investment value of 950 000 EUR for 6.5 km network rehabilitation, which is based on costs for network rehabilitation in the settlement Pesak, is in accordance with average prices for installation of pipelines of the given diameters.

3.2 Heating Substations

The 40-year-old heating substations are equipped with pressure control valves and calorimeters for heat metering only. They are just used as "central" distribution points of the circulating primary network water to a group of customers. As these heating substations are causing high costs for maintenance and repair and high pressure losses in the primary distribution network, the Consultant agrees to replace 25 of them by 105 new compact heating substations.

The new substations of compact design will be located decentral and closer to the customers. They will be insulated and equipped with heat exchangers and secondary circulation loops in order to separate the customers radiators from the main primary circulating network. Moreover, these substations of compact type will be equipped with ready-to-install electric power, pipe connection and measurement, control and regulation equipment (SCADA system). By separation of the primary network from the customers, pressure loses, heat losses, water losses and contamination of the circulating water can be reduced.

The DHC prepared design as well as layout drawings for 3 types of substations. In total, the DHC prepared the design for 35 different sized substations, out of 105 proposed for installation. Temperature regime of the heat substations will be 80/60 for primary and 70/50 for secondary loop.

The Consultant assumes unit prices for the heat substations, which are a little bit lower than those defined in Preliminary design for Senta.

Table 3-1. Prices and cost for installation of heat substations

Heat power	Number of units	Preliminary design		Consultant assumption:	
		price [EUR]	Total cost [EUR]	price [EUR]	Total cost [EUR]
80 kW	22	7,100	156,200	5 200	114 400
120 kW	4	7,400	29,600	6 000	24 000
180 kW	9	7,600	68,400	6 600	59 400
	35		**254,200**		**197 800**

Since the majority of these substations will be new, the capacities of the substations are still unknown. The consultant assumes that the capacities will be very similar for each of these 35 substations.

Based on the above assumptions, the Consultant assessed that the total cost of installation for all new 105 substations in Senta might amount to about 600 000 EUR.

3.3 SCADA

A new system for supervision and control (SCADA) should be implemented for the DH system in Senta. This implies supervision over the district heating network as well as over the heating substations, which will enable centralized control, monitoring and consumption metering. The location for the central control room has to be selected, finally.

SCADA system consists of a single fault tolerant server (with high availability) and a graphical user interface. The system must provide constant real-time communication with the equipment. Regarding the supervisory system: an industrial PLC should be of adequate quality and features, manufactured by a reputable company and the supervisory-control station on a PC server platform

Operator stations are primary user interface of the system. Each operator station must be equipped with an LCD monitor of adequate resolution, a mouse and a keyboard of industrial quality. Operator stations are connected to a server and server provides them with current data on demand. By using the operator stations, the user can obtain a comprehensive and clear overview.

A software for control (locally, in heating substations) and supervision should be implemented All the usual functions for control and supervision of the heating system must be covered:

- Active images of processes (dynamic display)
- Handling alarms and logs (all alarms must be recorded in the alarm log)
- Graphic system shall provide online as well historical data displaying as trends, curves and with printing functions
- Data collection over time and archiving (history of data, events and alarms)
- Reporting (preparation of reports for different time periods)

The settlement metering software must be developed and provided according the local needs.

Since the distributed control system (equipment in heating substations as well heating meters) is physically quite far away from the centralized control section of SCADA system, communication methods must be adequately chosen in order to meet all possible requirements.

The complete SCADA system must be installed in the control centre, which have to be built or provided in advance to accommodate the equipment. The SCADA system must be tested with all features and commissioned starting from data sources in the substations and from the control and monitoring components (like controller, sensors, meters, valves).

Heat meters have to be installed at the interface to the individual consumers or a group of consumers (e.g.in a larger buildings)

An employees' training must be included and should be organized before start-up of the SCADA system.

4 Economic Assessment

4.1 Heat Distribution Network

The benefits of replacing old pipe sections by new pre-insulated pipes result from fuel savings due to reduced heat losses, less maintenance and repair cost, as necessary network interventions will be reduced. Of the 9.6 km pipeline proposed for the KfW5 Project, only 4.2 km are the existing pipeline that will be rehabilitated, while the rest will be new pipeline. It is assumed that the total investment cost of 2.125 million EUR can be proportional divided independently on the fact whether the pipeline is now or not. In that case, the investment cost for the pipeline for rehabilitation amounts to 930 000 EUR. The total pipeline length is 30 km.

By replacing old pipe sections with poor insulation by new, pre-insulated pipelines, heat losses can be reduced from actually 22% to conservatively 10%. It is assumed that 3/4 of the heat losses occurs at the pipeline while 1/4 occurs in substations. Taking into account that the proposed sections for rehabilitation are those with higher losses, it is assumed that heat losses in these sections are higher for 50% than average at the pipeline.

During the heating season the water loss in the whole distribution system is about 80 m^3 per day, while out of the heating season the water loss is 20 m^3 per day, then the overall water loss amounts to 18,000 m^3 per year. It is assumed that the water loss will be halved after pipeline rehabilitation.

Additionally, maintenance and repair cost can be reduced significantly as the number of network interventions will be much lower considering that after finalizing replacement of old pipes, approximately 32% of whole network will then be made of new pre-insulated pipes.

Table 4-1: Economic evaluation of Network investment

Item	Unit	actual	after project realisation
Heat distribution network			
Investment costs	€		930,000
Heat production	MWh/a	13,500	13,172
Average Heat losses in distribution (pipeline + substations)	%	22	20
Heat delivered to all customers	MWh/a	10,530	10,530
Delivered heat assigned to 4.2km of pipeline for rehabilitation	MWh/a	1,474	1,474
Heat losses at pipeline for rehabilitation	%	25%	10%
	MWh/a	491	163
Fuel consumption for heat losses at pipeline for rehabilitation (boiler eff. 85%)	MWh/a	577	191
Water loss at the pipeline for rehabilitation	m3/a	5,760	2,880
Maintenance & Repair cost	€/a	56,000	21,250
Maintenance & Repair cost	€/a	56,000	21,250
Benefits			
Reduction of CO_2 (related to total heat production in the boiler house)	%		2.4

Item	Unit	actual	after project realisation
Total Fuel Energy Savings	MWh/a		386
Total Fuel Cost Savings	€/a		15,440
Water cost savings	€/a		14,400
Savings Maintenance / Repair	€/a		35,000
…Total savings per year			65,000
Economic Analysis			
Internal Rate of Return	%		3.4%
Simple Payback Time	years		14.3

Economic basic data:

- Fuel price for natural gas (33 MJ/m^3) in 2020: 40 €/MWh
- Water price: 5 €/m^3

Considering that the complete heat distribution network in Senta consists of old pipes in a poor condition, the Consultant is of the opinion that investment in replacing these old pipe sections step by step is required, independent from result of economic evaluation above as this will improve reliability of heat supply and proved the basis for future use of district heating in Senta.

4.2 Heating Substations

The DHC has already prepared precisely defined locations, capacities and other parameters of the new substations. It is assumed that the customers will receive the same quantity of heat with or without this project.

In the heating season 2019/2020, the DHC delivered 13,088 MWh/a to the customers. Taking into account heat losses in the distribution system of 22%, then the produced energy in the boiler house was about 16,780 MWh/a and the energy losses of the distribution system were about 3700 MWh/a. Based on an average energy efficiency of the boilers of about 85.5%, the fuel demand was about 19,500 MWh/a.

Assumed that

- despite of the future possibility of more detailed allocation of the heat energy consumption by the customers, it will remain on the same high level
- the annual average production efficiency of the boilers is 85.5%;
- about 30% of the heat losses in the distribution network can be assigned to the substations and connecting pipelines to the customers, these then amounting to 555 MWh/a (=3.3% of the produced heat)

Investment cost in a new equipment will be about 600 000 EUR.

The benefit will mainly result from reduced costs for maintenance and repair and from fuel savings due to improved overall system efficiency.

Table 4-2: Economic comparison for replacement of substations

Item	Unit	actual	after project realisation
Substations			
Peak load heat demand of all customers	MW	10	10
Heat consumption by all customers	MWh/a	13,088	13,088
Heat losses in distribution (pipeline + substations)	%	22 %	16.4%
	MWh/a	3,692	3,137
Heat losses in all substations	%	6.6%	3.3%
	MWh/a	1110	555
Heat production	MWh/a	16,780	16,230
Average boiler efficiency	%	85	85
Fuel consumption	MWh/a	19,740	19,090
Staff Number	No.	2	1
Investment Costs in total	€		600,000
Benefits			
Reduction of CO_2 (related to total heat production in the boiler house)	%		3.3
Total Fuel Savings	MWh/a		650
Total Fuel Savings	€/a		26,000
Savings of total operating costs	€/a		9,600
Savings maintenance / repair	€/a		9,000
Total savings per year	€/a		44,600
Economic Analysis			
Internal Rate of Return	%		5.5%
Simple Payback Time	years		13.5

Economic basic data:

- Fuel price for natural gas (33 MJ/m³) in 2020: 40 €/MWh
- Salary for operational staff in 2020: 9600 €/year

Although economic evaluation does not show that this project is attractive, the main benefit of the project is separation of internal installations of consumers (radiators) from the distribution loop. The separation will allow the less pressure in the internal installations, and generally will lead to less water leakages and consequently less heat losses. By the separation, the water leakages or any other interventions at internal installations will not affect the operation of the boilers and the distribution system. All these effects will improve the reliability of heat supply, and they are not quantified in the economic analysis. In addition, the benefit will result from reduced costs for maintenance and repair and from fuel savings due to improved overall system efficiency. As a final conclusion, the Consultant supports the project.

4.3 SCADA

Since the planned SCADA would comprise mainly monitoring, but not a really network control, it is not possible to quantify the benefits. But the information gathered by the monitoring will surely provide data for useful network operational interventions and future control and upgrading, which will contribute to the overall system efficiency and reliability.

Heat metering devices and remote settlement metering with the related billing software can produce a consumers' bill easier. The automated billing can reduce the effort of staff in the current department. This cannot really be quantified. Because at the other hand personal for operation and maintenance of the SCADA system as well for the metering system will be needed in addition.

5 Risk Assessment

5.1 Assessment of Permissions

The following table is an overview of subprojects and the required documentation in accordance with the regulation framework for each subproject of DHC Senta.

Table 5-1: Overview of the current status of each subproject for DHC Senta

Project name and type:	Conditions for Design, technical and EIA Documents and Permits	Legal obligation	Current status	Further actions and responsibilities
Project 1.1 – network in settlement of "Pesak"	Conceptual Design	no	yes	DHC
	Preliminary Design or Design for Construction Permit	yes		
	Construction Design	yes	no	Construction company
	EIA	no	no	-
	Location Requirements	yes	yes	DHC*
	Technical Requirements	yes	yes	DHC
	Approval of works or Construction Permit	yes	yes	DHC
Project 1.2 - network in other parts of Senta	Conceptual Design	no	no	DHC*
	Preliminary Design or Design for Construction Permit	yes	no	Construction company
	Construction Design	yes	no	Construction company
	EIA	no	no	-
	Location Requirements or Requirements for crossing and parallel pipeline management	yes	no	DHC*
	Technical Requirements	yes	yes	DHC
	Approval of works or Construction permit	yes	no	DHC
Project 2.1 – substations in settlement of "Pesak"	Conceptual Design	no	yes	DHC*
	Preliminary Design or Design for Construction Permit	yes		
	Construction Design	yes	no	Construction company
	EIA	no	no	-
	Location Requirements	yes	yes	DHC*
	Technical Requirements	yes	yes	DHC
	Approval of works	yes	yes	DHC
Project 2.2 - substations in other parts of Senta	Conceptual Design	no	no	DHC*
	Preliminary Design or Design for Construction Permit	yes	no	Construction company
	Construction Design	yes	no	Construction company
	EIA	no	no	-
	Location Requirements	yes	no	DHC*

Project name and type:	Conditions for Design, technical and EIA Documents and Permits	Legal obligation	Current status	Further actions and responsibilities
	Technical Requirements	yes	no	DHC
	Approval of works	yes	no	DHC

** According to Serbian law, the Conceptual Design is necessary for obtaining Location Requirements. However, in case of heating pipeline reconstruction, no Location Requirements are necessary but Conditions for crossing and parallel pipeline management. Public institutions are in charge of issuing the Conditions for crossing and parallel pipeline management based on the technical description of works that should be performed, which means that DHC is obligated to submit a minimal technical description of planed activities along with the Request for Approval, so that the relevant institutions are able to issue the necessary requirements.*
DHC Senta has obtained Location Requirement for subproject in settlement of "Pesak", which is one step more than required since obtaining of Location Requirements implies preparation of a Conceptual Design. DHC Senta plans to apply similar procedure for two subprojects, for which they did not obtain permits yet.

The DHC shall monitor the progress of all required permission procedures and in case of delays or other problems shall inform the CPIU and the Consultant accompanied with a proposal to overcome obstacles.

Table 5-2: Check list of potential risk

Subject	Assessment
Approval of works from the competent body?	DHC Senta has Preliminary Design and Approval of Works for projects "Project 1.1 – network in settlement Pesak" and "Project 2.1 – substations in settlement Pesak". DHC will prepare comprehensive input documentation, obtain Location Requirements and necessary permits for Project 1.2 - network in other parts of Senta and Project 2.2 - substations in other parts of Senta. Low risk, Municipality will support DHC.
Land owners permissions for the trace routing Available?	Low risk, DHC has to obtain land owners permissions.
Are there any objections from the population for any reason expected which may stop or delay the works?	Risk might exist for pipe replacement
Has the DHC/Municipality already informed or intends to inform the Public about the planned construction works?	Not until now.

5.2 Assessment of other Risks and Summary

In addition of the risk to obtain the necessary permission at all and in a reasonable time the Consultant assessed technical/operational risks, environmental and financial risks of the investments, which have been assessed as technically valid.

The following tables summarises all risks, which could have been assessed in this stage of investment preparation.

Table 5-3: Summary of risk assessment

Investment	Permission risk	Technical risk	Environmental risk	Financial risk	Overall risk
Network in settlement of "Pesak"	Low risk - DHC obtained permission	Low	Low	Low	Low
Network in other parts of Senta	Low risk, DHC has to obtain land owners permissions.	Low	Low	Low	Low
Substations in settlement of "Pesak"	Low risk - DHC obtained permission	Low	Low	Low	Low
Substations in other parts of Senta	Low: within facilities of the Toplana	Low	Low	Low	Low

6 Conclusions

The situation in Senta is different to other DHCs, as circulating water of the primary network is not protected from pollution or water losses by heat exchange in old substations, which are distributing the water directly to the radiators of many customers. The amount of investment costs is not fully based on design documentation but is partly estimated. The estimation differs between the DHC and the Consultant.

Moreover, the substance of the network is old and causing high heat and water losses as well.

Although it is essential to separate the primary network from the customers by plate type heat exchangers, the need of rehabilitation of the network itself should have higher priority.

Up to now, Senta does not have any SCADA system. Although SCADA will improve the measurement and control of the heating system, it is less important for the time being than the other proposed projects.

6.1 Ranking of Investment Proposals

The replacement of the existing pipelines in settlement of "Pesak" and other parts of the settlement "Senta" are put on rank one and two since heat losses and water losses will significantly be reduced as well as maintenance and repair cost. Necessary network interventions will be also minimized, and reliability of the network will be improved.

The Rehabilitation of the substations is ranked in third and fourth position in the table because it is more worthy to increase the efficiency of the district heating grid and cost estimation is on a safer level.

The Installation of a SCADA system is ranked fifth, as the rehabilitation of the substations is a precondition for installation of SCADA equipment.

The ranking is shown in **Table 6-1.**

6.2 Recommendations

All proposed investments have a reasonable return on investment or high qualitative benefits at an acceptable overall risk. The Consultant recommends considering all proposed investments in the investment plan.

Table 6-1: Ranking of investments for DHC

Rank	Investment	Description	Benefits	Simple pay-back period [Years]	Risk
1	Network in the settlement of "Pesak" Installation of new pipe - 988 m & Replacement of old pipes - 2,084 m	Installation of some 988 m of new pipeline trace from diameter DN40 up to DN100 Replacement of some 2,084 m of pipeline trace of existing 30-35 years old with diameter of DN40 up to DN200, which have high heat losses due to poor insulation	Increase of overall system efficiency and reduction of heat and water losses	14.3	Low
2	Network in other parts of Senta Installation of new pipe -2,123.4 m & Replacement of old pipes - 4,460 m	Installation of some 2,123 m of new pipeline trace from diameter DN40 up to DN100 Replacement of some 4,460 m of pipeline trace of existing 30-35 years old with diameter of DN40 up to DN200, which have high heat losses due to poor insulation	Increase of overall system efficiency and reduction of heat and water losses	14.3	Low
3	Rehabilitation of 35 substations in the settlement of "Pesak	Replacing and upgrading of 35 substations with new compact substations equipped with plate heat exchangers, frequency-controlled pumps, heat meters, and temperature control (automation)	Increase of overall system reliability and efficiency. Decrease of pressure losses by passing through radiators	13.5	Low
4	Rehabilitation of 70 substations in other parts of Senta	Replacing and upgrading of 70 substations with new compact substations equipped with plate heat exchangers, frequency-controlled pumps, heat meters, and temperature control (automation)	Increase of overall system reliability and efficiency. Decrease of pressure losses by passing through radiators	13.5	Low
5	Installation of SCADA	The current system of data collection at measuring points at the substations does not allow for consumption-based billing. of individual customers SCADA will be installed at the boiler house as well as at the new substations, which will be located closer to the customers.	Central data collection of heat consumption as well as central control of heat supply to customers[1]	N/A	low

[1] The SCADA system will be installed as a central processing unit in the central control room of the DHC. It will be an electronical support to the operational procedures of the DHC related to data collection and control of network regulation and operation. However, since only a part of substations is foreseen for reconstruction within this KfW V program, only those can be controlled by SCADA. The real benefit of SCADA is the later ability for improvement of balancing of the entire network. But this will mainly result in cost saving for operational and maintenance staff. Therefore, the investment in SCADA at a part of substations cannot be justified with energy savings in the context of the rehabilitation program KfW V. As mentioned before, the full benefit of SCADA can be achieved after connection of all substations to the system. Moreover, the effects of SCADA on energy savings are generally very arbitrarily estimated and depend on the previous activities of DHC related to regulation of system operation.

7 Investment Plan

The Consultant accepts the general approach of the DHC's proposal but proposes SCADA as an additional investment. The Consultant further recommends including the investments under this KfW Phase V financing Project according to their ranking. The following table shows the costs of all investments, which are proposed by the Consultant.

Table 7-1: Proposed draft investment plan for DHC

Description	DHC / Toplana	Consultant				
	Proposed investment [€]	Proposed investment with adaptations / additions [€]	Assessment	Recommended for KfW V [€]	Recommended for other financing [€]	Not recommended projects [€]
Rehabilitation of Network of "Pesak"	426,320	426,320	recommended	426,320		
Rehabilitation of network in other parts of Senta	1,698,680	1,694,310	recommended	1,694,310		
Replacement of 35 Substations in settlement "Pesak"	150,000	200,000	recommended	200,000		
Replacement of 70 Substations in other parts of Senta	300,000	400,000	recommended	400,000		
Installation of SCADA system	120,000	240,000	recommended	240,000		
Total costs	**2,695,000**	**2,960,630**		**2,960,630**		

8 Final Project settlement upon CPIU Decision

Pursuant to:

- Article 2. Item 2.1, Sub-item 2.1.1 of the Separate Agreement to the Loan Agreement dated 18th December 2019 and to the Grant Agreement dated 23rd April 2020, between KfW and the Republic of Serbia dated 23rd April 2020, upon which the Ministry of Mining and Energy is in charge of the overall Project coordination, monitoring and administration, in particular the Project financial management and monitoring through the Central Project Implementation Unit (hereinafter: CPIU);
- the Investment Plan Draft accepted by the Toplana upon Consent dated January 14, 2021;
- the Decree of the Minister of Mining and Energy ref. N0 401-00-00572/1/2019-06 dated 4th December, 2020 by which the CPIU has been formed;
- CPIU Decision N0 8 dated 30th March, 2021,

the right to use the Loan Funds at the amount of up to **EUR 2,960,630** is transferred to the Toplana.

In accordance with Article 2, Item 2.1, Paragraph 2 of the Trilateral Contract on the Usage of Loan Funds Dedicated for the Project (hereinafter: Contract), from the date of its signing stipulated below, this Investment Plan shall be considered as integral part of the Contract and the amount of EUR 2,960,630 shall be considered as the Loan (L_{IP}).

У складу са:

- Чланом 2., тачка 2.1, подтачка 2.1.1 Посебног споразума уз Споразум о зајму од 18. децембра 2019. године и уз Споразум о донацији од 23. априла 2020. године, између KfW и Републике Србије од 23. априла 2020. године, којим је Министарство рударства и енергетике задужено за за свеукупну координацију, праћење и администрацију Пројекта, а посебно за управљање и праћење финансијских аспеката Пројекта кроз Централну јединицу за имплементацију Пројекта (у даљем тексту: ЦЈИП);
- Нацртом инвестиционог плана усвојеним од стране Топлане на основу Сагласности од 14. јануара 2021. године,
- Решењем Министра рударства и енергетике број 401-00-00572/1/2019-06 од 04. децембра 2020. године којим је формирана ЦЈИП;
- ЦЈИП Одлуком број 8 од 30. марта 2021. године

Топлани се одобрава право коришћења Зајма у износу до 2.960.630 евра.

У складу са чланом 2., тачка 2.1., став 2 Трилатералног уговора о коришћењу средстава Зајма намењених Пројекту (у даљем тексту: Уговор), од доле наведеног датума његовог потписивања, овај Инвестициони план се сматра саставним делом Уговора а износ од 2.960.630 евра сматра се Зајмом (L_{IP}).

Date / Датум: _____.2021.

У име Топлане сагласан директор/On behalf of the Toplana, agreed by the Director

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