REHABILITATION AND MODERNIZATION OF THE DISTRICT HEATING (DH) SYSTEM IN THE CITY OF BANJA LUKA - FOCUS ON ENERGY EFFICIENCY

Rapid Assessment & Response Plan

May 2016

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LIST OF FREQUENTLY USED ABBREVIATIONS

BiH	Bosnia and Herzegovina
CPA	Consumer Protection Association
CTCN	Climate Technology Centre and Network
DH	District heating
EE	Energy Efficiency
EEAP	Energy Efficiency Action Plan
EnC	Energy Community
ESCO	Energy Service Company
EU	European Union
FBiH	Federation of Bosnia and Herzegovina
FDI	Foreign direct investments
GDP	Gross domestic product
GHG	Greenhouse gas
HFO	Heavy fuel oil
kg	Kilogram
km	Kilometre
LC	Local Community
LEAP	Local Environmental Action Plan
LSG	Local Self-Governance
m	Meter
MALSG	Ministry of Administration and Local Self- Governance of RS
MH EPRS	Mixed Holding "Elektroprivreda Republike Srpske" a.d. Trebinje – holding company
MIEM	Ministry of Industry, Energy and Mining of RS
MoFTER	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
MOFWM	Ministry of Agriculture, Forestry and Water Management of RS
MSPCEE	Ministry of Spatial Planning, Civil Engineering and Ecology of RS
MW	Megawatt
MWh	Megawatt-hour
NDE	National Designed Entity
PPP	Public-Private Partnerships
RES	Renewable energy sources
RERS	Regulatory Commission for Energy of RS
RS	Republika Srpska
SEAP	Sustainable Energy Action Plan
SERC	State Electricity Regulatory Commission
UNFCC	United Nations Framework Convention on Climate Change
ηt	Boiler efficiency

1 EXECUTIVE SUMMARY

The City of Banja Luka is the political and administrative centre of Republika Srpska (RS), and is located in the north-western part of Bosnia and Herzegovina (BiH). The City covers an area of 1,239 $km^2$and has a population of 199,191 inhabitants.

The district heating (DH) system in Banja Luka was established in 1970. The existing Joint Stock Company "Toplana" Banja Luka (the Company) was founded in 2003, and is the main heat supply company in RS which supplies the area of the City. The majority owner is the City of Banja Luka with 77% of shares, whereas the remaining 19% is owned by the Company and 4% by other shareholders. The DH system covers only a part of the City – there is a large number of residential buildings as well as commercial and public buildings not connected to the current DH network, in the current service area for district heating as well as outside of the area. The Company serves around 30% of households, commercial and administrative buildings in the City, whereas the rest of buildings are heated individually with coal, firewood and electricity.

An assessment of the Company operations has confirmed that nearly every aspect of DH operations is unfavourable which results in serious financial shortcomings for the Company. As a result of inadequate level of service, the Company has lost 13% of the customers since 2011. In addition, the DH system which uses HFO as fuel is a major polluter in the City.

Based on the identified need for investments for the reconstruction of the City's network, as well as the need for fuel substitution, the City of Banja Luka has requested the technical assistance of the Climate Technology Centre and Network in order to evaluate options for rehabilitating and modernizing its DH system.

Biomass fuelled district heating is considered to be the least cost heating solution for the City, but has to be substantially improved in order to be competitive against alternative heating solutions. The current costs for district heating could be substantially lowered by switching from HFO to biomass, but also by giving the customers the possibility to regulate their heat consumption and save energy.

The Priority Investment Program (PIP) has been developed taking into account the current capabilities of the Company and the possibilities for financing PIP measures. The PIP addresses the identified issues by proposing fuel switch from HFO to biomass as environmentally friendly, renewable, locally available and cheaper fuel; modernization and rehabilitation of the existing HFO boilers to cut costs of fuel and electricity; rehabilitation and priority replacements in the distribution network to cut heat and water losses; and switching to consumption based metering and billing for improved quality of services and customer confidence.

The proposed measures are aimed at improving the service level and decreasing DH costs in order to improve the competitiveness of district heating in relation to alternative heating sources. The measures have been designed taking into account technical, financial and environmental considerations, in order to secure environmentally, technically and financially sustainable DH operations in the City and to improve the quality of the service in order to ensure the return of the disconnected customers.

In terms of environmental impacts, the implementation of the proposed measures under PIP will inevitably lead to short-term impacts that are related to construction works and generally associated with infrastructure projects of any type. The significance of negative impacts during the replacement and reconstruction works has been assessed as minor. On the other side, the implementation of the mentioned measures will result in long-term positive impacts on air quality, more efficient consumption of natural resources (fuel and water consumption) and overall increase in energy efficiency of existing district heating system. In terms of significance, positive impacts have been assessed as major environmental benefits.

The recommended improvements to the DH system in the City of Banja Luka are in line with the strategic objectives of BiH, RS and the City of Banja Luka in this sector. There is no specific legislation regulating the DH sector; DH operations are governed by various pieces of legislation on energy efficiency improvement, use of renewable energy sources, spatial planning and environmental protection. Even though the existing legislation relevant to DH operations is still being developed, it is considered to provide an adequate framework for the suggested improvements to the DH system.

The financial analysis of the effects of the proposed PIP measures shows that the increase in the share of biomass in total fuel consumption would change the situation of the Company from a loss-making into a profitable enterprise. This achievement rests on a number of critical assumptions:

- The price of biomass and HFO remains at current levels;
- 80% of disconnected customers are reconnected to the DH network within 4 years;
- Consumption-based billing is introduced fully;
- The financing loan is approved for a ten year period, with a grace period of 1 year.

2 BRIEF INTRODUCTION

The City of Banja Luka has requested the technical assistance of the Climate Technology Centre and Network (CTCN) in order to evaluate options for rehabilitating and modernizing the district heating (DH) system. Banja Luka is the second largest DH system in Bosnia and Herzegovina (BiH). It experiences significant energy losses (in large part due to hot water leakages and heat losses) during transmission and end-use, thereby incurring major, avoidable costs to the City and the publicly owned Company, while also producing unnecessarily high amounts of greenhouse gas emissions.

The Company has identified the need for investments for the reconstruction of the City's network. The Company has also identified the need for fuel substitution and is considering conversion of the biomass or alternative cheaper energy sources (away from heavy fuel oil) for various parts of its operations.

The CTCN technical assistance and parallel work of the District Energy in Cities Initiative is intended to deliver an actionable evaluation of options with associated investment and policy development plan that will ensure the investment is a) attracted from private sector or other actors where required, b) does not deliver a technical solution without the policy framework that will ensure long-term sustainability of the DH system's business plan (e.g. building efficiency policies and tariff regulation).

Implementation of the Project is expected to increase the energy efficiency of DH operations in the City of Banja Luka, leading to reduction in the use and procurement of crude oil, helping the City of Banja Luka to reduce heat and financial losses, while encouraging the local economy and creating possibilities for local job development. Furthermore, the Project is expected to contribute to the improved operational efficiency of the Company, through the process of knowledge transfer and capacity building of the City and the Company representatives.

The evaluation of options will be focusing on (i) a report on the present status of the DH system in the City including the analysis of the DH Company, socio economic analysis of the City and the DH network, (ii) a draft short-term strategy for efficient sustainable DH operation that will include potentials for smart technologies and fuel switching, and that will define short term investment priorities, (iii) a financial analysis of the priority investments projects proposed in the short term-strategy, (iv) a rapid environmental assessment of proposed priority investment projects, and (v) a policy/regulatory gap analysis.

3 ASSESSMENT OF THE PRESENT STATUS OF THE DH SYSTEM

3.1 District Heating in Bosnia and Herzegovina

In Bosnia and Herzegovina, larger centralized DH systems emerged in the 1960s and 1970s of the last century. DH systems used to be in most cities with a population of 20,000 and above. Before the war, the number of DH companies was more than 30, but lacking maintenance and repairs resulted in big damages and eventually heat supply had to be stopped. DH in BiH served 120,000 flats, equivalent to 450,000 inhabitants or 10% of the population. In the urban areas, DH is still a significant heating option with about 39% of the households connected to the systems[1].

The Sarajevo DH system is the largest in BiH. Centralized DH system in Sarajevo started in 1968 under the umbrella of the local housing company by operating boiler facilities previously managed by tenants' council.

The DH system of the City of Banja Luka is the largest one in Republika Srpska. The centralized DH system was constructed in 1972.

Significant investments have been channelled into DH system rehabilitation over the last decade, following the war. These investments have in particular focused on eliminating the damages encountered during the war and reducing major heat and water losses, improving pipe insulation, upgrading valves, replacing heat exchangers, replacement of boilers and burners, and substation modernization.

Although this has improved system efficiency most DH systems face substantial continued investments in network improvement over the next decade. One of the reasons for this has been that many DH systems were out of operation for several years during and after the war, leading to serious corrosion of the network.

Most heat production units are using fuel oil for heat only boilers or coal for CHP plants. Natural gas is only available in a few places, primarily in Sarajevo.

Domestic hot water is predominantly produced in individual gas-fired or electric heaters. There are only few cases (mainly in Sarajevo) where the hot water is produced and distributed by the DH Company. This is an important potential for future expansion of DH to all-year operation (the system presently only operates during October-April) and would create a better basis for future production of combined heat and power and production based on biomass fuels and/or waste incineration.

There are only few cases of limited private sector participation in the DH sector (e.g. Livno, Gračanica, Gradiška) where biomass is used for heat production.

3.2 District Heating in Banja Luka

The Company[2] is the sole provider of district heating services in Banja Luka. According to the available data[3], it serves around 30% of households, commercial and administrative buildings in the city. The rest of buildings are heated individually. In private households, wood is usually used as the energy source for heating. The Company provides the thermal energy only for space heating, while the DHW is individually prepared in each household, usually by electric boilers.

The Company provides the thermal energy for space heating in Banja Luka only during the heating season, which usually starts on October 15th and lasts until April 15th. Thermal energy supply lasts in the average of 188 days. Heat is supplied from 6 h to 22 h on the daily basis during the season. During that time, it is intended to maintain the inner temperature of +21°C (+/- 1°C). However, maintaining continuous temperature under the current operating state of the district heating system is impossible due to very high losses and poor control possibilities. During the night, DH system operates under reduced regime. Analysis has shown that this type of operation is economically more efficient compared to complete shut off and start over in the morning, avoiding high peaks in fuel consumption.

[1] Statistical Office, Living Standard Measurement Survey in BiH
[2] A.D. – Joint stock company
[3] Održivi energetski akcioni plan Grada Banja Luke, 2010

3.2.1.1 Service Area for District Heating

The City of Banja Luka has an area of 24.25 km^2. Out of this area, DH system covers 10.7 km^2 or about 44%. District heating installations in City of Banja Luka consist of a heat source made up of three heating plants. Central plant for thermal energy production includes four heavy fuel oil boilers, each with a capacity of 58 MW. The central heating plant is located on the bank of the river Vrbas in the central part of the city. On the east and north of the plant is an industrial zone, while the residential area, the major consumer of heat from the plant, is located on southwest, west and northwest. In addition to the central heating plant, there are two new biomass boilers. One of the boilers has the capacity of 10 MW (hereinafter referred to as the heating plant Starčevica), while the other has the capacity of 6 MW (hereinafter referred to as the heating plant Kosmos). The heating plant Starčevica is located south of the central plant supplying heat to residential buildings in its vicinity, which are located east of the plant itself. The heating plant Kosmos is located within Kosmos Aviation Institute in Kočićev Vijenac neighbourhood.

The service area of the Company is shown in the following Figure.

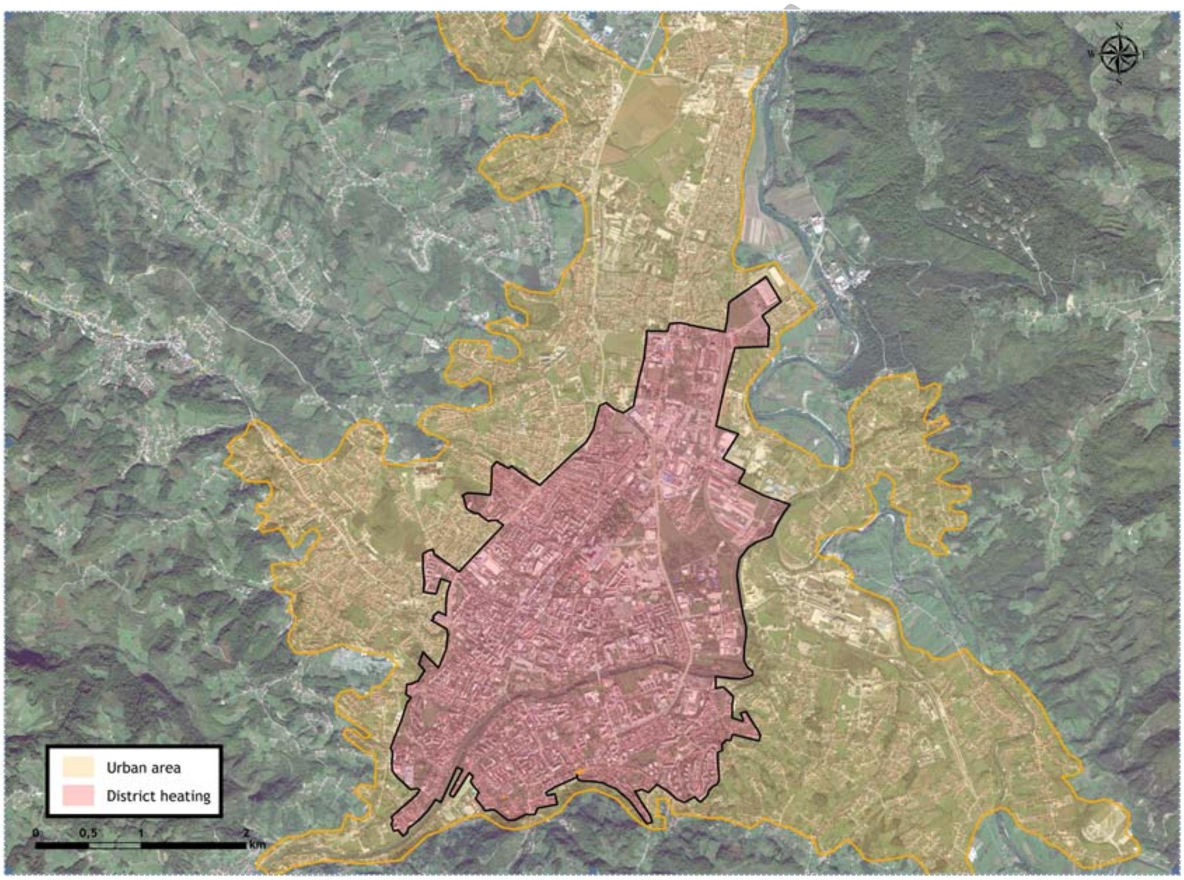


Figure 1: *District Heating Supply Area*

3.3 Location and Natural Environment

3.3.1.1 Geographical Location

Banja Luka is located in the north-western part of Bosnia and Herzegovina, in the centre of the western part of Republika Srpska. Banja Luka is surrounded by the mountains Manjača (1,338 m), Tisovac (1,172 m), Osmače (948 m) and Crni Vrh (548 m) from south and southeast, from the northwest by the mountain Kozara (421 m) and to the north by the Pannonia basin. The territory of the city covers an area of 1,239 km² and borders with the Municipalities of Gradiška, Laktaši, Čelinac, Mrkonjić Grad, Ribnik, Oštra Luka and Prijedor. The maximum distance between the northern and southern points of the territory of the city is 55 km, and 40 km between the western and eastern point.

The rural area of the city represents about 85% of the territory of the city Banja Luka. It consists of 40 settlements and two partial settlements: Agino Selo, Barlovci, Bistrica, Bočac, Borkovići, Bronzani Majdan, Cerići, Čokori, Dobrnja, Dragočaj, Dujakovci, Goleši, Kmećani, Kola, Kola Donja- dio, Krmine, Krupa na Vrbasu, Lokvari, Lusići, Ljubačevo, Melina, Motike, Obrovac, Pavići, Pervan Donji, Pervan Gornji, Piskavica, Prijakovci, Potkozarje (Ivanjska), Prnjavor Mali, Radmanići, Radosavska, Rekavice- dio, Slavićka, Stratinska, Stričići, Subotica, Šimići, Šljivno, Verići, Vilusi and Zelenci. The major part of the city is located in the Vrbas River basin, and a smaller part belongs to the Sana River basin.

The Company is located in the southern part of the urban area of the city, on the left bank of the river Vrbas, in the Local Community Borik 1. The Police Academy of Banja Luka is located in the proximity of 10 m of the location of the Company on the west side, and the University Campus of Banja Luka on the north side. Less than 5 residential buildings are located at about 20 m from the west and south side of the Company.

Figure 2: *Location of the Company*

(Source: Google Maps, 09/03/2016)

3.3.1.2 Climate

Banja Luka's climate is classified as warm and temperate. Banja Luka is a city with significant rainfall. Even in the driest month (August), there is 57.6 mm of rainfall. According to Köppen and Geiger, this climate is classified as Marine-Mild Winter (Cfb). The average annual temperature is 10.8°C and 17.2°C in the vegetation period from March to November. The monthly temperatures for most of the period are above 0°C, which shows that the area does not have long periods with very low temperatures. The highest average monthly air temperature is in July (20.7 ° C) and August (20.5° C), and the lowest in February (-1.4° C) and January (0.4° C).[4]

In 2015, the average annual temperature was 12.7°C, which shows that the temperature was higher compared to the general average annual temperature. The highest average monthly air temperature was in July (25.2° C) and August (24° C), and the lowest in February (2.4° C) and December (3.2° C), according to the Hydrometeorological Institute of Republika Srpska.

The vegetation period starts on March 15th and lasts until November 23rd, which is the period of daily temperatures above 5°C. The period with average daily temperature above 20°C is an average of 46 days. There are also days with tropical temperatures, i.e. periods when the temperatures are higher than 30°C.

The average annual amount of precipitation is 1,017 mm/m^2.The amount of precipitation increases in spring and autumn and decreases over the summer and winter periods.[5]

[4] Institute for Urban Development of RS, A.D. Banja Luka, Rural Development Strategy of the City of Banja Luka 2010 – 2015, Banja Luka, 2010

[5] *Ibid*.

Spatial distribution of annual precipitation indicates that the northern part of Banja Luka, in the lower course of Vrbas, has less precipitation (an average of 850 mm to 1,000 mm/p.a.) than the southern part, in the upper course of Vrbas River, with an average between 1,000 mm and 1,500 mm.[6]

The dominant winds are north – north-east and northwest-west winds. About 40% of the days per year are without wind, which is indicated by a high frequency of silence. The highest average wind speed amounts to about 2.9m/s in Banja Luka.

The average annual relative humidity is 78%, which means that the air above Banja Luka is moderately moist. The greatest value of relative humidity is in November and January. The foggiest days are in December, January and October, and the least foggy days are in April and June.

3.3.1.3 Land Use, Cultural Heritage and Nature Protection

The land where the DH facility is located belongs to the valley land types. The most important type of land in this group is fluvisol. This type of land is being converted to construction land, without adequate treatment of the surface humus layer.[7] The land on which the DH facility is located is categorized as urbanized land, according to the *Map for Urbanized Land and Constructed Units* from the Spatial Plan of the City of Banja Luka.[8]

Due to its long history, Banja Luka is rich in culture. There are several museums including the Museum of Bosanska Krajina, the Ethnographic Museum and the Museum of Modern Art of RS. One of the most famous cultural sites in Banja Luka is the cultural centre of "Banski Dvor" (Halls of the Ban) located about 2 km northwest from the DH facility. The mediaeval castle Kastel Fortress is located in the city centre, and is one of Banja Luka's main attractions. The fortress is located about 2 km west from the DH facility. All cultural attractions and objects (including sacral objects) are located about 2-3 km from the facility in the west, southwest and northwest direction.

There are no protected areas for conservation of nature or ecology in the city centre of Banja Luka, or in the proximity of the area where the facility is located. The closest protected areas are located in the rural areas of the city or out of the city, according to the *Local Environmental Action Plan for Banja Luka*.

3.3.1.4 Geomorphology and Geology

The area of Banja Luka belongs to the Pannonia rim and Inner Dinarides. General characteristics of the area are gradual rising of the relief from the Sava basin from the north to the south. The geomorphologic and geologic characteristics were analysed based on the *Geological Map* from the *Spatial Plan of the City of Banja Luka*[9] and based on the *General Geological Map of SFRY 1964-1969*.

The city is located at altitudes that range from 140 m a.s.l - coast of Vrbas - Zalužani to 1339 m a.s.l - Goli vis – Čemernica, while the central part of the city lies at an altitude of 163 m a.s.l. Banja Luka was developed on the southern edge of the Banja Luka valley, which extended into the southwest-northeast direction. The valley is surrounded by hills from the tertiary age. The valley is surrounded on the south side by the hill Starčevica (433 m), Ponir (589 m), Banj - brdo (403 m), Krčmarice (302m) and Šibovi on the southwest (333 m). Mountainous hills dominate the north, such as Motajica, Prosara, Kozara and between them is the Lijevće Field (90-100 m a.s.l). On the south-western and southern side of the territory of Banja Luka valley are the Manjača, Osmača, Tisovac and Čemernica mountains. Other geomorphologic forms in Banja Luka are: caves, abysses, etc. The Company is located on the left river terrace of Vrbas, and no other relevant geomorphologic forms are identified in the closer area.

The DH facility is geologically located on a lower terrace (t_1) formed during the Holocene geologic period. Other geologic forms in the near area are marlstones, clays and sandstones with melanopsis, and also flysch, breccias lime stones, marlstones and calci – rudites.

[6] *Ibid*.
[7] City of Banja Luka, Local Environmental Action Plan, Banja Luka, 2009
[8] Spatial Plan of the City of Banja Luka
[9] *Ibid.*

3.3.1.5 Ground Conditions

The ground conditions of the DH facility and the surrounding area consist of loose sedimentary soils that are mainly developed on lowland and flood plain deposits dominated by clay, sand stones and gravel.

3.3.1.6 Surface and Groundwater Quality

The territory of the city of Banja Luka is characterized by a hydrographical network of siliceous flysch terrain and karst hydrology. The hydrographical network consists of large and small rivers, and periodic and permanent streams that build two river basins: Vrbas and Sana.

Most of the area of the city belongs to the Vrbas River basin, which includes the eastern part with an area of 891 km², and a smaller part of Sana River basin, which includes the western part with an area of 342 km². The Vrbas River basin is the most important water resource in the western part of Republika Srpska, as three quarters of the city are located in its catchment area, and the longest tributaries of the region are Vrbanja and Suturlija. Vrbanja flows into the Vrbas River several hundred meters downstream from the location of the DH Company, from the south-east side.

The Vrbas River is characterized by three main areas:

- The upper course from the source to the city Jajce, with abrupt falls and relatively small flow, with the characteristics of a mountainous river stream and water quality of category I and II.
- Midstream from Jajce to Banja Luka, a deep limestone canyon with accentuated fall of the riverbed. Water quality is in the categories I and II.
- The lower course from Banja Luka to the estuary of the river flows through the alluvial flat land. It has the characteristics of lowland rivers, a small riverbed fall and a meandering course. Water quality of this part of the river belongs to the category II and III.

The Company is located in the area of the midstream of the river Vrbas, which means that the water quality of the nearest watercourse is in the categories I and II.

The area of Banja Luka is characterized by a large number of groundwater courses, which are pronounced during significant amounts of precipitation. However, no underground waters were identified at the location of the Company, but infiltration through alluvium deposits may cause contamination and change the water quality category.[10]

Based on the *Regulation on the Conditions for Discharging Wastewater into the Public Sewerage System*[11], the Company also undertakes measurements of water quality. The report on the results of measurements of physical and chemical features is shown in Table 1.

Table 1: *Report on the Results of Measurements of Physical and Chemical Features*[12]

Parameters	Established values	Reference value	Unit of measurement
pH	8.10	6.50-9.50	pH unit
$KMnO_4$	10.5	/	$mg\ L^{-1}$
Sediment after 0,5h sedimentation	0.3	≤5	$mg\ L^{-1}$
Total suspended solids	110	≤500	$g\ m^{-3}$
Electrical conductivity	404	/	μScm^{-1}
Ammonia	0.04	/	$g\ m^{-3}$
Nitrites	0.03	/	$g\ m^{-3}$
Nitrates	2.97	/	$g\ m^{-3}$
Manganese	<50	≤500	$mg\ m^{-3}$
Detergents	<50	≤10,000	$mg\ m^{-3}$
Lead, Pb	<10	≤500	$mg\ m^{-3}$
Cadmium, Cd	<10	≤50	$mg\ m^{-3}$
Arson, As	5	≤100	$mg\ m^{-3}$
Overall chrome, Cr	<10	≤1,000	$mg\ m^{-3}$

[10] City of Banja Luka, Local Environmental Action Plan, Banja Luka, 2009
[11] Official Gazette of RS, No. 44/01
[12] Measurements performed by the Institute of Public Health, Service for Sanitary Chemistry - laboratory for testing waste water

Parameters	Established values	Reference value	Unit of measurement
Sulphates	71.7	≤200	g m^{-3}

The established values of the parameters are within the referenced values, in accordance with the *Regulation on the Conditions for Discharging Wastewater into the Public Sewerage System*.

3.3.1.7 Air Quality

There is no continuous city-wide ambient air quality monitoring and measurement. Exceptions are measurements conducted for specific needs at certain locations. The most significant single source of air pollution in Banja Luka are the existing boiler houses at the facility, which is the reason why the Company undertakes regular measurements of pollutants, as shown in the tabular presentation of measured and calculated values of the process parameters and the concentration of pollutants and limit values of emissions for the measured emissions of air pollutants in accordance with the *Regulation on Measurements for Prevention and Reduction of Air Pollution and Air Quality Improvement*[13]. The measurements were undertaken in two boiler houses (boiler house 1 and boiler house 4).

The measurements in boiler house 1, were performed on 14 December 2015 between 12:22 and 12:28 hrs. During the measurement, fuel oil was used and the thermal power of the combustion chamber was 58 MW. The measured values are shown in Table 2.

Table 2: *Measured, Calculated and Threshold Values of the Concentration of Flue Gases for Boiler House 1*[14]

Pollutants					**Emission thresholds for liquid fuels for large plants**	
Compound	Chemical formula	Measurement unit	Measured concentration	Recalculated concentrations on 3% O_2	Official Gazette of RS, No. 3/15 and 51/15	
					Power of plant MW	ELV, mg/m^3
Oxygen	O_2	%	10.29	3		
Carbon dioxide	CO_2	%	8.10	-		
Carbon monoxide	CO	mg/m^3	5	8	≥50	
Sulphur dioxide	SO_2	mg/m^3	1,624	2,729	≥50	1,700
Nitrogen oxides	NO_x	mg/m^3	389	654	50-500	450

The measurements in boiler house 4, were performed on 14 December 2015 between 13:07 and 13:13 hrs. During the measurement, fuel oil was used and the thermal load of the combustion chamber was 58 MW. The measured values are shown in Table 3.

Table 3: *Measured, Calculated and Threshold Values of the Concentration of Flue Gases for Boiler House 4*[15]

Pollutants					**Threshold values for liquid fuels for large plants**	
Compound	Chemical formula	Measurement unit	Measured concentration	Recalculated concentrations on 3% O_2	Official Gazette of RS, No. 3/15 and 51/15	
					Power of plant MW	ELV, mg/m^3
Oxygen	O_2	%	11.37	3		
Carbon dioxide	CO_2	%	7.34	-		
Carbon monoxide	CO	mg/m^3	3	6	≥50	
Sulphur dioxide	SO_2	mg/m^3	1,470	2,746	≥50	1,700
Nitrogen oxides	NO_x	mg/m^3	385	720	50-500	450

The main pollutants emitted include nitrogen oxides (NO_x), solid particles (particulate matter (PM)) and sulphur oxides (SO_x).

[13] Official Gazette of RS, No. 3/15 and 51/15
[14] Report on Measurement of Emissions of Air Pollutants, measured by the Institute of Protection, Ecology and Informatics of RS
[15] *Ibid*.

In addition to air emissions from the Company, traffic and in particular burning of wood in private households contribute to poor ambient air quality in Banja Luka, particularly during the heating season. There are, however, no calculations or measurements available for emissions from transportation and private households.

Table 60 and Table 61 provide a detailed calculation of the current emissions of pollutants due to the operation of the Company. The proposed project, once implemented, is not expected to have any or have marginal negative impacts on air quality in Banja Luka. However, fully implemented, it should have a positive impact due to reduction of particularly SO_2 emissions. In addition, the greenhouse gas contribution will be reduced.

Pursuant to the *Law on Air Protection*[16], the Company undertakes regular measurements of ambient air quality, which is summarized in a report. The report lists the following average daily values of pollutants, measured between 17 and 18 December 2015.

Table 4: *Daily Average Concentration of Pollutants in location of Central Boiler House*[17]

Pollutant	Date	Minimum average daily concentration (μg/m^3)	Maximum average daily concentration (μg/m^3)	Daily average concentration (μg/m^3)	Threshold value(μg/m^3)	Tolerated value (μg/m^3)
SO_2	17-18 February 2016	15.19	96.91	32.68	125	125
NO_2	17-18 February 2016	12.15	38.48	22.26	85	119,28
CO	17-18 February 2016	493.72	1,253.76	851.89	5,000 (5 mg/m^3)	9,280 (9,28 mg/m^3)
O_3	17-18 February 2016	57.47	100.41	76.98	120	-
PM 10	17-18 February 2016	25.90	86.40	60.10	50	71.40

As shown in Table 4, the measured values do not exceed the threshold (limit) values.

Following is table with results of continues measurement of concentration of Pollutants in Borik settlement which is approximately 1,2 km away from central Boiler House. The table lists concentration of pollutants in December 2015.

Table 5: *Results of continues measuring of air pollution in location of Borik settlement in December 2015*[18]

Analysed pollutants	CO (mg/m^3)	SO_2 (μg/m^3)	O_3 (μg/m^3)	NO (μg/m^3)	NO_2 (μg/m^3)	NO_X (μg/m^3)	Char (μg/m^3)	P 2,5 (μg/m^3)	P 10 (μg/m^3)
Nr. of measurements	31	31	31	31	31	31	31	31	31
Average monthly concentration	2.727	31.987	41.585	23.042	42.983	66.026	23.963	28.490	47.484
Minimal average daily concentration	1.526	21.852	31.200	15.836	31.752	48.543	14.810	17.609	29.349
Maximum average daily concentration	4.092	42.127	55.261	32.589	57.080	88.020	34.580	41.248	68.747
Quality category	I	I	-	-	I	-	-	-	II

Taking in consideration proximity of Central Boiler House and Borik it is expected that air quality in Borik is significantly affected by emissions of pollutants from Central Boiler House.

[16] Official Gazette of RS, No. 53/02

[17] Report on Measurement of Emissions of Air Pollutants, measured by the Institute of Protection, Ecology and Informatics of RS

[18] http://www2.banjaluka.rs.ba/static/uploads/clanci/2016/02/aerozagedjenja.pdf accessed on 31/03/2016

3.3.1.8 Noise

The main noise sources in Banja Luka are road traffic, construction machinery used for public works, industry, machinery and vehicles for urban areas management, and sport activities, concerts, amusement parks, alarm systems, etc.[19]

Based on the *Regulation on Permissible Levels of Noise*[20], the Company undertakes regular measurements of noise. The testing of noise levels in the environment is carried out in locations within the immediate vicinity of the DH facility. The measured noise levels and the values are given in the table below, whereas the measurement points are shown on the map.

Table 6: *Measured Noise Levels and Allowed Values*[21]

Measurement parameters	Measurement point 1	Measurement point 2	Measurement point 3	Measurement point 4	Measurement point 5	Allowed values in accordance with the Law
Noise dB (A)	58.2	59.5	54.1	60.2	61.3	70 dB (A)

As shown in Figure 1: **District Heating Supply Area** and Figure 3: **Location of Noise Measurement Points**, the measured noise levels are below the threshold values.

Figure 3: *Location of Noise Measurement Points*[22]

3.4 Socio-economic Analysis

In order to determine the consumer affordability of the heating costs, it is necessary to review the main socio-economic parameters of the population and household consumption in the Banja Luka region. The affordability analysis will measure the extent to which households can afford to pay their heating bills after the implementation of all rehabilitation and modernization measures on the district heating (DH) system in the City of Banja Luka.

The socio-economic analysis is based on the official data provided by the Institute of Statistics of Republika Srpska, as well as the preliminary results of the Census of Population, Households and Dwellings in BiH 2013, issued by the Agency for Statistics of BiH, together with other data collected through desk - research/study.

[19] City of Banja Luka, Energy Strategy of Republika Srpska until 2030, Banja Luka, 2012
[20] Official Gazette of SRBiH, No. 46/89
[21] Records of Testing Noise Levels in the Environment Surrounding the Company, measured by the Institute of Protection, Ecology and Informatics of Banja Luka
[22] *Ibid*.

3.4.1.1 Population Analysis

According to the 1991 Census, the City of Banja Luka had 195,692 inhabitants. Based on the preliminary results of the Census of Population, Households and Dwellings in BiH 2013, the City has 199,191 inhabitants, 65,225 homes and 87,986 apartments. The City has 53 settlements, with a total area of 1,239 km^2. Given the area, as well as the number of inhabitants according to the preliminary results, the population density is 160.76 inhabitants per km^2.

The largest share of population, households and dwellings is concentrated in the urban area of Banja Luka, which is a part of the City of Banja Luka. Urban areas of Banja Luka are partly covered by the DH system. The share of population, households and dwellings in urban areas compared to the wider area of the City is presented in the figure below.

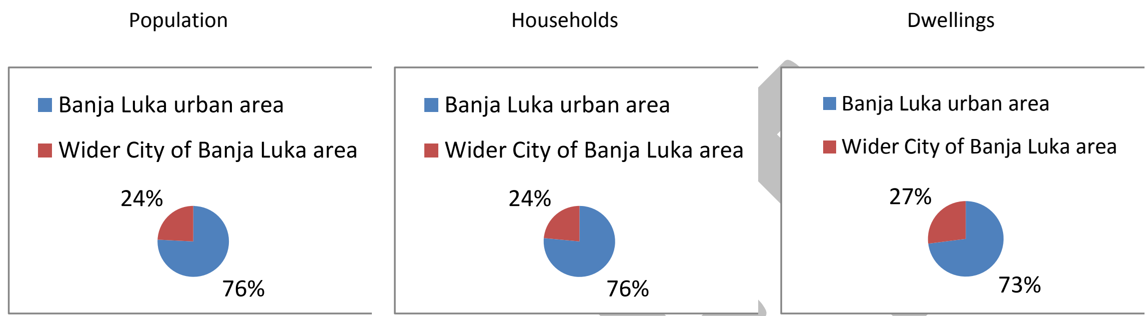


Figure 4: *Share of Population, Households and Dwellings in the Urban Areas of the City of Banja Luka in Relation to the Wider Area of the City*

The total population in the City increased in 2014 due to natural population growth (difference between birth rate and death rate) by 721 inhabitants in comparison with 2010.

According to available data provided by the Institute of Statistics of RS[23], Banja Luka has a greater number of immigrants than emigrants, and most of the migration movement was en route from other municipalities of RS to the City of Banja Luka. The total population of the City increased in 2014 due to migration (positive difference between immigrants and emigrants) by 4618 inhabitants in comparison with 2010.

Taking into account the population growth, migration balance, as well as the number of inhabitants in 2010 (deducted by natural increase and migration balance of total population in 2013), it is evident that the population of the City of Banja Luka increased in the period 2010 - 2014 at an average rate of 0.5%.

[23] Institute of Statistics of RS, Demographic Statistics, Bulletin 18, 2nd, corrected release, 2015

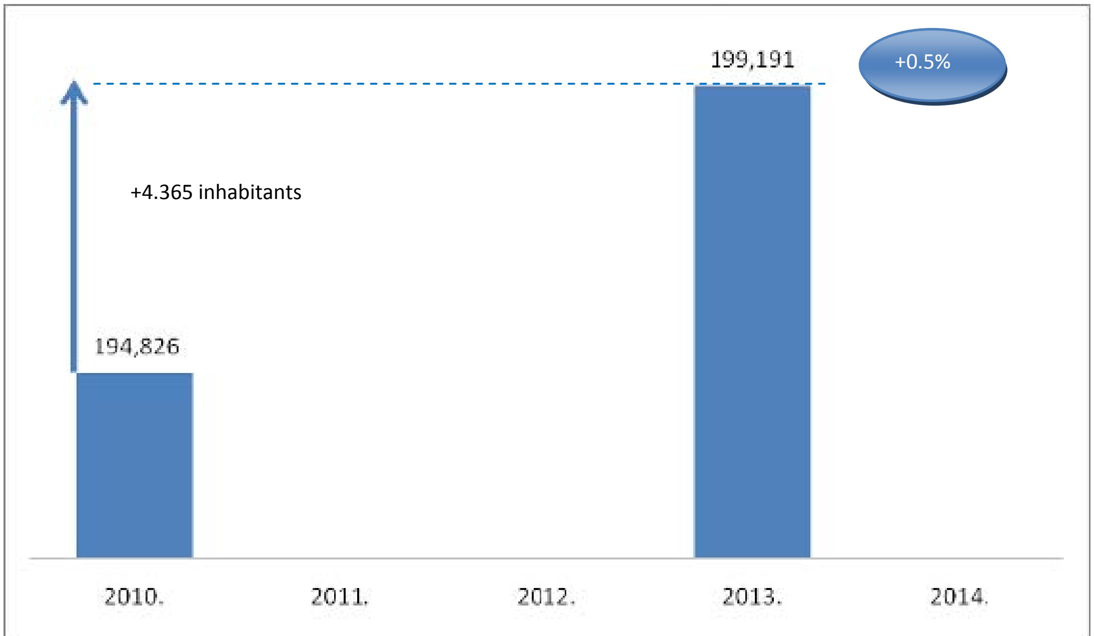


Figure 5: *Population Growth in the City of Banja Luka from 2010 to 2014*

According to the Development Strategy of the City of Banja Luka[24], the City should develop to accommodate a comfortable life for up to 300,000 people through:

- Balanced urban and rural development, as well as balanced development of the urban part of the City, and a housing shift from the city centre to the suburbs;
- Creating conditions for demographic renewal of the City in terms of a favourable age structure, which may only take place within the context of rapid economic development and revitalization of the entire area of the City, as an integral part of these processes;
- The settlement of rural areas with working age and reproductive age population;
- Enhanced relations of the City with the Diaspora;
- Continued development of human resources.

Given the average rate of population growth and other analysed demographical data, measures on rehabilitation and modernization of the DH system in the City of Banja Luka must be aligned with the stated rates and projected population growth.

3.4.1.2 Household Income and Expenditure Analysis

According to data published by the City of Banja Luka[25], the City had a total of 61,821 employed persons on 31/12/2014, whereas the number of unemployed persons was 17,598[26]. The average monthly net salary in the City in 2014 was 956 BAM, which is 15.8% higher than the average salary in RS.

Table 7: *Average Net Salaries in RS and the City of Banja Luka*

	2010	**2011**	**2012**	**2013**	**2014**
RS average	784	809	818	808	825
Banja Luka average	908	935	954	939	956

The size of the average household in the City is 3.05 household members.

[24] Development Strategy of the City of Banja Luka for 2007 – 2015, April 2008, pg. 54
[25] http://www2.banjaluka.rs.ba/static/uploads/clanci/2015/03/demografska_slika.pdf , accessed on 09/03/2016
[26] *Ibid*.

According to data from 2015, the consumer basket[27] for a family of four in RS amounted to 1.862,29 BAM[28]. The following table shows the percentage of monthly expenditures (including energy expenditures) and the rest (rural) areas in RS[29].

Table 8: *Average Expenses by Category of Expenses*

Category of expenses	Value (BAM)			Structure (%)		
	Total	**Urban areas**	**Other areas**	**Total**	**Urban**	**Other**
Total	1,381.46	1,510.48	1,299.38	100.0	100.0	100.0
Total – food and beverages	469.18	462.48	473.45	34.0	30.6	36.4
Total – non-food products	912.27	1048.00	825.93	66.0	69.4	63.6
Electrical energy, gas, water, other fuels	127.93	139.55	120.53	9.3	9.2	9.3

The above presented data show that that the average urban four-person household has an average monthly energy expenditure of 9.2%. According to estimates of the Institute of Statistics of RS[30], 19.5% of the population lives in relative poverty, and every sixth household is poor. The threshold of relative poverty is 416.40 BAM (212.9 EUR) of monthly income. According to the methodology of the World Bank (WB), 15% of households in BiH live below the absolute poverty line[31]. The threshold of absolute poverty is 235 BAM.

3.4.1.3 Consumer Affordability Analysis

Customer affordability is estimated in order to determine the financial capacity of households for payment of heating bills. As defined by the Organization for Economic Cooperation and Development (OECD), a household does not have the ability to pay bills for heating if the amount of the average bill payment would make a substantial impact on the ability of such household to buy essential foodstuffs and services (food, health, education). According to the general criteria used by international financial institutions for expenditure of households in Europe, households should not spend more than 10% of their average monthly income on heating bills[32].

The following table provides an overview of the elements of average monthly household income in the City of Banja Luka in 2014.

Table 9: *Average Monthly Household Income in the City of Banja Luka in 2014*

No.	Category	Amount
1.	Total amount of tenants	199,191
2.	Total amount of households	65,255
3.	Average number of household members	3.05
4.	Total number of employed persons	61,821
5.	Total number of pensioners	29,631
6.	Average net monthly wage (BAM)	956
7.	Average monthly pension (BAM)	342.68
8.	Average number of employed household members	0.94
9.	Average number of pensioners household members	0.45
10.	Average monthly income per household (BAM)	1,052.54

It should be noted that the above mentioned monthly household income does not include additional sources of revenue, including unofficial salaries of employees (service contracts, etc.), gifts, the grey market, etc. Considering that the calculation of the monthly income of households is based solely on official data, it may be expected that the real monthly incomes are higher than those presented in the table above.

[27] A sample of consumer goods and services used to track prices
[28] Federation of Labor Union RS
[29] Institute of Statistics of RS, Household Budget and Poverty Survey in RS in 2011, 3rd corrected release, 2013
[30] *Ibid*.
[31] Report on Progress of the Realization of Millennium Development Goals in BiH, UNDP, 2012
[32] Can poor consumers pay for energy and water? An affordability analysis for transition countries, Working paper No. 92, May 2005

In order to assess the consumer power in the City of Banja Luka, it is necessary to compare the average monthly household income with the monthly heating expenditures. Given that there are no data on household heat consumption, estimates were calculated on the basis of the average amount that consumers have been paying to the Company in 2015.

Table 10: *Estimated Consumption of Thermal Energy Delivered to Final Consumers Where the Payment Calculation is made per MWh and m²*

Overview of estimated thermal energy consumption delivered to consumers, calculation made per MWh		**Overview of estimated thermal energy consumption delivered to consumers, calculation made per m²**	
Number of consumers	4,277	Number of consumers	14,802
Delivered energy per MWh	15,454	Delivered energy per MWh	115,333
Total area per m²	235,721	Total area per m²	771,999
Average size of the apartment (m²)	55.11	Average size of the apartment (m²)	52.16
Consumption of thermal energy per m² (MWh)	0.065	Consumption of thermal energy per m² (MWh)	0.15
Annual consumption per m² in BAM (excluding VAT)	7.50	Annual consumption per m² in BAM (excluding VAT)	16.92
Price of MWh in BAM (excluding VAT)	114.38	Price of MWh in BAM (excluding VAT)	114.38
Average bill in BAM (with fixed charge and VAT)	58.86	Average bill in BAM (with fixed charge and VAT)	103.75

The monthly costs for thermal energy per household in Banja Luka, presented as a percentage of average net household income, amounted to 5.59% for households where the calculation is made per MWh, and 9.86% at the upper limit of affordability for households where the calculation is made per m², respectively.

The segment of the population with a net monthly income lower than 235 BAM faces difficulties in paying the heating bills; hence, this issue has to be taken into account in the context of the social security system in the country. On the other hand, since the calculated household income does not include unofficial sources of income, it may be reasonably expected that the degree of accessibility is higher than presented in the table above.

3.5 Policy/Regulatory Framework for District Heating Operations

3.5.1 International Commitments of Bosnia and Herzegovina

3.5.1.1 United Nations Framework Convention on Climate Change (UNFCC) and the Kyoto Protocol

BiH signed the *UNFCCC* in 2000 and the *Kyoto Protocol* to the UNFCCC in 2008. As a non-Annex I country, BiH has general obligations under the UNFCCC, and should fulfil those general obligations to be eligible for technical and economic assistance.

BiH has to date fulfilled the following UNFCCC requirements:

- adopted the *Climate Change Adaptation and Low Emission Development Strategy for BiH* (2013),
- adopted the *Initial and Second National Communication on Climate Change* (2009 and 2013 respectively),
- established the Designated National Authority for implementation of the Clean Development Mechanism in the Kyoto Protocol, and
- prepared the First Biennial Update Report (FBUR) of BiH under the UNFCCC (2014),
- submitted in October 2015 to the Conference of the Parties its Intended Nationally Determined Contributions (INDC) towards achieving the objective of the Convention as set out in its Article 2.

The *Initial and Second National Communication on Climate Change* concluded that the major source of CO_2 emissions in BiH is the energy sector. The *Second National Communication on Climate Change* states that:

- The energy sector is responsible for more than 70% of total CO_2 emissions in BiH, and therefore has the greatest potential for GHG emissions reduction and climate change mitigation by improving energy efficiency in energy generation, distribution and end use, and by introducing technologies based on renewable sources of energy,
- In the majority of BiH, DH companies, heating plants and accompanying equipment are predominantly 25 to 30 years old. In Banja Luka (the second biggest DH system in BiH), the average age of boilers is close to 35 years old, and they will soon reach the end of their expecting operating lifetime. This places the modernization of Banja Luka's DH system among some of the major national priorities.

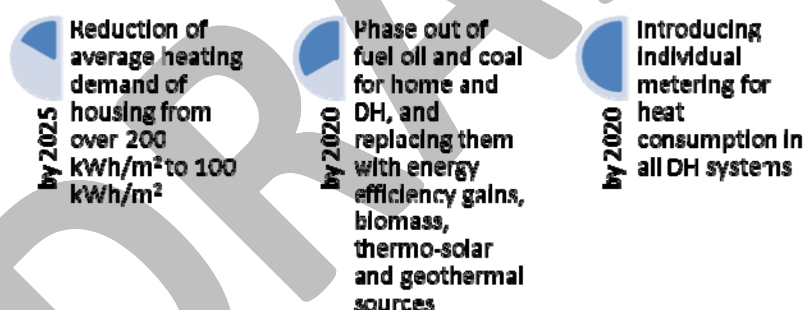
The *Second National Communication on Climate Change* also contains measures and priority actions for reducing CO_2 emissions from the DH sector in BiH for the period 2010-2025, which include:

- increasing the capacities of the existing DH system,
- improving the efficiency of the systems by optimizing their operations,
- expansion of heating networks.

Measures for improving the DH network infrastructure include pipeline repairs and replacement of old distribution networks in critical areas with insulated pipes, as well as reconstruction of steam pipes and heat and hot water pipelines.

According to the *Climate Change Adaptation and Low Emission Development Strategy for BiH*, 4 sectors were identified as priority sectors, among which are DH and energy efficiency in buildings. The Strategy states that maintenance and investment in the functioning DH has been low, leading to obsolete technologies, and low efficiency and large heat losses on the network. There is almost no regulation in this sector and only a few examples of individual heat metering in the country, while DH providers are struggling with many customers who are not paying their bills.

The Strategy also sets objectives for the DH sector for the period 2013-2025, among which are:



According to BiH's submitted INDC as mentioned above, in line with the trend of consumption and energy production growth, as a result of development of the country, total emissions also have an upward trend. According to the developed scenarios - their peak occurs in 2030; according to the baseline scenario (BAU) in 2030 expected emissions are 20% higher than the level of emissions in 1990. Emission reduction that BiH unconditionally might achieve, compared to the BAU scenario, is 2% by 2030 which would mean 18% higher emissions compared to the base year 1990. Significant emission reduction is only possible to achieve with international support, which would result in emission reduction of 3% compared to 1990, while compared to the BAU scenario it represents a possible reduction of 23%.

3.5.1.2 Energy Community (EnC)

BiH is a member of the EnC and a signatory of the EnC Treaty[33], thus required to adopt the core EU energy legislation.

[33] An international treaty signed in October 2005 by the EU on one hand, and countries from the South East Europe and Black Sea region on the other hand

The requirements set forth by *EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources* have been introduced into the EnC legislation through Decision 2012/04/MC-EnC of the EnC Ministerial Council, which stipulates the binding national targets to be achieved through the use of renewable energy in the electricity, heating and cooling, and transport sectors by 2020. BiH has a renewable energy target of 40 % by 2020 compared to 34 % of energy in 2009.

Furthermore, BiH was also required to submit its *National Renewable Energy Action Plan* (NREAP) to the EnC Secretariat by 30 June 2013[34]. However, BiH has not adopted its NREAP to date. FBiH and RS adopted their own Renewable Energy Action Plans (REAPs) in 2014. The Ministry of Foreign Trade and Economic Relations is currently preparing the NREAP which should include the REAPs of both entities and of Brčko District.

The relevant EU directives on energy efficiency introduced by the EnC include:

- *Directive 2006/32/EC on energy end-use efficiency and energy services* which strives for the adoption of an indicative energy savings target of 9% for the ninth year of application of this Directive, and the development of National Energy Efficiency Action Plans (NEEAPs),
- *Directive 2010/31/EU on energy performance of buildings* which provides the legal framework for setting minimum energy performance requirements for new and existing buildings,
- *Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other recourses by energy-related products*,
- *Directive 2012/27/EU on energy efficiency* which sets binding energy efficiency targets and contains specific prescriptions related to the DH sector: by 30 November 2018, Contracting Parties must carry out and notify to the EnC Secretariat a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient DH and cooling. Contracting Parties must also ensure that final DH customers are provided with competitively priced individual meters that accurately reflect the end customers' actual energy consumption,
- *Directive 2001/80/EC of the European Parliament on the limitation of emissions of certain pollutants into the air from large combustion plants* which applies to combustion plants with nominal thermal input of 50 MW or more, regardless of the type of fuel (solid, liquid or gaseous). As of January 1, 2016, this Directive was superseded by *Directive 2010/75/EC on industrial emissions* – IE Directive or IED which integrates Directive 2008/1/EC of the European Parliament and of the Council concerning integrated pollution prevention and control, Directive 2000/76/EC of the European Parliament and of the Council on the incineration of waste, 2001/80/EC of the European Parliament and the Council on the limitation of emissions of certain pollutants into the air from large combustion plants, Directive 1999/13/EC of the European Parliament and the Council on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, Council Directive 78/176/EEC on waste from the titanium dioxide industry, Council Directive 82/883/EEC on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry and Council Directive 92/112/EEC on procedures for harmonizing the programs for the reduction and eventual elimination of pollution caused by waste from the titanium dioxide industry.

3.5.2 Policy Framework

There is currently no common energy strategy or policy (including the DH sector) at the level of BiH. According to the Constitution BiH, the entities are fully autonomous in defining their energy policies, regulations and procedures, and energy issues fall under responsibility of the two entities, while the state government institutions only coordinate this work including relationships with international and regional bodies and programs.

3.5.2.1 National Energy Efficiency Action Plan (NEEAP)

Following the requirements of the *Directive 2006/32/EC on energy end-use efficiency and energy services*, BiH prepared its first NEEAP, focusing on the period 2010-2018, providing the overall target for 2018 as well as intermediate targets for 2012 and 2015, but the NEEAP has not yet been adopted to date by national authorities[35].

[34] As required by Decision 2012/04/MC-EnC of the EnC Ministerial Council

[35] The draft NEEAP consists of entity level energy efficiency action plans (EEAPs). However, it could not be adopted to date as the draft EEAP of FBiH was not adopted due to the lack of a law on energy efficiency at FBiH level. NEEAP was

NEEAP establishes the national indicative targets on reduction of final energy consumption based on the baseline final energy consumption. A reduction of 9% of final energy consumption, its average value for the period 2006-2010, should be achieved by the end of 2018 (as required by Directive 2006/32/EC), which means that the country should ensure energy savings in the amount of 12.47 PJ, including 3.77 PJ energy savings for RS and 8.33 PJ for FBiH. Moreover, in order to implement the targets, NEEAP establishes a list of programs/measures to be implemented within the given period: among the measures for improvement of energy efficiency which will contribute to reach the indicative saving targets developed by NEEAP are also measures regarding energy efficiency in buildings and introduction of meters for consumers of DH services.

The level of energy savings in the residential sector in BiH expressed in energy units is shown in the figure below. It is expected to achieve energy savings of 5.25 PJ by the end of the period.

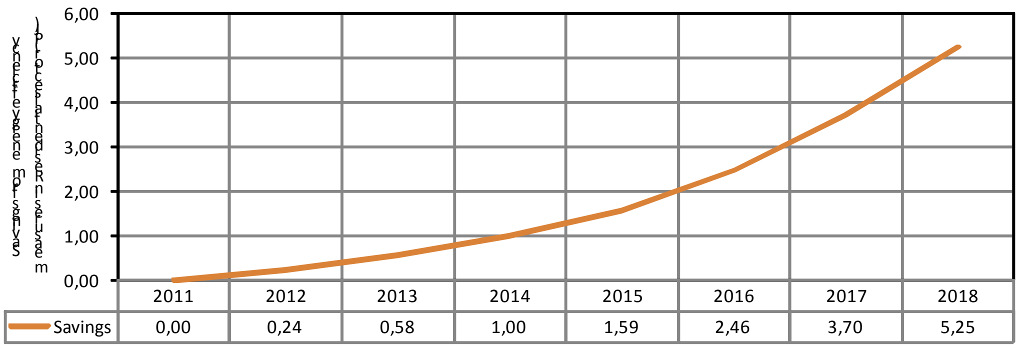


***Figure 6:** Savings from Planned EE Measures (PJ) in the Residential Sector in BiH*

The level of energy savings in the residential sector in RS expressed in energy units is shown in the figure below. It is expected to achieve energy savings of 1.75 PJ by the end of the period.

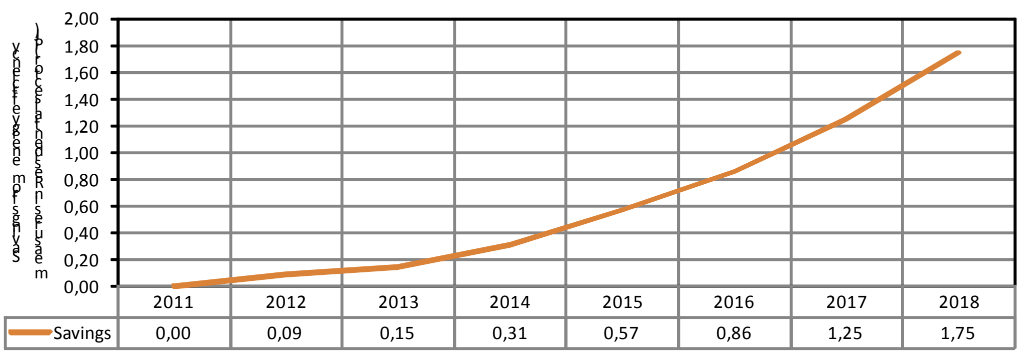


***Figure 7:** Savings from Planned EE Measures (PJ) in the Residential Sector in RS*

Energy efficiency improvement measures in the residential sector are shown in the table below.

***Table 11:** Overview of Energy Efficiency Improvement Programs and Measures in Households*

Title of the program/measure	**Overall energy savings expected in 2012/ 2018 (PJ)**		
	BiH	**RS**	**FBiH**
Minimum Equipment Energy Performance standards	0.012/0.26	0.04/0.09	0.08/0.17
Renovation of existing residential buildings and individual houses	0.084/1.84	0.032/0.64	0.052/1.20
Energy-efficient construction of new buildings	0.084/1.84	0.032/0.64	0.052/1.20
Energy-efficient heating systems	0.024/0.53	0.009/0.18	0.016/0.35

nevertheless considered in the framework of this analysis as it provides a basis for comparison of savings from planned EE measures at state level and RS level.

Title of the program/measure	Overall energy savings expected in 2012/ 2018 (PJ)		
	BiH	RS	FBiH
Compulsory division and calculation of heating costs in multi-dwelling and other buildings according to actual consumption	0.024/0.53	0.009/0.18	0.016/0.35
Domestic generation of renewable energy	0.012/0.26	0.04/0.09	0.08/0.17
Total for Residential Sector	0.24/5.25	0.09/1.75	0.16/3.43

3.5.2.2 Energy Development Strategy of RS until 2030

This Strategy was adopted by the National Assembly of RS in March 2012. According to the Strategy, DH plants in RS use out-dated and inefficient boilers and are in need of urgent renovation and reconstruction of the boiler houses. Network systems are not well maintained and experience high transmission and distribution heat losses. In addition to these technical issues, public enterprises owning and operating the DH plants are facing financial problems preventing them from investing in new technologies.

<u>The Strategy states that the operation of the DH sector must be legally regulated in order to achieve economically sustainable position and financial stability of DH companies</u>. In particular, the following issues must be regulated: general conditions of production, transmission, distribution and supply of heat energy, procurement of energy sources, planning and management of energy balances and security of supply of heat energy, introduction of measurement, control, management and charging of heat energy according to the actual consumption of individual consumer (leaving flat-rate calculation), which will stimulate increase of energy efficiency on the demand side.

The Strategy further states that the development of DH sector will be affected by gasification of RS. The development of highly-efficient gas cogeneration in Banja Luka is planned, as well as the gradual replacement of fuel oil with gas. The development of the DH system can take place within existing and future electricity distribution companies, as they represent well organized systems. Development of smaller gas cogeneration systems in urban areas are envisaged as well as the use of biomass and geothermal energy. <u>The Strategy also contains measures for energy efficiency in buildings as a measure for decreasing the energy demand.</u>

The building sector in RS (which includes households and the service sector) is the greatest consumer of final energy, with a total share of 51.8% of final energy consumption in 2005, i.e. 26.58 PJ (46.9% households and 4.9% service sector). The expected consumption in the sector without the implementation of EE measures would be 43.30 PJ in 2030, compared to 37.40 PJ with the implementation of such measures in residential and non-residential buildings. The successful implementation of EE measures in the building sector of RS will be based on:

- amendments of the legal framework and compliance with EU legislation,
- increase of the obligatory level of thermal protection of existing and new buildings,
- increase of the efficiency of heating, cooling, ventilation and air conditioning systems,
- increase of the efficiency of lighting systems and energy consumers,
- energy audits and energy management in existing and new buildings,
- setting the target value of total annual consumption of building per m^2 or m^3,
- introducing the energy certificate and adoption of an unified methodology for energy audits of buildings,
- education and promotion of measures to increase EE.

3.5.2.3 Action Plan for Use of Renewable Energy Sources of RS

The Action Plan[36] was developed and adopted by the RS Government in accordance with the *Law on Renewable Energy Sources and Efficient Co-generation*[37]. <u>The Action Plan sets objectives for participation of energy from renewable energy sources (RES) in the gross final energy consumption by sector as well as the measures for achieving these objectives</u>, including:

[36] Official Gazette of RS, No. 45/14
[37] Official Gazette of RS, No. 39/13, 108/13 and 79/15

- Specific measures for the fulfilment of the requirements of Articles 13, 14, 16 and Articles 17 to 21 of Directive 2009/28/EC,
- Support schemes to promote the use of RES in electricity,
- Support schemes to promote the use of RES in heating and cooling,
- Support schemes to promote the use of RES in transport,
- Special measures to promote the use of energy from biomass,
- Planned use of statistical transfers between countries and planned participation in joint projects.

The Action Plan also defines the amount of electricity generated from RES or in efficient co-generation facilities (quotas) from 2009 to 2020. Table 12 below presents the quotas of electricity to be produced from RES in RS from 2014 to 2020. Table 13 presents quotas of electricity produced in efficient co-generation facilities in RS from 2014 to 2020. Table 14 presents quotas of electricity produced from solar facilities and biomass plants according to the Action Plan from 2014 to 2020.

Table 12: *Amount of Electricity Produced from RES Eligible for Incentives according to the Action Plan for Use of Renewable Energy Sources of RS from 2014 to 2020*

	Amount of electricity produced from renewable sources of energy eligible for incentives according to the Action Plan for Use of Renewable Energy Sources of RS from 2014 to 2020.													
	2014		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**	
	MW	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**
Hydro	**32.06**	**149.55**	**37.97**	**175.23**	**49.09**	**224.83**	**60.71**	**276.99**	**71.87**	**326.24**	**94.81**	**428.76**	**112.36**	**507.12**
< 1MW	3.00	13.50	4.70	21.30	6.86	30.90	9.60	43.20	11.95	53.78	14.90	67.20	17.88	80.50
1 MW - 5 MW	23.36	110.40	27.32	128.35	35.54	164.60	43.76	200.87	51.98	237.23	68.62	309.99	81.10	364.50
5MW - 10 MW	5.70	25.65	5.95	25.58	6.69	29.33	7.35	32.92	7.94	35.23	11.29	51.57	13.38	62.12
Solar photovoltaic cells	**3.00**	**3.60**	**3.25**	**3.90**	**3.45**	**4.14**	**3.65**	**4.38**	**3.85**	**4.62**	**4.05**	**4.86**	**4.20**	**5.00**
Wind	**30.00**	**60.00**	**35.00**	**70.00**	**45.00**	**90.00**	**55.00**	**110.00**	**65.00**	**130.00**	**85.00**	**170.00**	**100.00**	**200.00**
Biomass	**4.95**	**13.37**	**5.78**	**15.60**	**7.43**	**20.05**	**9.08**	**24.51**	**10.73**	**28.97**	**14.03**	**37.88**	**16.50**	**44.56**
-solid	3.00	8.87	3.50	10.35	4.50	13.30	5.50	16.26	6.50	19.22	8.50	25.13	10.00	29.56
-bio-gas	1.95	4.50	2.28	5.25	2.93	6.75	3.58	8.25	4.23	9.75	5.53	12.75	6.50	15.00
-bio-liquids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total RES	**70.01**	**226.52**	**82.00**	**264.73**	**104.97**	**339.02**	**127.44**	**415.88**	**150.41**	**489.83**	**196.35**	**641.50**	**233.06**	**756.68**

Table 13: *Amount of Electricity Produced in Efficient Co-generation Facilities Eligible for Incentives according to the Action Plan for Use of Renewable Energy Sources of RS from 2014 to 2020*

	Amount of electricity produced in efficient co-generation facilities eligible for incentives according to the Action Plan for Use of Renewable Energy Sources of RS from 2014 to 2020													
	2014		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**	
	MW	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**
Fossil fuels	10.05	41.83	11.73	48.80	15.08	62.75	18.43	76.69	21.78	90.63	28.48	118.52	33.50	139.44
-solid	0.96	5.37	1.12	6.27	1.44	8.06	1.76	9.85	2.08	11.64	2.72	15.22	3.20	17.91
-gas	9.09	36.46	10.61	42.53	13.64	54.69	16.67	66.84	19.70	78.99	25.76	103.30	30.3	121.52
Landfill gas	2.70	3.55	3.15	4.14	4.05	5.32	4.95	6.50	5.85	7.68	7.65	10.05	9,00	11.82
Total	**12.75**	**45.38**	**14.88**	**52.94**	**19.13**	**68.07**	**23.38**	**83.19**	**27.63**	**98.31**	**36.13**	**128.57**	**42.50**	**151.26**

Table 14: *Amount of Electricity Produced in Solar Facilities and Biomass Plants Eligible for Incentives According to the Action Plan for Use of Renewable Energy Sources of RS from 2014 to 2020*

		Amount of electricity produced in solar facilities and biomass plants eligible for incentives according to the Action Plan for Use of Renewable Energy Sources of RS and their realization													
		2014		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**	
		MW	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**
Electricity under incentives according to the Action Plan of RS (1)	**Solar facilities with the photovoltaic cells**	3.00	3.60	3.25	3.90	3.45	4.14	3.65	4.38	3.85	4.62	4.05	4.86	4.20	5.00
Entitled to incentives (2)	**Solar facilities with the photovoltaic cells**	0.47640	0.558877	1.07084	1.296702	0.82119	0.959877	0.82119	0.959877	0.82119	0.959877	0.82119	0.959877	0.82119	0.959877
Obtained preliminary entitlement to incentives (3)	**Solar facilities with the photovoltaic cells**	1.57	1.604972	2.84	3.801879	2.84	3.801879	2.84	3.801879	2.84	3.801879	2.84	3.801879	2.84	3.801879
Remaining amount of electricity which could be entitled to incentives (4)=(1)-(2)-(3)	**Solar facilities with the photovoltaic cells**	**0.9572**	**1.436151**	**-0.66**	**-1.20**	**-0.21**	**-0.62**	**-0.01**	**-0.38**	**0.19**	**-0.14**	**0.39**	**0.10**	**0.54**	**0.24**
Entitled to incentive, but waiting for	**Solar facilities with the**	0.00	0.00		1.1986	0.00		0.00	0.3818	0.00	0.1418	0.00	0.00	0.00	0.00

available amount of electricity under incentives	**photovoltaic cells**														
Electricity under incentives according to the Action Plan of RS (1)	**BIOMASS**	4.95	13.37	5.78	15.60	7.43	20.05	9.08	24.51	10.73	28.97	14.03	37.88	16.50	44.56
	-solid	3.00	8.87	3.50	10.35	4.50	13.30	5.50	16.26	6.50	19.22	8.50	25.13	10.00	29.56
	-bio-gas	1.95	4.50	2.28	5.25	2.93	6.75	3.58	8.25	4.23	9.75	5.53	12.75	6.50	15.00
	-bio-liquids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Entitled to incentives (2)	**BIOMASS**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-solid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-bio-gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-bio-liquids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Obtained preliminary entitlement to incentives (3)	**BIOMASS**	0.00	0.00	0.00	0.00	0.99	6.75	0.99	8.25	0.99	8.27	0.00	0.00	0.00	0.00
	-solid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-bio-gas	0.00	0.00	0.00	0.00	0.99	6.75	0.99	8.25	0.99	8.27	0.00	0.00	0.00	0.00
	-bio-liquids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
The remaining amount of electricity which could be entitled to incentives (4)=(1)-(2)-(3)	**BIOMASS**	**4.95**	**13.37**	**5.78**	**15.60**	**6.44**	**13.30**	**8.09**	**16.26**	**9.74**	**20.70**	**14.03**	**37.88**	**16.50**	**44.56**
	-solid	**3.00**	**8.87**	**3.50**	**10.35**	**4.50**	**13.30**	**5.50**	**16.26**	**6.50**	**19.22**	**8.50**	**25.13**	**10.00**	**29.56**
	-bio-gas	**1.95**	**4.50**	**2.28**	**5.25**	**1.94**	**0.00**	**2.59**	**0.00**	**3.24**	**1.48**	**5.53**	**12.75**	**6.50**	**15.00**
	-bio-liquids	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Entitled to incentives, but waiting for available amount of electricity under incentives	**BIOMASS**	0.00	0.00	0.00	0.00	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-solid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-bio-gas	0.00	0.00	0.00	0.00	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-bio-liquids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.5.2.4 Energy Efficiency Action Plan (EEAP) of RS

The EEAP for the period until 2018[38] was adopted in 2013 by the RS Government. It was prepared according to the *Law on Energy Efficiency*[39] by the Ministry of Industry, Energy and Mining and the Ministry of Spatial Planning, Civil Engineering and Ecology, in cooperation with the Ministry of Finance and the Environmental Protection and Energy Efficiency Fund of the RS.

The EEAP includes:

- an assessment of state of energy efficiency in the period immediately prior to the adoption of the EEAP,
- energy efficiency improvement measures,
- indicative energy savings targets,
- timetable for implementation of measures for achieving indicative targets,
- estimation of financial resources necessary for the implementation of the EEAP.

According to the EEAP, the overall energy savings target is 3.77 PJ / 90 ktoe (9%) to be achieved in 2018, with two intermediate targets: 0.2 PJ in 2012 and 1.4 PJ in 2015. The energy savings targets for the residential sector are 0.09 PJ by 2012, 0.57 PJ by 2015 and 1.75 PJ by the end of 2018.

The foreseen energy efficiency improvement measures in the residential sector are presented in the table below.

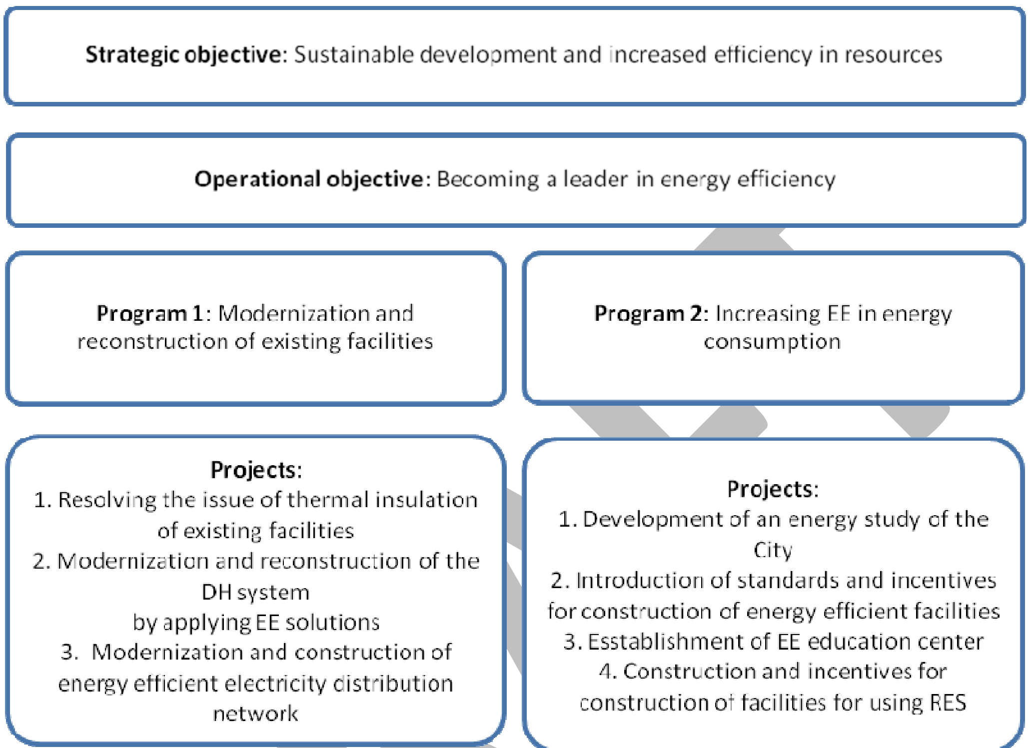
Table 15: *Energy Efficiency Measures for the Residential Sector According to the EEAP of RS*

Title of the program/measure	Overall energy savings expected (PJ)		
	2012	**2015**	**2018**
Labelling of household devices with energy efficiency labels	0.004	0.03	0.09
Renovation of existing residential buildings and individual houses and the construction of new buildings according to the principles of energy efficiency	0.064	0.39	1.21
Energy efficient heating, ventilation and cooling systems	0.009	0.06	0.18
Compulsory division and calculation of heating costs in multi-dwelling and other buildings according to actual consumption	0.009	0.06	0.18
Production of energy from renewable sources in order to increase energy efficiency	0.004	0.03	0.09
Total for residential sector	0.09	0.57	1.75

[38] Official Gazette of RS, No. 59/13
[39] Official Gazette of RS, No. 59/13

3.5.2.5 Development Strategy of the City of Banja Luka

The Strategy, initially adopted for the period 2007-2015 and extended for an additional 4 years (i.e. until 2019[40]), recognizes the city heating system as one of the key problems in the development of the City in terms of the infrastructure and the used fuel, as well as the heating price. The objectives set by the Strategy in the field of district heating and energy efficiency are provided in the following graph.



3.5.2.6 Sustainable Energy Action Plan (SEAP) of the City of Banja Luka

In accordance with the *Law on Energy Efficiency*[41], the City of Banja Luka as a local self-governance unit (LSG) with more than 20,000 inhabitants is required to develop and adopt its Energy Efficiency Action Plan (EEAP), harmonized with the EEAP of RS. However, since the City is a party of the Covenant of Mayors[42] (as of 2009) and developed its Sustainable Energy Action Plan (SEAP) in 2010, the SEAP is considered as an EEAP.

Energy efficiency measures developed in EEAPs for LSG units contain:

- activities on the renovation and maintenance of facilities used by the LSG unit, its administrative offices, as well as public enterprises and public institutions established by the LSG unit,
- activities to improve public utilities (public lighting, thermal energy supply, water supply, waste management, etc.) and transport, in order to improve energy efficiency,
- other activities to be carried out in the LSG unit regarding energy efficiency improvements.

[40] The extension was determined on the basis of the Decision on Amendments to the Decision on Adoption of the Development Strategy of the City of Banja Luka issued by the City Assembly, published in the Official Gazette of the City of Banja Luka, No. 28/15

[41] Official Gazette of RS, No. 59/13

[42] The Covenant of Mayors is a European cooperation movement involving local and regional authorities. Signatories of the Covenant voluntarily commit to increase energy efficiency and the use of RES on their territories.

The implementation of these measures and activities is to be financed from the budget of the LSG units, the Environmental Protection and Energy Efficiency Fund of the RS and other sources.

The SEAP of the City of Banja Luka defines the approach of the City to achieve the reduction of CO_2 emissions by 20% until 2020. SEAP contains activities related to both the private and public sector, in the fields of construction, municipal infrastructure, land use, renewable energy sources, and public and private transport.

Significant energy savings as well as reduction of CO_2 are expected in the DH sector, where particular attention is paid to the modernization of distribution network, thermal sub-stations and the boiler house at the DH plant.

SEAP envisages that the implementation of all measures related to DH in the City of Banja Luka will result in savings in fuel consumption by 2020 (compared to the projected consumption without the implementation of modernization). The expected savings in fuel consumption are 4,500 t of crude oil (approx. 50,293.88 MWh of thermal energy), which will result in the reduction of approx. 14,020.92 t of CO_2 emissions.

The estimated costs for the implementation of all measures related to the DH amount to EUR app. 36,500,000.00.

Table 16: *Measures for DH Modernization Contained in the SEAP of the City of Banja Luka*

Measure	**Objective**	**Planned activities**	**Estimated costs**	**Estimated savings in fuel consumption by 2020**
Boiler house modernization	Improvement of the efficiency of transformation of thermal energy fuels in the boiler house through: • Improved combustion of fuel, less combustion emissions into the air, • Fuel and energy savings, • Cost savings, • Improved operation and safety.	• Purchase of new oil burners, pumps, motors and fans, • Installation of variable speed drives to main motors, • Installation of local automation, • Installation of heat meters in boiler houses, • Installation of equipment for gas (oxygen) removal from the make-up water.	EUR 4,700,000.00	1,170 t of crude oil/per heating season (app. 13,066 MWh of thermal energy) expected to result in the reduction of app. 3,645.42 t of CO_2 emissions.
Reconstruction of primary and secondary distribution network	Expanding the customer base and achieving savings in maintenance costs, fuel and water costs through: • Reduced heat and water losses, • Improved reliability and quality of heat supply, • Reduced maintenance costs.	• Replacement of heavily damaged network sections, • Replacement of valves in chambers and other components.	EUR 10,500,000.00 (primary distribution network) EUR 15,000,000.00 (secondary distribution network)	Primary network: 1,395 t of crude oil/per heating season (app. 15,578.7 MWh of thermal energy) expected to result in the reduction of app. 4,346.47 t of CO_2 emissions. Secondary network: 1,170 t of crude oil (app. 13,066 MWh of thermal energy) expected to result in the reduction of app. 3,645.4 t of CO_2 emissions.

Modernization of operational substations	• Cost savings, • Improved comfort and services to customers, • Measurement of heat consumption of each group of buildings supplied by each substation, • Monitoring of water consumption in secondary networks and buildings.	• Replacement of control valves and automatic regulators, • Replacement of heat exchangers, • Installation of water flow meters between primary and secondary networks, • Installation of heat meters, • Automation.	EUR 3,600,000.00	720 t of HFO (app. 8,040.64 MWh of thermal energy) expected to result in the reduction of app. 2,243.33 t of CO_2 emissions.
Installation of heat meters in buildings	• Facilitate the monitoring of heat consumption and heat losses in secondary networks • Create conditions for payments based on actual consumption of heat energy	• Installation of heat meters in all customer buildings	EUR 2,600,000.00	-

Furthermore, according to SEAP, the construction of a new DH plant is planned in the draft version of the Urban Development Plan for the City of Banja Luka for the period 2008 – 2020. The new DH plant would serve for purposes of heating the City areas that are not connected to the existing DH network. SEAP stipulates the development of a new feasibility study, which would focus on the expansion of the existing DH network and on the possibilities for fuel switching (e.g. geothermal, biomass, etc.). The estimated costs of the feasibility study are EUR 100,000.00.

3.5.2.7 Local Environmental Action Plan (LEAP) for the City of Banja Luka for the period 2016-2021

According to the *Law on Environmental Protection of RS*[43], a LEAP has to be developed by municipalities and cities in order to mitigate the negative impacts of environmental polluters, and to prevent future pollutions with the implementation of the measures which will contribute to local sustainable development.

The LEAP for the City of Banja Luka for the period 2016-2021 was adopted by the City Assembly in December 2015. According to the analysis of the air pollution in the City, pollution is caused by individual heating systems on oil, coal and wood with increased emission of fumes, particles and other combustion products. The DH system also contributes to air pollution by using crude oil as fuel, thus considered to be one of the main air polluters.

In order to improve air quality and decrease air emissions, the following measures are proposed for the modernization of the DH system:

- Modernization of the equipment for electro-filtration of the existing DH,
- Development of feasibility studies for small DH systems in Lauš, Paprikovac and Lazarevo,
- Expansion of the DH network to cover new urban areas,
- Reconstruction of the existing system of distribution network for households and reduction of heat loss,
- Boilers reconstruction and fuel switch – from crude oil to biomass.

[43] Official Gazette of RS No. 71/12 and 79/15

3.5.2.8 Spatial Plan of the City of Banja Luka

According to the Spatial Plan of the City of Banja Luka[44], DH remains the main source of heating in the narrow urban area of the City of Banja Luka. The key points of the Spatial Plan with regard to DH are as follows:

- the DH system is in need of reconstruction and modernization, as the pipeline network is damaged - thus resulting in heat and water losses, HFO is used as fuel which causes pollution, house boiler equipment is outdated etc.,
- it is necessary to replace the old heavily damaged network sections with new pipelines, and build two new DH plants, one in the southern and one in the northern part of the urban area, which will enable the development of the heating network to reach new consumers. Instead of the construction of one or both DH plants, another option would be the construction of co-generation plant on natural gas, which would provide a relatively cheap thermal energy for heating and supply of hot water. The supply of hot water from DH systems would significantly reduce electricity consumption for this purpose. Co-generation system on gas has a much lower impact on the environment without sulphur oxides, slag and ash in the exhaust gases. The projected installed capacity of this co-generation plant is 450 MW_{el} and 250 MW_{th},
- gasification of the City of Banja Luka is also planned through connection with the main gas pipeline of the South Stream. This will enable the supply of thermal energy for new consumers. Until the connection to the main gas pipeline it is planned the gasification of the City by using the liquefied natural gas (LPG).

3.5.3 Legislation Related to District Heating

In Bosnia and Herzegovina, there is no specific legislation at either BiH or entity level regulating the DH sector. DH operations are governed by various pieces of legislation on energy efficiency improvement, use of renewable energy sources, spatial planning and environmental protection.

According to the *Energy Sector Study in BiH* prepared in 2008[45], the current legal regulation in the DH field is undeveloped. It provides an overview of the relevant EU regulatory framework, and in particular of the DH legislation framework in Croatia, as an example of how the development of DH legislation in BiH could proceed.

Since there are no laws or regulations specific for DH activities and operation of DH systems, the current legal framework relies on the *Law on Public Utilities*[46] and *Law on Local Self-Government*[47], whereby public companies and local self-government units regulate the operations related to the DH sector.

3.5.3.1 DH Company Operations

3.5.3.1.1 Regulations on Operations of the Company

The Company is a public enterprise incorporated in accordance with the *Law on Public Enterprises in RS*[48] and the *Law on Companies of RS*[49]. The *Law on Public Enterprises in RS* regulates the specific management and operational issues of public enterprises in RS. According to this Law, a public enterprise is an enterprise that carries out activities of public interest (energy, communications, municipal services, management of public assets and other activities of public interest), and in which the municipality, city or RS is the majority owner. All issues not regulated by this Law are regulated by the *Law on Companies of RS* which defines in general the establishment, operations, management and closing of companies in RS.
The Company is a Joint Stock Company where the majority owner is the City of Banja Luka (77% of shares), whereas the remaining 23% is owned by the Company (19% of shares[50]) and other shareholders (4% of shares)[51].

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[44] Official Gazette of the City of Banja Luka, No. 11/14
[45] This is the only energy sector analysis at the level of BiH. Since 2008, the Study was not updated, and no further sector studies were prepared.
[46] Official Gazette of RS, No. 124/11
[47] Official Gazette of RS, No. 101/04, 42/05, 118/05 and 98/13
[48] Official Gazette of RS, No. 79/11
[49] Official Gazette of RS, No. 127/08, 58/09, and 100/11
[50] According to the Law on Companies of RS (Article 219), joint stock companies which acquire up to 10% of shares in their own initial capital are required to sell such shares within one year, and within 3 years for more than 10% of shares.

The Company bodies have been established in accordance with the *Law on Public Enterprises in RS* which sets forth the mandatory bodies of all public enterprises, i.e., the Shareholders Assembly, the Supervisory Board, the Management and the Auditing Board, whose responsibilities are elaborated in detail in the Statute of the Company.

3.5.3.1.2 Regulations on DH Organization in the City of Banja Luka

DH operations in the City of Banja Luka are regulated by the *Law on Public Utilities*[52], the *Law on Local Self-Government*[53], the *Statute of the City of Banja Luka*[54] and the *Decision on General Conditions for Heat Delivery*[55].

Pursuant to the *Law on Public Utilities*[56], the City of Banja Luka regulates:

- The conditions and manner of providing public utility services,
- The conditions for the financing, development, construction and maintenance of utility facilities,
- The conditions for the functioning of the technical and technological unity of the system and devices,
- The possibilities of subsidised prices of utilities, user categories and conditions of subsidising.

The *Statute of the City of Banja Luka* regulates some of the issues defined by the *Law on Local Self-Government*, in particular the responsibilities of the City of Banja Luka with regard to local infrastructure for public utilities. According to the Statute, the City of Banja Luka is responsible for public utility services; the organizational, financial and other conditions for the construction and maintenance of public facilities and public infrastructure; and the incorporation and termination of utility enterprises.

The Company operates in accordance with the City level *Decision on General Conditions for Heat Delivery*[57]. This Decision regulates the:

- conditions and manner for the distribution of thermal energy,
- management of heat distribution system and heat supply to customers,
- the tariff system for the calculation of delivered heat,
- conditions and manner of ensuring continuity in the supply of thermal energy to customers in the City Banja Luka,
- rights and duties of producers, distributors and customers of thermal energy,
- the rights and obligations of heat energy.

3.5.3.1.3 Regulations on Borrowing

Local self-governance (LSG) units (in this case, the City of Banja Luka) have the possibility to assume both short-term and long-term debts according to the *Law on Borrowing, Debt and Guarantees of RS*[58]. Long-term debts may be assumed only with the purpose of financing capital investments and if the loan does not exceed 18% of the regular income realized in the prior fiscal year.

LSG units may become borrowers or issue a guarantee only on the basis of a decision adopted by the LSG Assembly, through a loan agreement and by the issuance of securities.

LSG units may also issue guarantees to legal entities majority owned by the LSG with the purpose of financing capital investments, refinancing of existing debt, financing transferred obligations or financing of obligations incurred during the restructuring and consolidation of such legal entity.

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[51] Source: Business Report of the Company for the year 2015
[52] Official Gazette of RS, No. 124/11
[53] Official Gazette of RS, No. 101/04, 42/05, 118/05 and 98/13
[54] Official Gazette of the City of Banja Luka, No. 25/05, 30/07 and 17/12
[55] Official Gazette of the City of Banja Luka, No. 26/13
[56] Official Gazette of RS, No. 124/11
[57] Official Gazette of the City of Banja Luka, No. 26/13
[58] Official Gazette of the City of Banja Luka, No. 71/12 and 52/14

3.5.3.2 Alternative Sources of Energy

Alternative sources of energy include renewable energy sources (RES), co-generation and the use of waste as fuel.

Renewable energy sources and co-generation in RS are regulated by the *Law on Renewable Energy Sources and Efficient Co-generation of RS*[59], according to which power plants which use RES for electricity production are divided into:

- plants which utilize the energy potential of water courses,
- plants which utilize wind energy,
- plants which utilize energy obtained from biomass,
- plants which utilize energy obtained from biogas (waste gas, gas from the facility for the waste water treatment and agricultural biogas),
- plants which utilize geo-thermal energy,
- plants which utilize non-accumulated solar energy (photo-voltaic cells and solar thermal-energy facility),
- co-generation plants,
- plants which utilize a combination of multiple renewable energy sources.

According to this Law, co-generation plants can be based on the following technologies:

- combined cycle gas turbine with heat recovery,
- anti-pressure steam turbine,
- condensing steam turbine with the steam deduction,
- gas turbine with heat recovery,
- internal combustion engine,
- micro-turbine,
- Stirling engine,
- fuel cells,
- steam machine,
- Organic Ranking Cycle,
- other types of technology which generate heat and electricity at same time in one process.

Waste incineration is regulated by the *Law on Waste Management of RS*[60], according to which the reuse of waste is possible by using waste incineration technologies, divided into waste incineration and waste co-incineration. Waste incineration (combustion) is the thermal treatment of waste in stationary or mobile plants with the use of energy produced by combustion or without use of energy generated from combustion whose primary role is thermal treatment of waste, which includes the pyrolysis, gasification and combustion of plasma. Co-incineration is the thermal treatment of waste in stationary or mobile plants whose primary function is to produce energy or material products, which uses waste as a primary or additional fuel or in which waste is thermally treated for disposal.

3.5.3.3 Incentives and Subsidies

There are currently no energy efficiency incentives, such as tax incentives, in place at BiH or RS level. The existing incentives and subsidies are provided only for electricity produced using renewable energy sources. These incentives are prescribed by different laws in RS.

The *Law on Energy of RS*[61] regulates the use of RES and a system of subsidies for production of energy from RES and co-generation, and methods for obtaining and use of incentives regulated by the Regulatory Commission for Energy of RS, upon the prior consent of the Government of RS.

[59] Official Gazette of RS, No. 39/13, 108/13 and 79/15
[60] Official Gazette of RS, No. 113/13
[61] Official Gazette of RS, No. 49/09

The *Law on Electricity*[62] regulates the production and distribution of electricity in RS. The Law regulates the conditions for the cost-effective development of production and distribution of electricity, as well as the rights and obligations of electricity producers and the possibilities of acquiring the status of eligible electricity producer in accordance with the conditions and incentives set by the Regulatory Commission for Energy of RS.

The *Law on Renewable Energy Sources and Efficient Co-generation*[63] regulates the planning of and incentives for the production and consumption of energy generated from RES and efficient co-generation. This Law defines the types of incentives for generation of electricity from RES or in efficient co-generation, follows:

- Benefits for connection to the network,
- Advantages in access to the network (dispatching),
- Right to the obligatory purchase of electricity,
- Right to the feed-in tariff,
- Right to the premium for consumption of electricity for its own needs, or sale to the electricity market.

The *Decision on the Level of Guaranteed Purchase Prices and Premiums for Electricity Generated from Renewable Energy Sources and in Efficient Co-generation*[64] was adopted by the Regulatory Commission for Energy of RS on the basis of *the Law on Renewable Energy Sources and Efficient Co-generation*. This Decision determines the amount of guaranteed feed in tariffs and premiums for electricity generated from RES or in efficient co-generation facilities. The methodology of calculation of the guaranteed feed in tariffs and premium is based on the calculation of the total annual costs of generation of electricity from the typical generation facilities, depending on the type of the plant, using the annuity method of the investment valuation, whereby this calculation is based on the technical and economic parameters which to the greatest extent represent specific technologies of the electricity generated being stimulated. Feed in tariffs and premium for electricity generated in power plants on biomass and by efficient co-generation plant are presented in the Table 17 below. Prices and premiums presented in Table 17 do not include value added tax (VAT).

Table 17: *Feed-in Tariffs and Premiums for Electricity Generated in Power Plants on Biomass and Efficient Co-generation Plants*

Type of power plant according to installed power	**Sale at compulsory purchase at guaranteed purchase prices**			**Sales on the market and consumption for own needs**	
	Guaranteed purchase price BAM/kWh	**Reference Price BAM/kWh**	**Premium (in guaranteed price) BAM/kWh**	**Reference Price BAM/kWh**	**Premium BAM/kWh**
Power Plants on Solid Biomass of capacity					
Up to and including 1 MW	0.2413	0.0541	0.1872	0.0829	0.1584
Over 1 MW up to and including 10 MW	0.2261	0.0541	0.1720	0.0829	0.1432
Power Plants on agricultural biogas up to and including 1 MW	0.2402	0.0541	0.1861	0.0829	0.1573
Conventional sources of energy in efficient co-generation facilities (guaranteed purchase price up to and including 10 MW, and premium for sale on the market and consumption for own needs up to and including 30 MW					
New cogeneration plant on gas up to and including 1 MW	0.2117	0.0541	0.1576	0.0829	0.1288
New cogeneration plant on gas from 1	0.1864	0.0541	0.1323	0.0829	0.1035

[62] Official Gazette of RS, No. 08/08, 34/09, 92/09 and 01/11
[63] Official Gazette of RS, No. 39/13, 108/13 and 79/15
[64] Official Gazette of RS, No. 88/14

Type of power plant according to installed power	Sale at compulsory purchase at guaranteed purchase prices			Sales on the market and consumption for own needs	
	Guaranteed purchase price BAM/kWh	Reference Price BAM/kWh	Premium (in guaranteed price) BAM/kWh	Reference Price BAM/kWh	Premium BAM/kWh
MW up to and including 10 MW					
New cogeneration plant on lignite up to 1 MW	0.1197	0.0541	0.0656	0.0829	0.0368
New cogeneration plant on lignite from 1 MW up to and including 10 MW	0.0882	0.0541	0.0341	0.0829	0.0053
Landfill gas in the efficient co-generation facility					
Up to and including 1 MW	0.0698	0.0541	0.0157	0.0829	0
Over 1 MW up to and including 10 MW	0.0541	0.0541	0	0.0829	0
Solar facilities with the photovoltaic cells (Guaranteed feed in prices and premium from July 1, 2015)					
On the structures of up to and including 50 kW	0.3198	0.0541	0.2657	0.0829	0.2369
On the structures of more than 50 kW up to and including 250 kW	0.2766	0.0541	0.2225	0.0829	0.1937
On the structures of more than 250 kW up to and including 1 MW	0.2207	0.0541	0.1666	0.0829	0.1378
On the land of up to and including 250 kW	0.2566	0.0541	0.2025	0.0829	0.1737
On the land of more than 250 kW up to and including 1 MW	0.2042	0.0541	0.1501	0.0829	0.1213

3.5.3.4 DH Tariffs

The DH tariff system is regulated by the City of Banja Luka, on the basis of:

- the *Law on Public Utilities*[65],
- the *Law on Local Self-Government*[66],
- the *Regulation on the Approval to the Prices of Certain Goods and Services*[67],
- the *Statute of the City of Banja Luka*[68], and
- the *Decision on General Conditions for Heat Delivery*[69].

The *Decision on General Conditions for Heat Delivery of the City of Banja Luka* regulates the tariff system which establishes the elements of and method of calculation of thermal energy tariffs for different group of customers.

[65] Official Gazette of RS, No. 124/11
[66] Official Gazette of RS, No. 101/04, 42/05, 118/05 and 98/13
[67] Official Gazette of RS, No. 11/11
[68] Official Gazette of the City of Banja Luka, No. 25/05, 30/07 and 17/12
[69] Official Gazette of the City of Banja Luka, No. 26/13

The tariff system determines the group of heat customers, tariff elements, tariff rates and billing of thermal energy delivered to customers, criteria and benchmarks for the pricing of heat energy, and the criteria for determining tariff rates. The Decision differentiates 5 customer categories:

Tariff Group 1	households for which the delivered thermal energy is calculated per m^2 of a floor area
Tariff Group 2	households for which the delivered thermal energy is calculated on the basis of actual consumption - expressed in MWh
Tariff Group 3	business customers for which the delivered thermal energy is calculated on the basis of actual consumption - expressed in MW
Tariff Group 4	business customers for which the delivered thermal energy is calculated per m^2 of a building's floor area
Tariff Group 5	business customer for which the delivered thermal energy is calculated on the basis of installed capacity - expressed in MW

Tariff elements are:

- supply power[70],
- amount of delivered thermal energy,
- heated surface.

Tariff rates are:

- Price for heating per m^2 - for household customers,
- Price for heating per m^2 - for customers in the business premises,
- Price per unit of installed capacity - for customers in the business premises,
- Price for the supply heating power - for customers in households [BAM/kW],
- Price for the supply heating power - for customers in business premises [BAM/kW],
- Price for the amount of delivered thermal energy for heating - for household customers [BAM/MWh],
- Price for the amount of delivered thermal energy for heating - for customers in business premises [BAM/MWh].

Prices for heat delivery are determined depending on the category of consumers, as follows:

- Residential customers with the price per m^2,
- Residential customers with installed meters,
- Business customers with installed meters,
- Business customers with the calculation made according to the installed capacity,
- Business customers with the price per m^2.

According to the aforementioned Decision, the total cost of heating for customers is the sum of the monthly cost of supply power for heating (fixed part) and the monthly cost for the amount of delivered thermal energy for heating (variable part).

Prices are determined by the Supervisory Board of the Company, after the prior consent of the City of Banja Luka (Assembly). The existing decision on tariffs was adopted in 2011[71].

Prices for the different groups of heat customers are:

Price for residential customers	1.65 BAM (VAT included) per m^2 (12 months)
Price for residential customers	133.82 BAM (VAT included) per MWh
Price for business customers	199.64 BAM (VAT included) per MWh

[70] Supply power for residential buildings or residential parts of residential/commercial buildings is the power from the main project of DH installation and residential substations. Supply power for commercial buildings or commercial parts of residential/commercial buildings is the power defined by the contract on sale of thermal energy.

[71] http://www.bltoplana.com/images/stories/dokumenti/cijena%20toplotne%20energije.pdf

In accordance with the *Decision on General Conditions for Heat Delivery*, consumers are entitled to an adequate discount/credit note depending on how lower the temperature inside a building is compared to the prescribed minimal temperature. This requirement is applied by the Company in its provision of DH services.

According to the *Report on Operations for 2015* developed by the Company, a subsidy was given by the City of Banja Luka to the Company in order to cover a part of DH costs for pensioners in the amount of 1,000,000 BAM.

3.5.3.5 Fuel and Electricity Prices

Prices for electricity in Banja Luka are based on the *Decision on Tariff System for Electricity in RS* adopted by the Regulatory Commission for Energy of RS. There are 7 tariff groups, of which 2 for households:

- Tariff group I: for which the active electricity consumption is measured by a single-rate meter,
- Tariff group II: for which the active electricity consumption is measured by a two-rate meter.

Two different tariffs for households with two-rate meters are in place:

- High Tariff – from 06.00 to 22.00 hours in winter, and from 07.00 to 23.00 in summer,
- Low Tariff – from 22.00 to 6.00 in winter, and from 23.00 to 7.00 in summer (this tariff include also the electricity delivered during the days of weekend).

Tariffs for residential consumers are presented in Table 18 and Table 19.

Table 18: *Residential Consumers – Electricity Tariffs (Winter)*

	Billing power BAM	**High Tariff BAM/kWh**	**Low Tariff BAM/kWh**	**Fee for renewables BAM/kWh**
Single-rate meter	6.7162		0.1172	0.0021
Two-rate meter	10.5830	0.1410	0.0705	0.0021

Table 19: *Residential Consumers – Electricity Tariffs (Summer)*

	Billing power BAM	**High Tariff BAM/kWh**	**Low Tariff BAM/kWh**	**Fee for renewables BAM/kWh**
Single-rate meter	5.1662		0.0902	0.0021
Two-rate meter	8.1406	0.1083	0.0021	0.0021

The average prices of other fuels are presented in Table 20 below.

Table 20: *Average Prices of Other Fuels*

Fuel	**Energy value expressed in kWh_{th}**	**Market Price**	**Fuel price expressed in BAM/kWh_{th}**
Heavy oil	10.03 kWh/lit.	1.75 BAM/lit.	0.174
Coal	3.61 kWh/kg	160 BAM/t	0.044
Briquette	4.16 kWh/kg	140 BAM/t	0.040
Pellet	4.70 kWh/kg	260 BAM/t	0.061
Firewood	2.85 kWh/kg	75 BAM/mp	0.053

3.5.3.6 Distribution Network

According to the *Decision on General Terms for Heat Delivery*[72]*,* the distribution network is divided into primary and secondary networks which are parts of the system of equipment and installations intended for distribution of thermal energy to customers. The distribution network and connections include pipelines from the Company to house or building substations including the valves at the entrance to the primary part of the building substations.

[72] Official Gazette of the City of Banja Luka, No. 26/13

According to this Decision, the Company is responsible for the maintenance of the distribution network and of all equipment and installations which compose the distribution network.

Pursuant to Article 29 of the Decision, maintenance of common parts of buildings, which includes the installation of DH, falls under the competence of the flat owners. According to the *Law on Maintenance of Buildings*[73], common parts of buildings are parts and devices that serve the building as a whole or specific parts of the building, and in particular: the foundations, main walls, roofs, stairs, chimneys, elevators, facade, basement, attic, hallways, laundry and drying rooms, garbage rooms, electricity, lighting, sewage, water supply and telephone networks, gas and hot water installations and television antennas.

Buildings are managed by Homeowner Associations, which issue decisions on the use and maintenance of the common parts of the building, on the provision and use of funds for maintenance of the common parts of the building and other issues of importance for the building management. Common areas in buildings are joint property of flat owners.

Homeowner Associations may be established for one or more buildings or part of a building. Homeowner Associations are legal entities with the power to conclude and execute binding agreements. Maintenance of a building may be entrusted to a public or private company registered for providing building maintenance services.

Flat owners are required to bear the costs of the investments for regular maintenance and urgent repairs on common parts of buildings.

3.5.3.7 Energy Efficiency (EE) in Buildings

Energy efficiency in buildings in RS is regulated through several laws and by-laws.

The *Law on Energy of RS*[74] regulates the basis of the energy policy of RS and the fundamental issues related to the regulation and realization of energy activities, as well as the conditions for achieving of energy efficiency. The Ministry of Industry, Energy and Mining of RS is responsible for energy efficiency improvements through the implementation of the overall framework of measures aimed at EE and energy savings. These measures include:

- Introduction of favourable conditions for investments through implementation of programs to increase EE (e.g. public-private partnerships, development of financial cooperation and investment funds, etc.),
- Cooperation between energy consumers, producers and suppliers, as well as the public services sector and the local government, to achieve the defined level of EE,
- Achieving the defined levels of EE through reduction of energy losses and energy consumption, by introducing new technological solutions in various sectors (public sector and public services, construction, agriculture, industry, transport, etc.),
- International cooperation in the field of EE.

Furthermore, the Law sets out the obligations of energy suppliers regarding the dissemination of information about rational and efficient energy use. Energy suppliers are required to inform their customers, at least once a year, on the impacts of rational use of energy on the environment and sustainable development, and are also required to educate and provide guidance to customers to use energy in a rational and cost-effective way. In order to reach the objective of rational use of energy, energy consumption calculations have to be based on the actual consumption of energy.

The *Directive 2010/31/EU on the Energy Performance of Buildings* has been transposed into the entity legislation by the *Law on Spatial Planning and Construction*[75] which regulates energy audits and energy performance of buildings. According to the Law, a building has to maintain its technical features and performances including EE, energy savings and thermal protection. Each new building must be designed, constructed and maintained in the

[73] Official Gazette of RS, No. 101/11
[74] Official Gazette of RS, No. 49/09
[75] Official Gazette of RS, No. 40/13

way to maintain the prescribed energy performances during its use. During the planning, design and construction of new buildings, as well as during major renovation of the existing buildings, a set of long-term measures must be applied, as well as minimum requirements regarding the reduction of energy consumption and switch to the use of energy from renewable sources.

The defined energy performance and minimum requirements, as well as the long-term measures, have to be provided through:

- mandatory installation of metering devices for each individual condominium (flat) owner in all new buildings, and in existing buildings during major renovation. At least one metering device for measuring the consumption of an entire building has to be installed,
- encouraging the introduction of intelligent metering systems whenever a building is constructed or undergoes major renovation,
- encouraging the use of district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources,
- the application of new technology of construction and installation of building products that enable the use of primary energy from renewable sources,
- the creation of stimulating conditions and measures to build new buildings and convert them into nearly zero-energy buildings,
- the establishment of a regular audit of technical building systems and equipment that is used for heating or cooling, ventilation, hot water and lighting,
- the creation of conditions for the development and establishment of a system of certification of the energy performance of building showing the energy performance of buildings.

The aforesaid measures are also defined in the *Law on Public Utilities*[76].

Energy audits are performed by legal entities holding the necessary license to carry out energy audits (issued by the Ministry of Spatial Planning, Civil Engineering and Ecology of RS). The legal entities which perform energy audits are required to submit a report on the completed audit to the Environmental Protection and Energy Efficiency Fund of RS. The Fund issues the energy certificate and sends the certificate to the legal entity that performed the energy audit, to the Ministry and the competent LSG unit on whose territory the audit was performed. This Ministry keeps a single registry of licensed legal entities, whereas LSG units keep a registry of certificates issued on their territory.

Energy performance certificates are issued for buildings or building units constructed after the adoption of the *Law on Spatial Planning and Construction*, before selling or renting them out to a new tenant.

Below is a list of secondary legislation adopted in RS in accordance with the obligations stipulated by the *Law on Spatial Planning and Construction* and regarding the energy performance of buildings:

- Regulation on Minimum Requirements for the Energy Performance of Buildings[77],
- Regulation on Methodology for Calculating the Energy Performance of Buildings[78],
- Regulation on Energy Audit of Buildings and Energy Performance and Energy Certification[79].

<u>Other measures for improving EE are contained in the *Law on Energy Efficiency*[80], according to which EE improvement measures include energy services, energy management and other measures.</u>

Distribution system operators, energy distributors and retail energy sales companies are required to offer energy services at competitive prices to their end customers, either directly or through other energy service providers. If a

[76] Official Gazette of RS, No. 124/11
[77] Official Gazette of RS, No. 30/15
[78] *Ibid*.
[79] *Ibid*
[80] Official Gazette of RS, No. 59/13

distribution system operator, energy distributor or retail energy sales company does not offer energy services at competitive prices to its end customers, it is required to pay a fee to the Environmental Protection and Energy Efficiency Fund of RS, which uses the collected fees to finance energy efficiency improvements.

Energy distributors are required to offer their customers the possibility to purchase and install individual energy consumption meters at competitive prices, if installation of individual meters is technically feasible and financially profitable compared to the long-term estimation of energy savings, in the following cases:

- when the energy is delivered to the end customers without measurement in place,
- during the renovations of the building,
- during the reconstruction of a connection to power system.

Individual metering is required in new buildings.

The following secondary legislation has been adopted on the basis of the *Law on Energy Efficiency*:

- Energy Efficiency Action Plan of RS until 2018[81],
- Regulation on Energy Class of the Product[82],
- Regulation on Methodology of Costs Estimate for Energy Service Supply[83],
- Instruction for Preparing Annual Report on Implementation of Energy Efficiency Action Plan of Local-Self Governments[84],
- Operational Plan to Improve Energy Efficiency in Public Administrative Bodies.

3.5.3.8 Private Sector Involvement

In BiH and RS, private sector participation is regulated by laws governing foreign direct investments (FDI), concessions and Public-Private Partnerships (PPP), providing the possibility of private sector participation (both local and foreign legal entities) in the DH sector in BiH.

BiH has a dedicated law in place to support FDI - the *Law on the Policy of Foreign Direct Investment in BiH*[85], according to which foreign investors are entitled to invest, and to reinvest profits of such investments into any and all sectors of the BiH economy (with the exception of armaments and media, where foreign control is limited to 49%, there are no restrictions on investment).
At the level of RS, FDI are regulated by the *Law on Foreign Investments RS*[86], according to which foreign investors have the same rights and obligations as the residents of BiH and have the possibility to invest in many sectors (including the energy sector).

Various incentives for FDI are provided by the *Law on the Policy of Foreign Direct Investments of BiH*[87], as follows:

- national treatment of foreign investors, i.e., foreign investors have the same rights and obligations as residents of BiH,
- the import of equipment of foreign investors is exempt from paying customs duties (with the exception of passenger vehicles, slot and gambling machines),
- foreign investors are entitled to open accounts in any commercial bank in domestic and/or any freely convertible currency on the territory of BiH,
- foreign investors are entitled to freely employ foreign nationals, subject to the labour and immigration laws in BiH,

[81] *Ibid*
[82] Official Gazette of RS, No. 69/14
[83] Official Gazette of RS, No. 28/14
[84] Official Gazette of RS, No. 1/14
[85] Official Gazette of BiH, No. 17/98, 13/03 and 48/10
[86] Official Gazette RS No. 25/02, 24/04, 52/11 and 68/13
[87] Official Gazette of BiH, No. 17/98, 13/03, 48/10 and 22/15

- foreign investors are entitled to transfer abroad, freely and without delay, in convertible currency, proceeds resulting from their investment in BiH,
- foreign investors may own real estate in BiH,
- foreign investors enjoy the same property rights in respect to real estate as BiH legal entities,
- foreign investors are protected against nationalization, expropriation, requisition or measures having similar effects; such measures may take place only in the public interest in accordance with the applicable laws and regulations and against the payment of an appropriate compensation, i.e. compensation that is adequate, effective and prompt,
- rights and benefits of foreign investors granted and obligations imposed by this Law cannot be terminated or overruled by subsequent laws and regulations

Local and foreign legal persons may be granted concessions in RS. Concessions in RS are regulated by the *Law on Concessions of RS*[88], which regulates the subject, modalities and conditions of concessions and sets the conditions under which local and foreign legal persons may be granted concessions for providing infrastructure and services, as well as exploitation of natural resources, financing, design, construction, rehabilitation, maintenance and/or operation of such infrastructure.

According to this Law, the following may be the subject of concessions:

- construction and operation of power generation facilities with installed capacity over 250 kW, with the exception of energy facilities on biomass and bio-gas and solar plant with photovoltaic cells on buildings regardless of installed capacity,
- exploring and/or use of energy and other mineral raw materials,
- utilities, except for water supply, and construction, rehabilitation, maintenance and/or modernization of utilities,
- use of other goods of general interest and public services, in accordance with laws regulating that sector.

Concessions for construction or reconstruction of buildings, facilities or plants may be granted according to the Build-Operate-Transfer (BOT) model, which includes the construction or reconstruction and financing of the entire building, facility or plants, its use and passing the ownership to the concedent within the agreed timeframe or according to other models.

Public-Private Partnerships (PPP) are regulated by the *Law on Public Private Partnership of RS*[89]. PPP is a form of cooperation between the public and the private sector, achieved by pooling of resources, capital and expert knowledge, for the purpose of fulfilment of public needs. According to this Law, eligible public partners may be public enterprises or LSG units (such as municipalities or cities), whereas private partners local or foreign legal entities established in accordance with the laws of RS, selected through a negotiation procedure in accordance with the norms of international law.

The subject of a PPP may be construction, use, maintenance and operation, or reconstruction, use, maintenance and operation utility infrastructure, management of ecological and solid waste, and other fields of interest for RS and LSG units.

Agreements in the field of cooperation between the public and the private sector may take two basic forms:

- contractual form of PPP, where the partnership between the public and the private partner is based exclusively on contractual relations, or
- institutional form of PPP, where the partnership between the public and the private sector includes cooperation by the vehicle established for that purpose.

The PPP contractual forms also include concessions and private finance initiatives (in which the private partner finances, performs, maintains or manages a public facility for the public sector needs and its services are mostly paid by the public sector). Long-term service contracts, where the public sector provides only services, without the

[88] Official Gazette of RS, No. 59/13
[89] Official Gazette of RS, no. 59/09 and 63/11

capital investments of the private partner and contracts for design, construction and performance of the public sector, are not considered PPP contractual forms.

3.5.3.9 Permitting Procedures

The environmental permitting procedure in RS is regulated by the *Law on Environmental Protection*[90] and the *Regulation on Plants and Facilities that May be Constructed and Operated Only with a Valid Environmental Permit*[91], whereas other permits necessary for the construction of plants and facilities (Location Conditions, Construction Permit and Use Permit) are all regulated by the *Law on Spatial Planning and Construction*[92].

An overview of the mentioned permits is provided in the table below.

Table 21: *Permits in the Construction Process in RS*

Type of permit	Legal regulations in RS	Summary of legal requirements	Competence for issuing the permit
Environmental permit (EP)	• *Law on Environmental Protection* • *Regulation on Plants and Facilities that May be Constructed and Operated Only with a Valid Environmental Permit*	Activities and facilities with a potential environmental impact (due to their nature, size or location) require the preparation of an Environmental Impact Assessment and issuance of an EP. The Regulation provides a list of activities and industrial facilities subject to permitting procedures at RS level and at level of the LSG unit.	The Ministry of Spatial Planning, Civil Engineering and Ecology of RS issues the EP for thermal-power plants with thermal power with and over 10 MW. The authority responsible for environmental protection of the City of Banja Luka issues the EP for thermal-power plants with thermal power below 10 MW.
Location Conditions (LCs)	*Law on Spatial Planning and Construction*	A construction may be authorized if it is in accordance with the spatial planning documentation and other conditions laid down for that area by the LCs.	LCs are generally issued by the authority responsible for spatial planning of the LSG unit (in this case, the City of Banja Luka). However, for specific plants and facilities listed under the Law, LCs are issued by the Ministry of Spatial Planning, Civil Engineering and Ecology of RS upon a prior opinion issued by the City of Banja Luka, as follows: • facilities for the production of thermal energy - DH and other facilities regulated by specific laws, • energy and other facilities and plants for electricity production, except for solar installations with photovoltaic cells and other facilities using all forms of renewable energy with an installed capacity up to 250 kW.
Construction Permit (CP)	*Law on Spatial Planning and Construction*	The CP is not required for routine maintenance works and restoration of damaged constructions, which may be	The CP is generally issued by the authority responsible for construction works of the LSG unit (in this case, the City of Banja Luka).

[90] Official Gazette of RS No. 71/12 and 79/15
[91] Official Gazette of RS, No. 124/12
[92] Official Gazette of RS, No. 40/13

		considered as current maintenance works. The CP must be obtained for construction of an entire facility or part of the building that makes a technical, technological or functional unit.	However, the Ministry of Spatial Planning, Civil Engineering and Ecology issues CPs for facilities for the production of thermal energy - DH and other facilities regulated by specific laws, and for energy and other facilities and plants for electricity production, except for solar installations with photovoltaic cells and other facilities using all forms of renewable energy with an installed capacity up to 250 kW.
Use Permit (UP)	*Law on Spatial Planning and Construction*	A construction may be used only after obtaining a UP upon a technical inspection of the construction. The technical inspection must be performed within 15 days from the day the request for UP is submitted to the same authority which issued the Construction Permit. The request for the issuance of UP contains the documents listed in the Law, including the CP.	Same authority which issued the Construction Permit

Digging of public areas within the City of Banja Luka is regulated by the *Decision on Manner and Conditions for Digging of Public Areas of the City of Banja Luka*[93], according to which digging of public areas for the construction of underground installations may only be carried out in accordance with the Construction Permit, upon the consent of the City authority responsible for public areas. The request for the digging of public areas is submitted by the investor. The Decision contains a list of documents which have to be attached to the request for digging of public areas, including the Construction Permit. Digging of public areas for maintenance and repairs of existing underground installations may be carried out only upon the issuance of consent by the City authority responsible for public areas. The request for such consent is submitted by the owner of the underground installation. In case of emergency repairs of underground installations, the digging of public areas may be performed without obtaining such consent, upon a notification to the City authority responsible for the management of public areas.

In addition, a permit must be obtained for activities of waste incineration plants and waste co-incineration plants in which more than 50 tons of waste are annually treated, according to the *Regulation on Conditions for the Operation of Waste Incineration Plants*[94]. The permit is issued by the Ministry of Spatial Planning, Civil Engineering and Ecology of RS.

3.5.3.10 Brief Gap Analysis

- **There is no dedicated law at either BiH or RS level regulating the DH sector, i.e. the production, distribution and delivery of thermal energy.** DH operations are governed by various pieces of legislation on energy efficiency improvement, use of renewable energy sources, spatial planning and environmental protection. A dedicated law to regulate measures for safe and reliable production and delivery of thermal energy, the timeframes for installation of meters and the conditions for disconnection from the heating network and other issues is missing.

[93] Official Gazette of the City of Banja Luka, No. 5/06, 19/06 and 19/07
[94] Official Gazette of RS, No. 39/15

- **There is no adequate system of thermal energy calculation implemented, that would take into account both the fixed and the variable part of the thermal energy prices.** Even though such a system has been formally established by the *Decision on General Conditions for Delivery of Heat Energy* adopted by the Assembly of the City of Banja Luka, the system is not implemented in practice. The existing DH tariff system is composed only of variable costs, and as such is not efficient and sustainable.
- **Legal requirements on the introduction of individual metering are not fully implemented in practice** - billing is based both on metering (actual consumption) for some consumers (if there are technical requirements for the installation of consumption meters) and on floor area for others. The *Law on Consumer Protection of RS*[95] stipulates that energy supplied to customers should be metered, and not allocated on the basis of occupied floor area, and the *Law on Consumer Protection of BiH*[96] states that the supplied energy charges must be based on individual actual consumption calculated on the basis of consumers' meters. Furthermore, the *Law on Energy Efficiency of RS* requires the energy distributors to offer their customers the possibility to purchase and install individual energy consumption meters at competitive prices, if installation of individual meters is technically feasible and financially profitable compared to the long-term estimation of energy savings, in the following cases: when the energy is delivered to the end customers without measurement in place, during the renovations of the building, during the reconstruction of a connection to power system. Individual metering is required in new buildings.
- **There are no incentives for energy efficiency or renewable energy, with the exception of a feed-in tariff for electricity from renewable energy sources and limited resources provided by the Environmental Protection and Energy Efficiency Fund of RS** which serves as a financing facility for implementation of measures defined in the Energy Efficiency Action Plans (in accordance with the *Law on Energy Efficiency of RS*)**.** According to the Energy Sector Study in BiH, there are no elaborate mechanisms for collecting financial resources that would be used to finance the preparation, implementation, and development of energy efficiency and renewable energy sources projects. The absence of clear incentives for energy efficiency measures and of any obligation to perform energy audits do not provide an incentive for residential or commercial/industrial consumers to change their consumption behaviour towards a more rational use of energy or the deployment of renewable energy sources. In addition, there is no requirement to consider energy efficiency projects in public procurement processes (currently not foreseen in the *Law on Public Procurement of BiH*).
- The so-called **free rider problem** (i.e. the problem of those who benefit from the district heating system in Banja Luka without paying for such services) is not regulated by criminal legislation in RS. Heating energy theft is recognized as one of the critical issues for the sustainability of the DH system by the Company (as reported in its Business Report for the year 2015). Such cases include the arbitrary disconnection of individual consumers in buildings (in the past years, a large number of consumers[97] disconnected from the DH distribution network in the City of Banja Luka, thus utilizing the energy paid by the still connected consumers through transfer of heat through walls), the illegal reconnection of disconnected consumers, the illegal addition of ribs to radiators by consumers, and the practice of not reporting the actual total heating area.

3.6 General Assessment of DH Company

The district heating system in the City of Banja Luka was constructed in 1970, immediately after the devastating earthquake which destroyed much of the City. The Company was founded under the authority of the Reconstruction Directorate of Banja Luka with the aim of expanding the city heating system and increasing the

[95] Official Gazette of RS, No. 6/12
[96] Official Gazette of Bosnia and Herzegovina, No. 25/06
[97] In the period from 1995 to 2015, 7,891 consumers disconnected from the heating system, according to the Business Report of the Company for the year 2015.

installed capacity of boilers. Today, the Company has an installed energy of 248 MW and is the largest DH system based solely on fuel oil in RS and BiH.

In parallel with the expansion of industrial boilers, a primary hot water network was built with a length of approximately 45 km, and a secondary hot water distribution network from the substations to the end consumers, with a total length of about 110 km. Crude oil storage tanks were also built with a volume of 12,530 m^3 which can store up to 11.500t of heavy fuel oil, which helps maintain continuity in supply, production of sufficient quantities of energy and optimal interim supplies of fuel oil.

The Company was founded in 2003 with partial privatization of the state owned capital as a legal successor of the previous company "Toplana" Banja Luka. The majority owner of the Company is the City of Banja Luka with a total share of 77%. The ownership structure of the Company is described in the graph below.

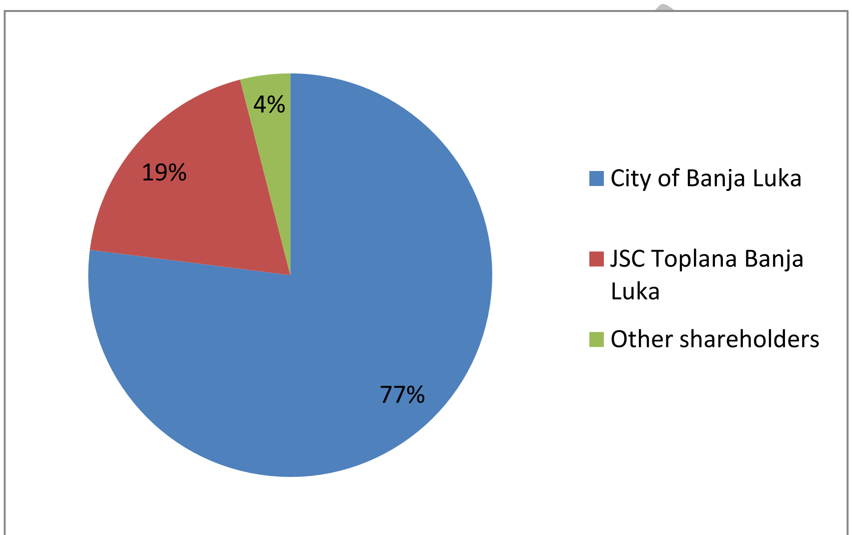


Figure 8: *Company Ownership Structure*

Organizational Structure

According to the Statute of the Company[98], the Company bodies are:

- Shareholders Assembly,
- Supervisory Board,
- Management (Managing Director and Executive Directors),
- Audit Committee

The organizational structure of the Company is given in the diagram below:

[98] Statute of "Toplana" Banja Luka

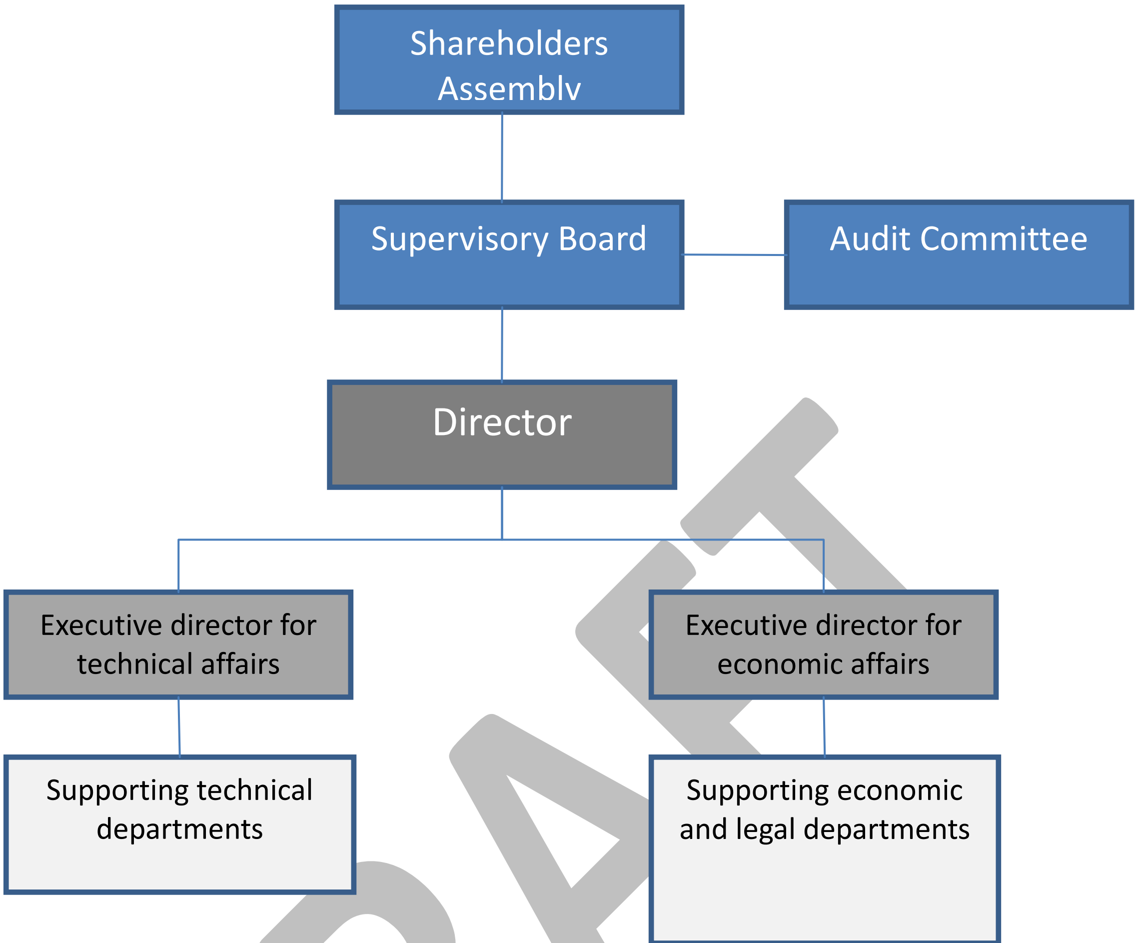


Figure 9: *Company Organizational Structure*

The responsibilities of the different management levels are summarized in the following table:

Table 22: *Responsibilities of Different Management Levels*

Managing authority	Jurisdiction
Shareholders Assembly[99]	Consists of all shareholders, and holds sessions once a year, with the following responsibilities: - Adopting statutory changes and changes in the legal form of the Company, - Approving the annual audited financial statements, - Adopting the annual business plan and investment program, - Appointing the Supervisory Board and Audit Committee, - Other responsibilities in accordance with the Law on Enterprises, the Law on Public Companies and the Statute.
Supervisory Board[100]	Consists of 5 members, who are responsible for, among other things: - Appointing the Management, - overseeing the work of the Management, - Monitoring the implementation of decisions adopted, - Adoption of guidelines on procurement and supervision of their implementation, - Making investment decisions in accordance with the Law and Statute.
Management[101]	Consists of the Managing Director and Executive Directors for the economic and technical

[99] *Ibid*.
[100] *Ibid.*

Managing authority	Jurisdiction
	affairs. Management is responsible for reporting to the Supervisory Board, lawful operation of the Company, the development and implementation of business plans and editing procurement procedure according to the law.
Audit Committee[102]	Consists of three members that are responsible to appoint an external auditor, to review the annual study of risk and audit plan, to report to the Supervisory Board on the implementation of recommendations from auditing reports, reports on financial operations of the Company and compliance with legal regulations. Audit Committee reports directly to the Shareholder Assembly.

The Company has 131 employees as of 31 December 2015 (according to the "Annual Report for 2015“[103]). The personnel qualification structure in the last four years is presented in the following table[104].

Table 23: *Personnel Qualification Structure*

No.	Qualification	Number of employees				Index		
		31/12/2012	31/12/2013	31/12/2014	31/12/2015	6/5	6/4	6/3
1	PhD	1	1	1	1	100	100	100
2	University degree	19	21	25	27	108	129	142
3	University diploma level	11	10	7	6	86	60	55
4	Vocational level	35	28	30	30	100	107	86
5	Higher qualified workers	58	55	51	48	94	87	83
6	Qualified workers	17	17	17	16	94	94	94
7	Unqualified workers	4	3	3	3	100	100	75
8	Total	145	135	134	131	98	97	90

Compared with the year 2012, the number of employees of the Company decreased by 14 in 2015. However, in 2014, the Company had 8 new jobs openings in the new biomass heating plants. Hence, the real number of employees at the end of 2015, compared to the end of 2012, decreased by 22. The number of employees based on work experience is presented in the following table[105].

Table 24: *Number of Employees by Work Experience as of 31 Dec 2015*

No.	Work experience	No. of employees	%
1	Up to 5 years	15	11%
2	From 5 to 10 years	9	7%
3	From 10 to 15 years	19	14%
4	From 15 to 20 years	23	18%
5	From 20 to 25 years	5	4%
6	From 25 to 30 years	8	6%
7	From 30 to 35 years	27	21%
8	From 35 to 40 years	25	19%
	Total	**131**	**100%**

As shown in the table above, 19% of workers will retire in the period from 2016 to 2020.

[101] *Ibid.*
[102] *Ibid.*
[103] Business Report for 2015 – “Toplana” Banja Luka
[104] *Ibid*.
[105] *Ibid*.

The average age of employees is 46.3 years, while 49% of workers are over 50 years of age. An overview of the age structure of employees is provided in the following table[106].

Table 25: *Age Structure of Employees*

No.	Age	Number of employees	%
1	<25	1	1%
2	25-29	8	6%
3	30-34	17	13%
4	35-39	16	12%
5	40-44	13	10%
6	45-49	12	9%
7	50-54	24	18%
8.	55-59	30	23%
9	60-64	10	8%
	Total	**131**	**100%**

3.6.1 DH System Analysis

3.6.1.1 Customers and Market

In 2015, the Company had 20,025 customers, out of which 946 were business customers and 18.359 were residential consumers. Bills for all business customers are calculated based on heat consumption in MWh consumed. With regard to residential customers, 4.277 households were billed based on actual consumption, whereas the remaining 14.082 were billed per square meter[107].

Table 26: *Number of Customers in the Period 2011-2015*

No.	Description	2011	2012	2013	2014	2015
1.	Business customers MWh	1,039	1,038	1,450	918	946
2.	Residential customers MWh	1,938	2,677	3,130	3,654	4,277
3.	Residential customers m^2	20,034	19,067	17,140	16,016	14,802
	TOTAL	**23,011**	**22,782**	**21,720**	**20,588**	**20,025**

The total number of residential users has been decreasing continuously over the last years by 3.4%/year in average. The number of users invoiced for actual consumption of heat is increasing every year for about 17.75% compared to the same category of users in the previous year. On the other hand, the number of users paying per m^2 of area is continuously decreasing for 7.27% in average compared to the same category of users in the previous year. This trend implies that those users billed per m^2 of area keep disconnecting due dissatisfaction with the price/quality ratio. On the other hand, users billed per actual consumption appear to be satisfied with the price/quality ratio. Number of commercial users is relatively stable, with slight increase in 2013, following by the decrease in the following year.

[106] *Ibid.*
[107] *Ibid.*

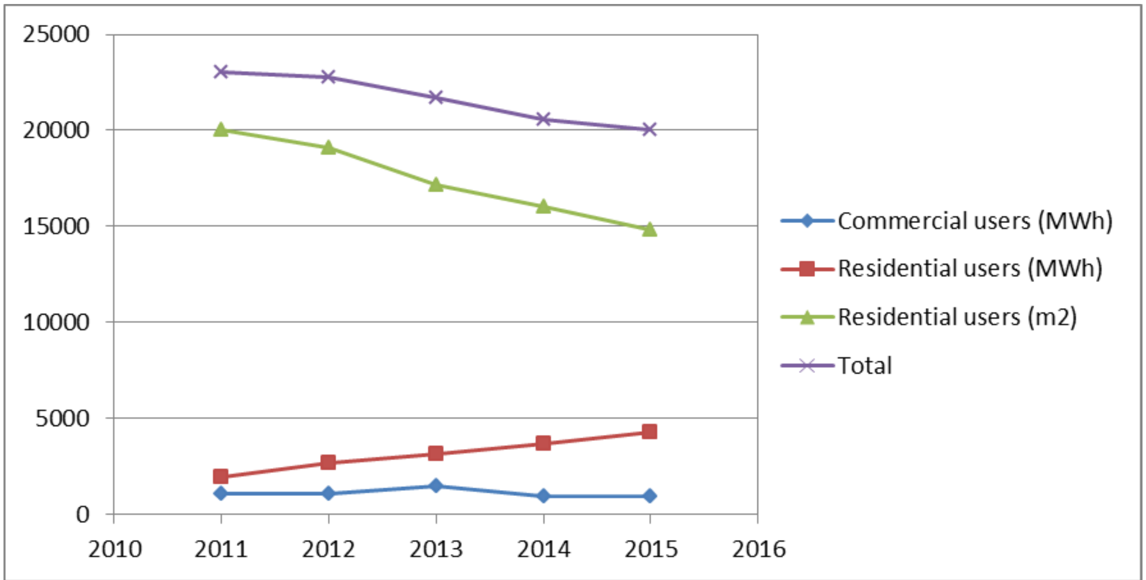


Figure10: *Number of Users in the Period 2011-2015*

Total space (commercial and residential) supplied with heating by the Company is currently 1,423,710 m^2 (December 31st 2015). Out of the total area, commercial space takes up 416,000 m^2, and residential space occupies 1,007,710 m^2.

The following table shows an overview of the total heated space by the Banja Luka DH system. The heat demand was calculated based on the age of the heated buildings, state of their thermal insulation and climate conditions.

Table 27: *Heated Space and Heat Demand*

Description	**Heated space** m^2	**Heat demand** kW
Residential space	1,007,720	98,608.39
Commercial space	416,000	48,848.20
Total	1,423,720	147,456.59

Therefore, current heat demand can be calculated at 147.45 MW in total, which corresponds to 103.57 W/m^2 or 114.12kW/m^2. For such a quality of the buildings' envelopes, typical average annual heat demand per reference area varies between 140 and 270 kWh/m^2. These figures show that comfort in the heated buildings is inappropriate or the inner temperature in the buildings is lower than required.

The following Figure shows the heat demand for Banja Luka DH system for 2015.

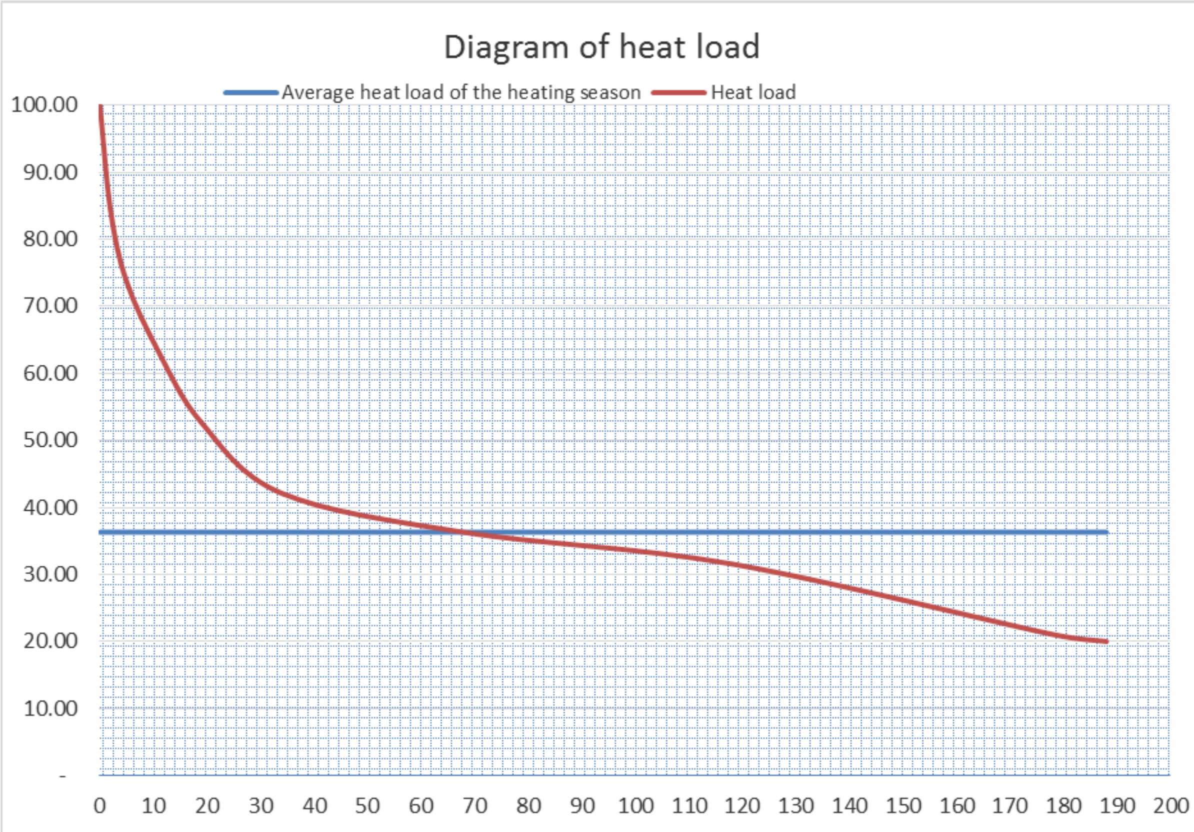


***Figure 11:** Heat Demand Curve for Banja Luka DH System for 2015*

Average load during the heating season amounts to 36.29% which corresponds to 68.22 days. It is evident that the installed capacity of 248 MW is considerably higher than current needs and total needed capacity at -8°C outer temperature is met by two boilers from the central heating plant. Out of four installed boilers, two of them are unused and function as spare boilers.

Prices of heating for the period 2006 -2015 are presented in the following table[108].

***Table 28:** Heating Prices in the Period 2006-2015*

No.	Customers	Price on 1 Jan 2006 (VAT incl.)	Price on 1 Jan 2011 (VAT incl.)	Price on 1 Aug 2015 (VAT incl.)
1	Residential customers m^2	1.35	1.65	1.65
2	Residential customers MWh	-	133.82	133.82
3	Business customers MWh	109.69	133.82	199.64

Since the majority of customers do not have installed calorimeters for measuring their monthly heat consumption, the annual amount of heat energy supplied to customers was estimated. The following table shows the distribution of heating energy consumed by customer's categories[109].

***Table 29:** Overview of Distribution of Heating Energy by Customers*

No.	Year	Estimated amount of	Consumption in MWh

[108] *Ibid.*
[109] *Ibid.*

		heat energy supplied to consumers per MWh	Individuals – per m² estimated in MWh	Individuals – per MWh (measured)	Legal entities – per MWh (measured)
1.	2012	189.368	137.732	8.584	43.052
2.	2013	182.857	133.097	10.213	39.548
3.	2014	149.523	107.505	9.145	32.873
4.	2015	168.205	115.333	15.454	37.418

In the period from 1996 to 2015, 7,891 customers disconnected from the DH system. Although official data on the reasons for disconnections do not exist, it may be assumed that the reasons for disconnection from the DH system are predominantly related to the price and the quality of heating provided by the Company. The majority of disconnected customers switched to electrical heating sources including electric convectors. According to the Company's Annual Report for 2015, a significant number of disconnected customers are illegally accessing the heating system of the Company. According to the Report, this and other types of heat theft reduce the revenues of the Company by 3,000,000 BAM per year.

3.6.2 Linear Heat Density

With 171 km of total pipeline length and 170 GWh annual heat sale[110], the linear heat density is calculated to approximately 0.99 MWh/m. Apart for the Prijedor DH system, there are no data available on linear heat density for other district heating systems in BiH. Hence, the calculated values for Banja Luka have been compared to district heating networks in Serbia, with equivalent climatic conditions, and with some district heating networks in Sweden, given in the following Table.

Table 30: *Comparison of Linear Heat Density between Banja Luka and Relevant DH Networks*[111]

City	Heat sales (GWh/year)	Linear heat density (MWh/m)
Banja Luka	170	0.99
Prijedor	46	1.74
Available data on linear heat density for cities in Sweden		
Ulricehamn	46	3.83
Höganäs	45	4.74
Emmaboda	47	1.48
Lerum	48	4.19
Simrishamn	46	3.83
Available data on linear heat density for cities in Serbia		
Čačak	65	2.70
Subotica	92	3.40
Valjevo	43	1.80

With a heat density of 0.99 MWh/m the system in Banja Luka is considered to be quite unsustainable for district heating. Anyhow, given the fact that many former customers have been disconnected and that preliminary investigations indicate a substantial potential for new connections to the district heating system, residential buildings as well as commercial buildings within the limits of the existing network, an increased heat density is considered feasible. As a comparison, Prijedor DH system with 1.74 MWh/m is considered to be on the margin of sustainability. In Sweden the heat densities are generally decreasing, since district heating companies find it more and more feasible to connect buildings with low heat demand located far from the production sites. The average value for heat density in Swedish district heating networks is 2.88 MWh/m.

[110] Source: Toplana Business Report 2015
[111] Source: Swedish Energy Markets Inspectorate and Gradiška DH Feasibility Study, Final Report 12 July 2013

3.6.3 Other Heating Options in the City

As stated previously, the DH system covers only a part of the city. There is a significant number of residential buildings as well as commercial and public buildings not connected to the current district heating network, in the current service area for district heating as well as outside of the area.

At this stage, no detailed analysis has been made regarding alternative heating most frequently found in the city. However, given the experience from other cities in the country it can be assumed that firewood is frequently used for heating, both in separate one family houses as well as for residential buildings. Coal is much less represented in Banja Luka compared to other cities in the region.

Another heating option that seems to be relatively frequently used is heating based on electricity. As DH does not provide heating for preparation of domestic hot water it is considered natural that electricity in great extent is used for this purpose in electric water heaters. However, electric devices are also used for space heating.

Based on information obtained on fuel prices, firewood is around 70-80 BAM/mp[112], pellet is around 260-310 BAM/t, briquette is 140-180 BAM/t (although there is a slight data deviation which shows that briquette is priced up to 300 BAM during winter time) and coal from Stanari coalmine has general prices amounting to 115-130 BAM/t. This data tends to disregard influence of black market, which offers some fuels for a lower price.

Table 31: *Energy Prices in Banja Luka, VAT included*

Fuel	Price	Price per energy (average)
Firewood	70 – 80 BAM/mp	53.00 BAM/MWh
Pellet	260 – 310 BAM/t	67.00 BAM/MWh
Briquettes	140 – 180 BAM/t	46.00 BAM/MWh
Electric energy (households) – HT[113]	126.71 BAM/MWh	126.71 BAM/MWh
Electric energy (households) – LT[114]	63.30 BAM/MWh	63.30 BAM/MWh
Coal – lignite Stanari	115 – 130 BAM/t	47.00 BAM/MWh

The table indicates that one of the cheapest thermal energy sources is coal. However, coal is also the greatest source of pollution.

Comparing these prices with the current heat tariff for household customers billed per actual consumption, as the largest category with the lowest billing price, in the amount of 133.82 BAM/MWh, DH has the highest price of energy, 2.9 times higher than the energy from briquettes or coal, or 2.1 times higher than low tariff electric energy. Considering the price of heat billed per m^2 of living area in the amount of 1.65 BAM/m^2 billed all year long, and taking into account an average household with an annual thermal energy needs of about 100 kWh/m^2, the situation is even worse with the price of energy going up to 198 BAM/MWh.

3.6.4 Heat Generation

Central heating plant provides heat supply to largest part of the city. Heating plant installation consists of four equal hot water boilers “VKLM 50” produced by "TPK" Zagreb, with the capacity of 58 MW each. Each boiler is equipped with a burner “SKV 300” 3,000 kg/h HFO capacity. The plant contains a smoke damper to which the flue gas channels are connected. Total heat output provided by the central heating plant is assumed to about 129,75 MW.

In 2014, three biomass (wood chips) boilers were additionally installed in two plants with a total capacity of 16 MW. Heating plant Starčevica contains two boilers of 6 MW and 4 MW capacity providing heat for about 12 MW

112 1 m3 = 1,5 mp

113 HT – high tariff, 6 am to 10 pm

114 LT – low tariff, 10 pm to 6 am

demand. Heating plant Kosmos has one boiler of 6 MW capacity providing heat for 5.7 MW demand. These heating plants serve about 12% of the total DH system heat demand.

There is no exact information on the total heat demand. It can only be assumed based on the total heating space, age of buildings, their state etc. The location of the heating plant in the city is given in the following map.

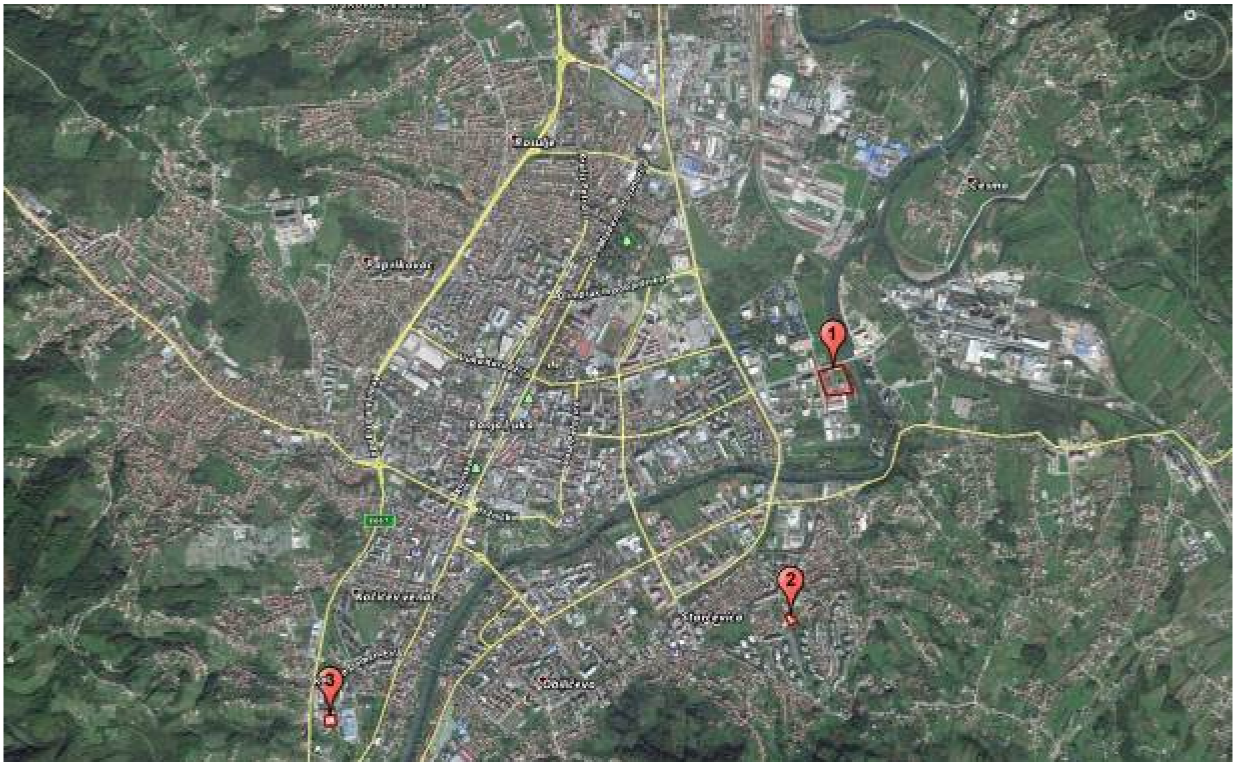


Figure 12: *Heating Plants Located in the City of Banja Luka*[115]

The equipment layout in the central heating plant is such that all boilers are aligned in parallel next to each other at a prescribed distance. In addition to the boilers, the heating plant also includes a system for maintaining the pressure in the hot water system, collectors, circulation pumps of the first and second degree, as well as two chimneys located outside the heating plant. Chimneys are arranged between two boilers each so that flue gases from two boilers are led into each of the chimneys. The connection between the chimneys and the boilers is made of metal sheet ducts. For the smooth operation of the boilers, the air is inserted into the plant through fans and air chambers. In order to avoid cold air into the plant, the air is treated (heated and filtered) in the air chamber.

The central heating plant also includes an appropriate system for maintaining the pressure in the heating system consisting of two open containers, centrifugal pump and associated metal framework and automation needed for smooth operation. Water treatment (chemical treatment) is located in a separate room within the plant. Two collectors are installed for proper distribution of the hot water in the heating plant, whose role is to collect the hot water from the boilers and transfer it to the distribution system (three branches - three hot water pipelines).

In order to analyse the heating plant equipment, appropriate description of each element within the central heating plant installations is given below.

[115] 1. Central heating plant – installed power of 232 MW, heavy fuel oil fired
2. Heating plant Starčevica – installed power of 10 MW, wood chips (biomass) fired
3. Heating plant Kosmos – installed power of 6 MW, wood chips (biomass) fired

3.6.4.1 Central Heating Plant Boilers

Central boiler house in Banja Luka was built in 1972, when the first boiler of 58 MW was installed. Other boilers were installed in 1975, 1979 and 1985 respectively. The boilers and most of the installed equipment are between 31 and 44 years old. This means that the equipment and devices are in operation longer than the standard average lifetime for this type of equipment. The technology in the boiler house corresponds to the period of 70's and 80's of the last century, impacting the efficiency of individual equipment and devices, and overall energy efficiency of the system.

Hot water boiler "VKLM 50", 58 MW capacity, is designed to work on heavy fuel oil (HFO). Its operation is based on overpressure, thus avoiding flue gasses fan installation. The required waterproof performance was achieved by a membrane design.

Fuel oil burners are installed at the boiler forehead, enabling optimal flame configuration. The flame flows through the boiler body, and then through an economizer located in the boiler extension. The economizer is designed in two packages of pipes forming vertical curtains horizontally connected with larger diameter pipes.

Therefore, flue gasses resulting from the combustion in the boiler are transported through the boiler, economizer and thin sheet channels system to the chimneys, and then into the atmosphere.

The water circulation through the boiler takes place uniformly. Water drain from the boiler and its venting are performed at the connection point of the piping system and a collector. In order to avoid a deformation of the boiler walls due to the excess pressure and thermal dilatations, reinforcement of steel profiles is placed around the boiler. The boiler is insulated with glass wool inside aluminium thin sheets.

The boiler consists of:

- drums,
- collectors,
- economizer pipes,
- boiler screen,
- steel boiler construction,
- outer boiler shell,
- rough metal framework,
- fine metal framework,
- boiler insulation walling,
- flue gas channels and
- galleries and stairs.

The boiler is made of four drums built from boiler steel with the dimensions of Ø600 x 16 mm. Collectors at the boiler are made of seamless pipes with a diameter of Ø219 x 12.5 mm. The economizer is made of Ø57 x 3.2 mm pipes vertically connected to the drums to form the curtain and so called economizer packages which are freestanding. Boiler screens are made of membrane walls formed by the seamless pipes Ø57 x 4.0 mm with a thread of 75 mm welded into the collectors. Steel construction made of rolled profiles in ring shaped welded version is built around the screen walls and lateral walls of economizer. All rings are welded to the ribs which are previously welded to the pipes forming the lateral boiler walls. Outer shell is also built from the outer side of the steel profiles, which is demounting at lateral sides. The shell is on the lateral sides made of aluminium plasticized sheet, whereas the shell made of steel sheets of 2.5 mm thickness is placed at lower and upper sides.

Fine framework contains:

- shutter on hot water supply and return pipeline DN 300 NP 16,
- fittings for venting the boiler,
- transit valves for collectors discharge,

- safety valves,
- measuring framework (manometers and thermometers) and
- measuring absorber.

The boiler insulation is made of special glass wool pillows located behind the welded boiler walls. Insulation thickness is about 100 mm, and between the insulation and the shell is an air layer. The collectors placed in fire are insulated by a special fireproof compound in order to protect them from the flue gasses.

The smoke damper is placed at the exit of flue gases from the boiler. Flue gas channels connected to the chimney are superimposed to this damper. Flue gas channels are made of steel sheets thermally insulated by the glass wool inside the aluminium sheets.

Figure 13: *Chimney Channels*

Figure 14: *Chimneys*

The boiler is equipped with a combustion device consisting of a burner and ignition and control device. Each boiler is equipped with two burners built at the boiler forehead. The burners are “SKV 300” produced by SAACKE, intended for combustion of heavy fuel oil.

Each burner has a capacity of 3,000 kg/h HFO heated up to 100°C, with 6-8 °E viscosity. HFO pressure in front of the burner amounts to 3 bars. The burner is designed in the way that the oil is sprayed by the rotation. Regulation range is 1:5. Ratio of the air quantity to the fuel quantity is constant due to continuous regulation.

Operation of the boiler is driven by the controller which, depending on the temperature of hot water at the boiler outlet, regulates the air and fuel quantity. The fuel flow meter is installed at the fuel inlet. For the smooth operation of the boiler, it is necessary to provide a sufficient air quantity with specific parameters. The equipment by which the air supply is prepared comprises:

- hot water air heater and
- fan for air supply to the heating plant.

__Figure 15__: Air Fan

__Figure 16__: Hot Water Air Heater

Combustion air temperature needs to be at a minimum of 20° C. Air supply and treatment (heating and filtering) is carried out via hot water heaters of 254 m^2 heating surface. The required overpressure is achieved by fan sucking the air from hot water heater and blowing it in the heating plant next to the burner.

Fans are of "NXVs-15,65 E66/C 107" produced by Juvent Zagreb, with 85,000 m^3/h capacity and 250 kW electro motor power.

Main technical characteristics of the hot water boiler are shown in the following table.

***Table 32:** Main Technical Characteristics of VKLM 50 Hot Water Boiler in Central Heating Plant*

Boiler VKLM 50		
Boiler capacity	58	MW
Water flow amount	1,250	m^3/h
Intel water temperature	90	°C
Outlet water temperature	130	°C
Concession pressure	25	Bar
Water pressure drop in boiler	1.5	Bar
Firebox heating surface	159	m^2
Boiler heating surface	1,450	m^2
Firebox dimensions	3.675 x 5.475 x 8.00	M
Firebox volume	161	m^3
Theoretical combustion temperature	2,034	°C
Firebox outlet temperature	1,100	°C
Economizer outlet temperature	220	°C
Firebox overpressure	140 (1,373)	mmH_2O (Pa)
Air fan		
Maximum amount of air	85,000	m^3/h
Maximum static overpressure	6,500	Pa
Air temperature	20	°C
Effective power	250	kW
Burners		
Capacity per burner	3,000	kg HFO
Capacity per boiler	6,000	kg HFO
HFO lower calorific value	39,775	kJ/kg
HFO temperature	100	°C
Efficiency at 58 MW	90	%
Efficiency at 29 MW	91	%
Circulation water quality		
Appearance	clear and colourless	

Total hardness	max 0.1	°D
Iron content	max 0.05	mg/l
Copper content	max 0.01	mg/l
Oxygen content	max 0.05	mg/l
pH value measured at 20 °C	9.0 – 10.0	
KM_2O_4	< 10	mg/l
Oil	< 1	mg/l
P_2O_5	15 - 10	mg/l
Hydrazine excess	1 -2	mg/l

Nominal installed capacity of the central heating plant totals to 4 x 58 MW = 232 MW. The first boiler was put in operation during 1972, the second boiler during 1975. Remaining two boilers were put into operation during 1979 and 1985, respectively. These boilers are 30-45 years old. Due to a history of poor maintenance and lack of modernization, they work with lower level of production efficiency compared to the declared or usual efficiency levels of boilers. This results in higher costs, increase in CO_2 and other pollutants. Possible replacement of these boilers is desirable. However, due to the financial situation on the Company, it would be unrealistic to expect their replacement, however continuous repairs should be considered in order to extend their lifetime as much as possible.

In the years since the boiler plant was commissioned, emergency replacement of some worn out vital parts of boilers (screen and economizer packages) was carried out.

Identified deficiencies in the central heating plant:

- Even though during last heating season there was no significant interruption in production and delivery of thermal energy from the boilers, nor did the Company receive significant complaints on the quality of service provided, the exceeded lifetime of the boilers does not provide sufficient guarantees for the provision of safe basic functions of thermal energy production in the longer period;
- Annual costs of boiler unit repairs and costs of replacement of their vital parts are extremely high;
- Substitution of certain vital parts of the plant, as well as the elimination of defects as a result of leakage, is performed if necessary, and not for preventive maintenance purposes;
- Existing burners are single-stage burners not allowing modular management of the operation, working only at full load. In this way, the overall efficiency level of assembly boiler-burner is far lower than assembly with modern technological solution, fuel consumption is higher, and thus there are higher emissions of harmful gases;
- On the basis of the estimated heat demand, two boiler units in the central heating plant are sufficient for the functional operation of the district heating system in almost the entire period of heating, while two boiler units are on stand-by regime;
- Regulation of hot water supply temperature according to the outside temperature is not performed automatically;
- Heavy fuel oil with 3% sulphur content is used as a primary energy source, which adversely affects the quality of the combustion products and exhaust gases and causes atmospheric pollution. Also, high percentage of sulphur increases the possibility of creating significant amounts of sulphuric acid, which damages boiler walls;
- Since the installed equipment and technical solution in the plant is obsolete, the problem of substantial energy consumption for the heavy fuel oil preparation (electricity and heating media) is emphasized;
- Air supply ventilators used for combustion are extremely high power (250 kW) engines without frequency regulation;
- Circulation pumps in the heating plant (main pumps through which the circulation of the entire hot water system is ensured) are installed. Total installed capacity of the pumps is 1915 kW, and the power of each largest engine (2 pieces) is 560 kW. All pumps are equipped with motors without frequency regulation, most of which were installed between 30 and 44 years ago. All pumps operate with constant flow;

- All oil pumps are equipped with conventional electric motors. There is no frequency regulation, and the power consumption is high;
- Other installed parts, equipment and devices are generally outdated;
- Existing insulation of pipelines and equipment is mainly in line with the standards of the old installations, which affects the high temperature area in the boiler house, and increases heat losses and costs of energy;
- Boiler plant does not work automatically, since there is no system for automatic operation of the plant;
- There are no heat meters installed in the heating plant, hence the exact amount of produced thermal energy cannot be determined. Heat energy produced in the boilers is estimated indirectly on the basis of annual heavy fuel oil consumption;
- Considering that neither the heat energy meter nor balance valve are installed, the exact flow in the main branch of hot water system cannot be determined;
- There is no equipment for continuous measurement of important products of combustion on the boilers;
- There are no centralized data on management, control and monitoring of the system.

3.6.4.2 Biomass Boilers

In order to achieve proper functioning of the district heating in the City of Banja Luka, additional two heating plants were introduced: Starčevica and Kosmos. They are located in peripheral, remotest parts of the city.

Heating plants consist of two boilers in Starčevica and one boiler in Kosmos plant, fired with biomass (wood chips), with all associated equipment on the fuel dosing and flue gasses sides, two heat storage tanks of 50 m^3 capacity, expansion module, circulation pumps and associated fittings. Temperature regime of warm water network operation is 90/70ºC.

***Figure 17**: Biomass Boilers*

The boilers are designed as hot water boilers with biomass (wood chips) used as fuel. All electrical equipment is based on 400/230 V, 3-phase, 50 Hz.

***Table 33:** Main Technical Characteristics of Biomass Boilers*

Capacity	6	4	MW
Max working pressure	10	10	bar
Temperature regime	110/90	110/90	°C
Boiler efficiency for 35% fuel moisture	91	91	%
O_2 content (dry gasses)	6	6	%
Solid particles emission	max 20 mg/Nm^3 for 11% CO_2		
NO_x emission	max 250	250	mg/MJ
CO emission	max 150	150	mg/MJ
Fuel	wood chips, crust, sawdust, pieces		

Sawdust content, max	8	8	%
Fuel moisture, guaranteed value	20-50	20-50	%
Fuel moisture, max	55	55	%
Fuel moisture, min	20	20	%
Lower calorific value	1.75	1.75	MWh/t
Fuel density	250-400	250-400	kg/m^3
Ash content	normally 1-3%, max periodically 6%		
Ash melting point	> 1200	> 1200	°C
Annual plant utilization	> 97	> 97	%
Ratio of regulation in modulating operation	30-100	30-100	%
Noise level, max, at 1m from the source	80	80	dB(A)

The boiler insulation consists of mineral wool of 150 mm thickness on a wire mesh. The maximum temperature of the contact surface is 60°C. Rough metal framework consists of control and inspection openings with lids, devices for combustion monitoring (with fire clay lining and window glass) and a boiler plate. For the purpose of access to the valves on boiler, considering the boiler height, a platform exists for servicing. It consists of load-bearing steel profiles, floor grids and protective fence.

Figure 18: *Equipment in the plant*

The expansion in the substations is still performed through the expansion modules which are an integral part of the substation installations. These expansion modules have been reconstructed and modernized. Filling up the system by chemically prepared water is carried out from the central heating plant, through the hot water network and existing expansion modules in the substations. The following Figures provide an overview of equipment within the heating plants.

Figure 19: *Platform with Expansion Modules and Circulation Pumps*

Figure 20: *Main Circulation Pumps*

It may be concluded that the heating plants Starčevica and Kosmos are constructed according to the latest standards and their operation is automatic. They only require regular inspection and maintenance.

3.6.5 Fuel Supply and Fuel Handling

Main heating plant boilers use heavy fuel oil as the energy source, while two plant boilers use wood chips. Their main characteristics are given below.

3.6.5.1 Heavy Fuel Oil (HFO)

Two burners with a capacity of 3000 kg/h are installed on one boiler for the combustion of fuel oil, heated to about 100 °C and with viscosity of 6-8 °E. The pressure of fuel oil in front of the burner is 3 bars.

Given that four boilers are installed in the heating plant, the required amount of fuel is 4 x 2 x 3,000 kg/h = 24,000 kg / h, provided that all boilers operate at maximum capacity.

The quality of the fuel oil used in the central heating plant is verified by the Quality Control Laboratory "Polysan" from Bulgaria. .

Table 34: *Main Characteristics of Fuel Used in Central Heating Plant in Banja Luka (Jan 19, 2016)*

Flash point in a closed container	110	°C
Viscosity at 100 °C	17,05	St
Density at 15 °C	1.002	g/ml
Sulphur content	0.762	%
Ash content	0.014	%
Water and precipitation content	0.0	%
Carbon residue	11.21	%
Lower calorific value	40.89	MJ/kg

HFO installation consisting of the following parts:

- storage tank,
- pumping facility,
- pouring point and
- pipeline.

Aboveground steel tanks are installed for storage of liquid fuel. Heavy fuel oil is stored in 3 fuel tanks with a total volume of 12,750 m^3 (11,850 tons of HFO), which is equivalent to about 3 months of consumption during the heating season. Fuel oil is supplied by tankers to the oil storage tanks. The capacities of the above ground storage tanks are approximately:

- 10000 m^3,
- 2200 m^3,
- 500 m^3.

The tanks are all of a similar construction being cylindrical in shape and made of steel. All appear to be in a reasonable state of repair. Although there is some discoloration of the outer covers, visual inspection of the tanks and of their foundations did not reveal any signs of distortion, cracking or subsidence.

Annual theoretical maximum consumption of fuel oil with currently applicable design conditions and maximum installed capacity of 232 MW, with the designed boiler efficiency of 90 % and the specific weight of fuel oil of 860 m^3/kg, amounts to 23,844.52 tons, so that the required volume of the storage tank on annual basis is 27,726.19 m^3. Therefore, considering the total capacity of the storage tanks, the fuel oil is being supplied twice during the heating season.

Tanks are equipped with heating, connections for charging, venting (AT-valves or respiratory valves installed on the tank roof), filling level measurement, connections to the suction and return line and other equipment necessary for smooth operation. In addition, the tanks are supplied with installations for cooling the roof and the shell, as well as an installation of fire extinguishing by heavy foam.

There is no bund built around the reservoirs. The ground on which the reservoirs are located is recessed to the surrounding by approximately 1.0 to 1.2 m. The tanks are thermally insulated at the time of installation. The tank of 10,000 m^3 volume has its insulation renewed. The following figures show the reservoirs with a fixed roof, with the capacity of 10,000 m^3 and 2,200 m^3.

Figure 21: *Aboveground HFO Tank with 10,000 m^3 Volume, Thermally Insulated*

Figure 22: *Aboveground HFO Tank with 2,200 m^3 and Old Thermal Insulation*

The following figures show the substation for heating the tanks.

Figure 23: *Circulation Pumps in Substation for HFO Tanks Heating*

Figure 24: *Splitter and Collector Located Beside HFO Tanks in Substation*

Figure 25: *Wood Chips Stored in Regional Heating Plants*

Quantity of wood chips consumed in 2015 was 15,380 tons (equivalent to 3,400 tons of HFO).

The fuel is deposited in the storage rooms with dimensions of 12.5 x 13.0 m, with masonry construction, in which floor pushers are installed for each boiler separately. Wood chips are transported from these storages by automatic dosing to boiler rooms, through the metering equipment.

Figure 26: *Wood Chips Dosing System*

Figure 27: *Multicyclone*

3.6.6 Heat Distribution Network

Hot water thermal power lines network in Banja Luka consists of three main lines connected partly into a ring. The ring consists of main heat source (central power plant) and two regional power plants. Pipelines of all three main lines are laid mostly underground, using concrete trenches. Over the rivers they are led aboveground, using appropriate frames below bridges.

The layout of the district heating is given in the following map:

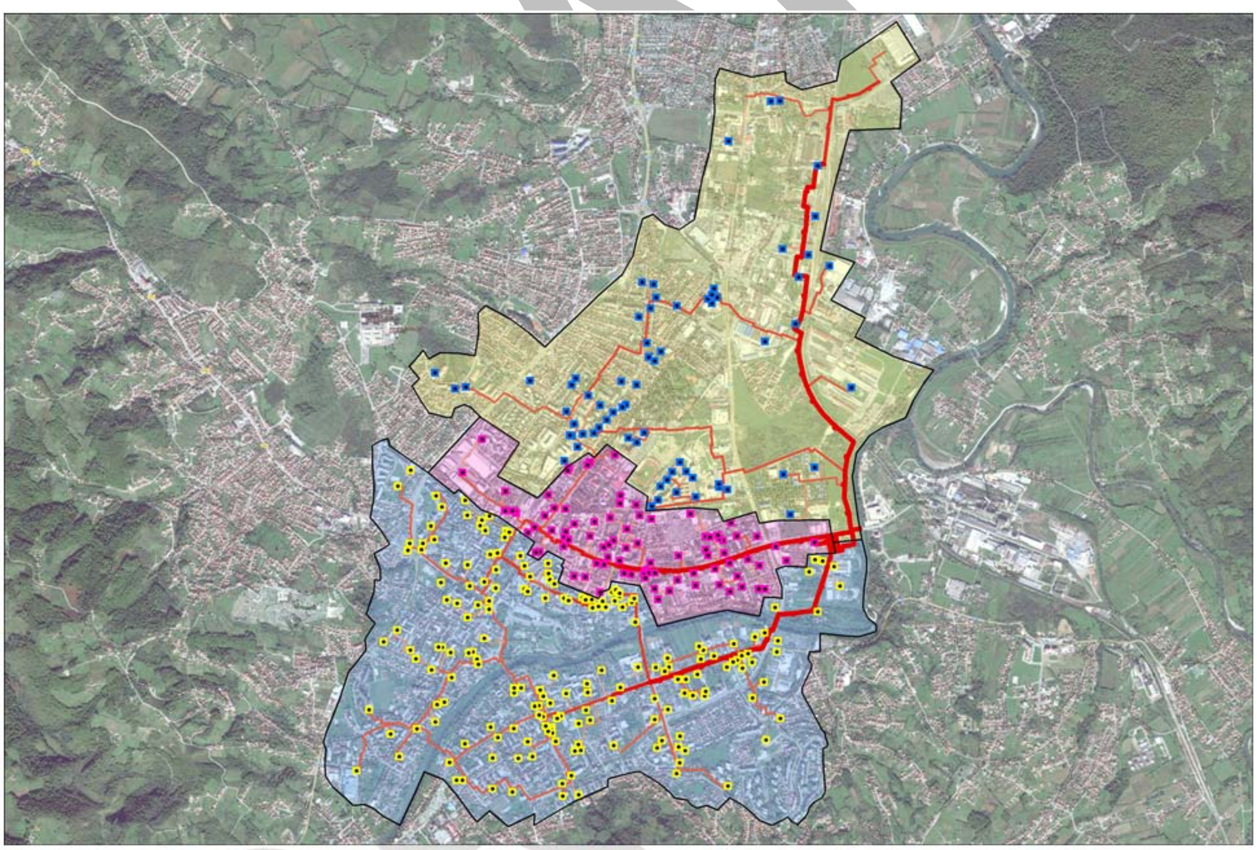


Figure 28: *Banja Luka District Heating Network*

Hot water network consists of three main pipelines:

- First main pipeline “Borik”, heating plant – Paprikovac, covers 0.95 km^2, pipe length 9.28 km,
- Second main pipeline “Vrbas”, heating plant – Starčevica, Obilićevo, Kočićev Vijenac, covers 4.96 km^2, pipe length 27.24 km,
- Third main pipeline “Industrija”, heating plant – industrial zone “Jelšingrad”, Nova Varoš, Krajina, Campus, covers 4.79 km^2, pipe length 19.46 km.

***Table 35**: Distribution of Dimensions and Lengths of Primary Pipelines*

DN	„Borik“ line	„Vrbas“ line	„Industrija“ line	Total
500	1,866.18	2,013.77	3,208.76	7,088.71
400	452.92	269.40	-	722.32
350	177.19		792.35	969.54
300	109.30	2,086.72	-	2,196.02
250	-	610.05	5,384.02	5,994.07
200	578.14	12,017.01	3,943.13	16,538.28
175	261.28	43.05	420.64	724.97
160	-	98.53	-	98.53
150	1,845.68	2,210.16	1,246.44	5,302.28
125	773.90	2,007.18	1,205.04	3,986.12
100	1,188.12	1,582.32	326.56	3,097.00
80	1,136.45	2,137.82	1,656.99	4,931.26
Total	**8,387.16**	**25,076.01**	**18,138.93**	**51649,10**

The total length of primary pipelines is approximately 52 km. The total length of the secondary network is taken from the Company Business Report 2015, and amounts to 115 km of pipelines. Therefore, the total length of pipelines adds up to 171 km. The first main hot water pipeline “Borik” starts from the central heating plant. It is laid along a main street through Borik, and then along the main street through Nova Varoš, ending in neighbourhood Paprikovac. Lines for heat transmitting stations (primary to secondary media) are separated from the main pipeline along its route. In Nova Varoš, the pipelines are connected into a ring.. Each part of the pipeline within the ring part of the grid has valves and fittings used for separation of pipes, enabling uninterrupted functioning of the system. This part of the City has undergone a population increase and therefore its heat demand has been increased. Hence, the original pipeline of 500 mm has been increased to 600 mm during reconstruction. The following figure shows the main hot water pipeline “Borik”.

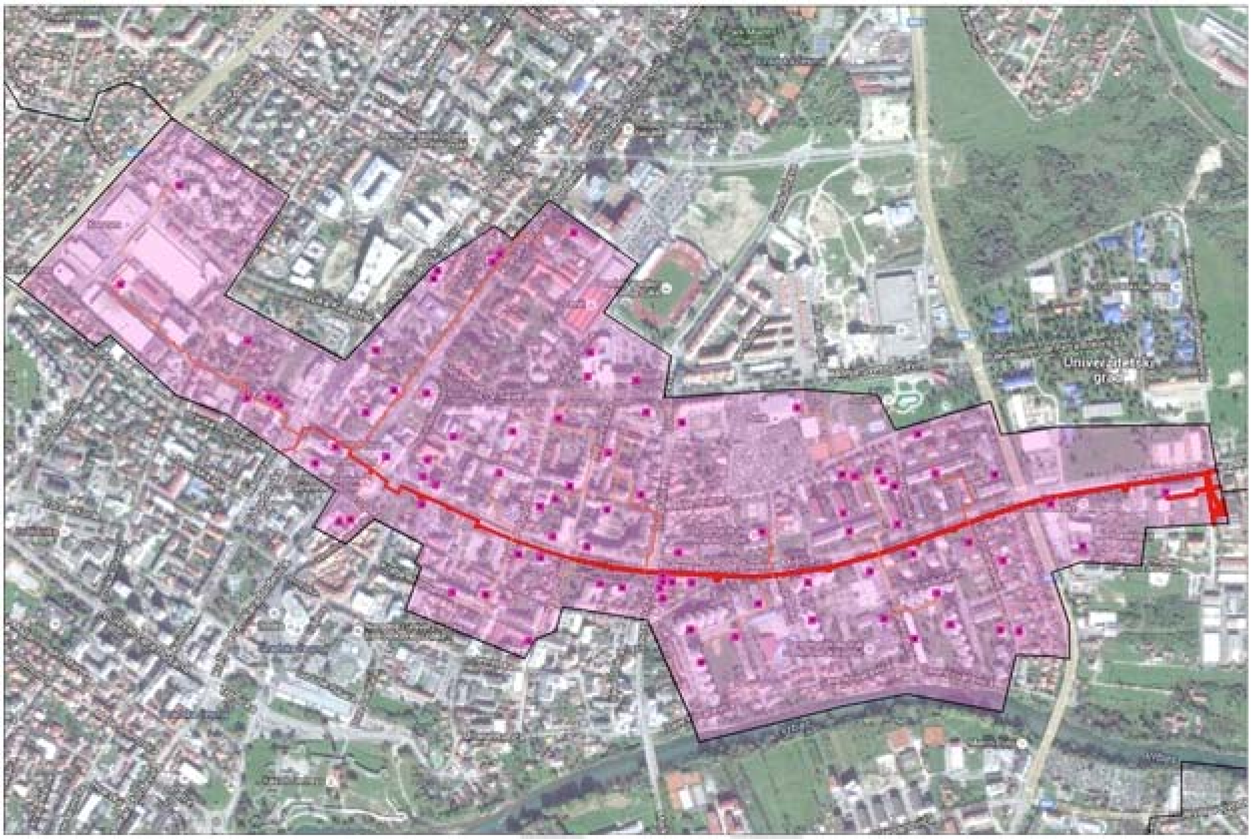


Figure 29: *Map Overview of First Main Hot Water Thermal Power Line "Borik"*

Originally, the pipeline was built from welded black steel pipes of appropriate diameter, insulated with mineral wool in aluminium or zinc-coated steel thin sheets (with some parts insulated with bitumen sheets). Pipes were laid in concrete trenches. Part of reconstructed pipeline is made from pre-insulated seamless steel pipes. During the reconstruction, pipeline route remained unchanged and pre-insulated pipes were laid in previously cleaned concrete trenches.

Figure 30: *Pipeline Prior to Reconstruction (Trench Open, But Pipes Still Not Removed)*

Figure 31: *Trench Cross-Section (Pipeline Prior to Reconstruction)*

The insulation has been severely damaged (both protective sheet and mineral wool. Protective anti-corrosion paint also lost its properties due to prolonged usage, therefore providing no corrosive protection for pipes.

Following figures show the dismantled parts of the existing pipeline. It is obvious that pipes were corroded and their wall thickness was reduced (in some places even holes are present), leading to leakage.

Figure 32: *Part of Dismantled Pipe*

Figure 33: *Part of Dismantled Pipeline*

The following figures show concrete trenches cleaned and prepared for a new pipeline. As pre-insulated pipes are used, there was no need to repair the trench walls. Therefore the previous concrete trench became a soil trench, as shown in the following Figures.

Figure 34: *Concrete Trench, Cleaned and Prepared for Laying of New Pipes*

Figure 35: *Pipes Laid in Soil Trench*

There is total of 6,345 m of pipeline reconstructed. Out of this length, 37% of pipeline was substituted with larger diameter compared to initial size.

The second main hot water pipeline "Vrbas" starts from the central heating plant. It is laid under meadows to the bridge over Vrbas river, then along the main street to Obilićevo, and then across the bridge to Kočićev Vijenac. Lines for heat transmitting stations (primary to secondary media) are separated from the main pipeline along its route. First of them is for Starčevica, second part is routed again across the bridge to downtown (Borik), while the third is routed across Patra bridge to the neighbourhood beside Kastel. Entire grid of this main line originally had form of ray, but after erection of heating plants I and II it took the form of a knot.

The pipeline is laid mostly using trenches. Over the river it is laid aboveground using frames along the bridges. The following figure shows the main hot water pipeline "Vrbas".

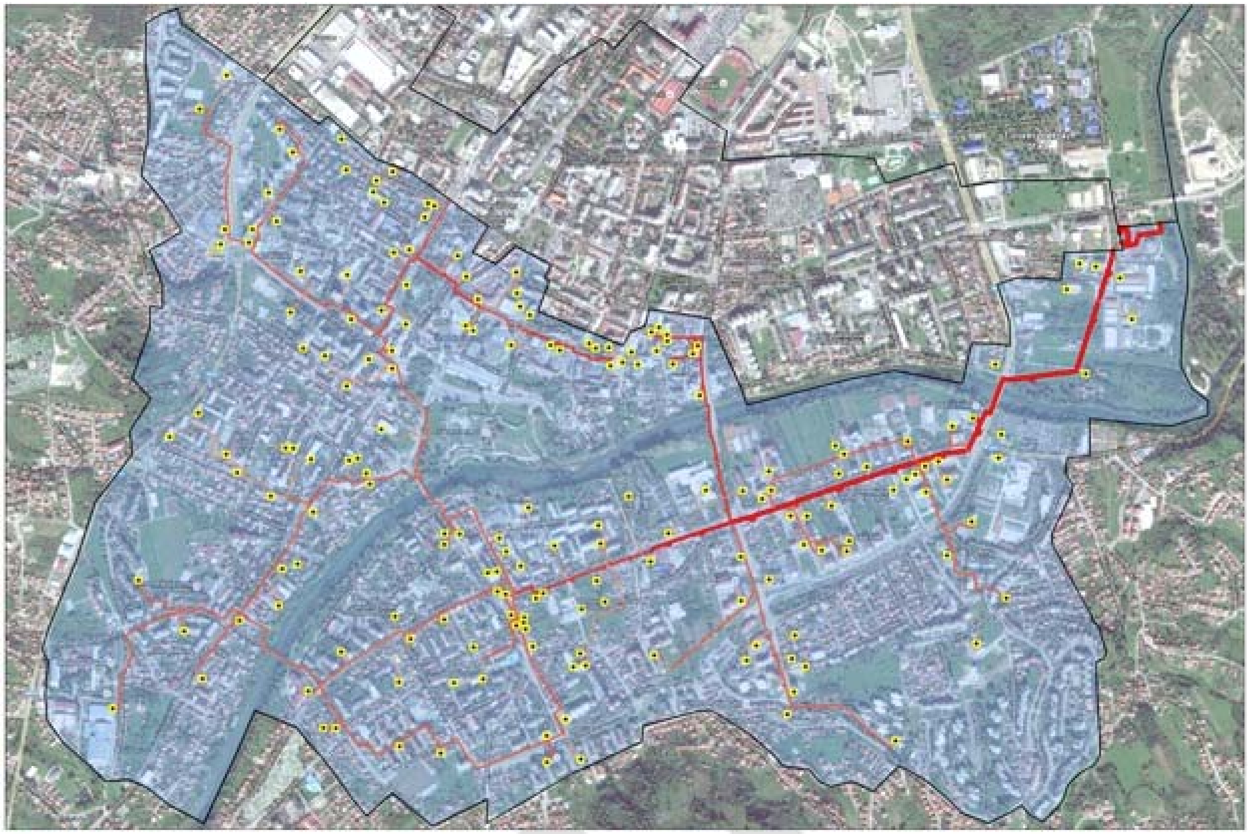


***Figure 36**: Map Overview of Second Main Hot Water Thermal Power Line "Vrbas"*

The total length of reconstructed pipelines is 5,505 m.. Out of this length, nearly 83% of pipeline was substituted with larger diameter compared to the initial size.

Starčevica and Kočićev Vijenac are quite distant from the central heating plant and placed on uneven terrain. Therefore, heat supplied from the central heating plant was insufficient. Two heating plants, "Starčevica" and "Kosmos", have been additionally built to fulfil heat demand. The network itself has not been expanded, nor has heat demand been increased, but only the quality of the heat supply was increased.

The third main hot water pipeline "Industrija" starts from the central heating plant. It is laid along the bank of river Vrbas, continuing along the street beside the industrial zone onto the crossing with Braće Pišteljića street, and then further along the Ilije Gračanina street.

Lines for heat transmitting stations (primary to secondary media) are separated from the main pipeline along its route. The biggest separation occurs at approximately middle of the pipeline. It is used for supplying heat to the Borik neighbourhood. This pipeline is built in form of ray grid. Pipeline is laid in a concrete trench. Reconstructed part, built from pre-insulated pipes, is laid in soil trenches. The following figure shows the third main hot water thermal power line "Industrija".

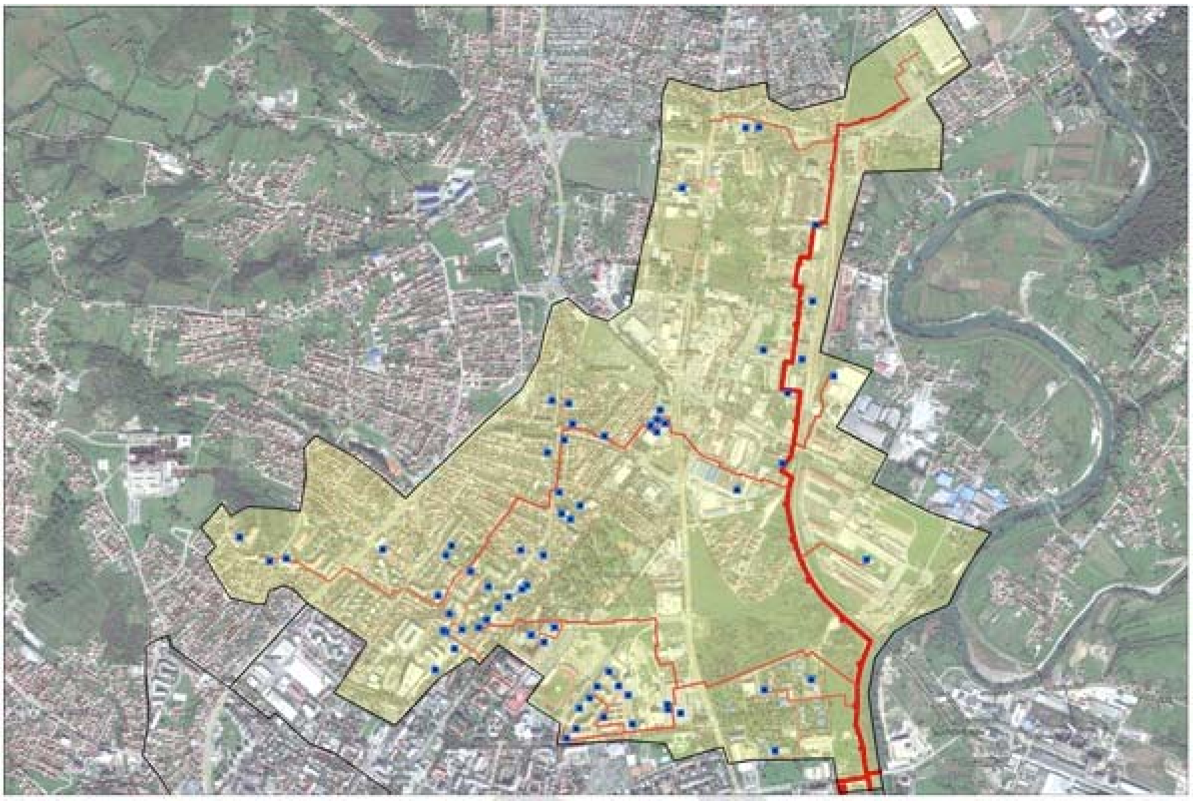


Figure 37: *Map Overview of Third Main Hot Water Thermal Power Line "Industrija"*

The total length of reconstructed pipelines is 2,826. Out of this length, nearly 37% of pipeline was substituted with larger diameter compared to the initial size.

The following show the recently reconstructed parts of the three main pipelines.

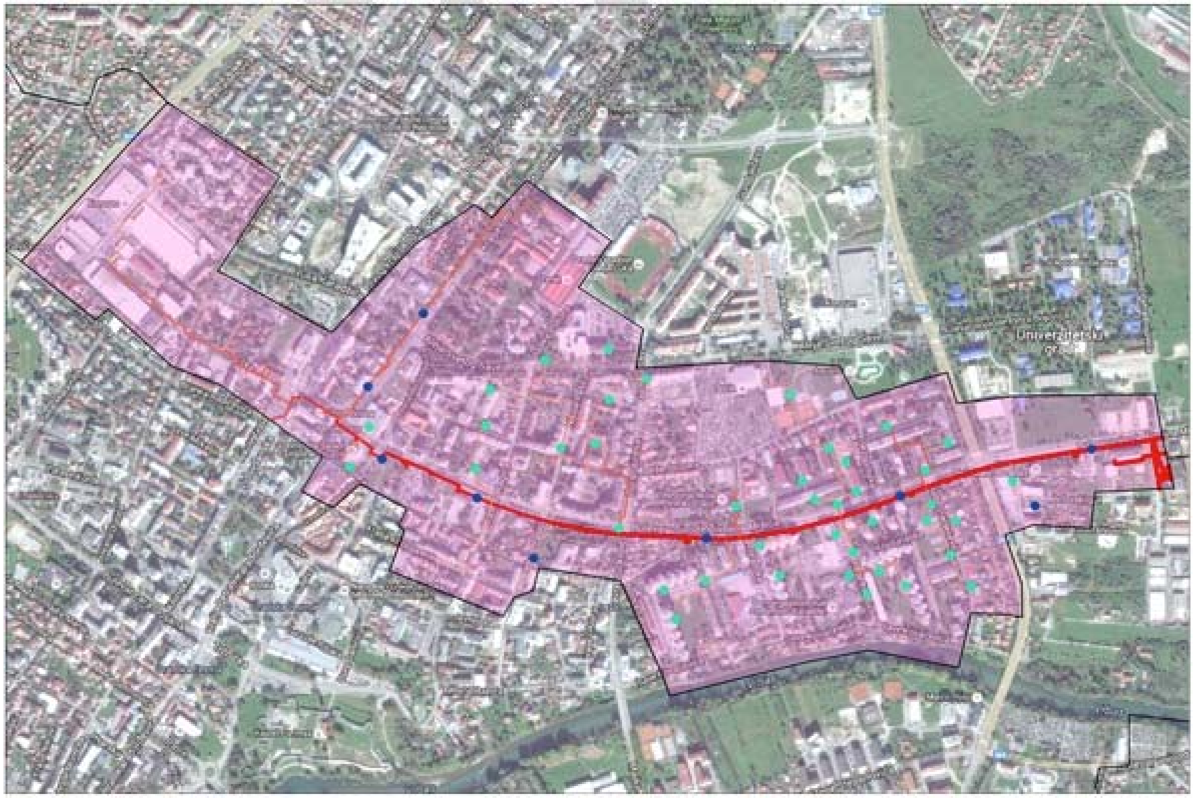


Figure 38: *Reconstructed Part of "Borik" Pipeline*

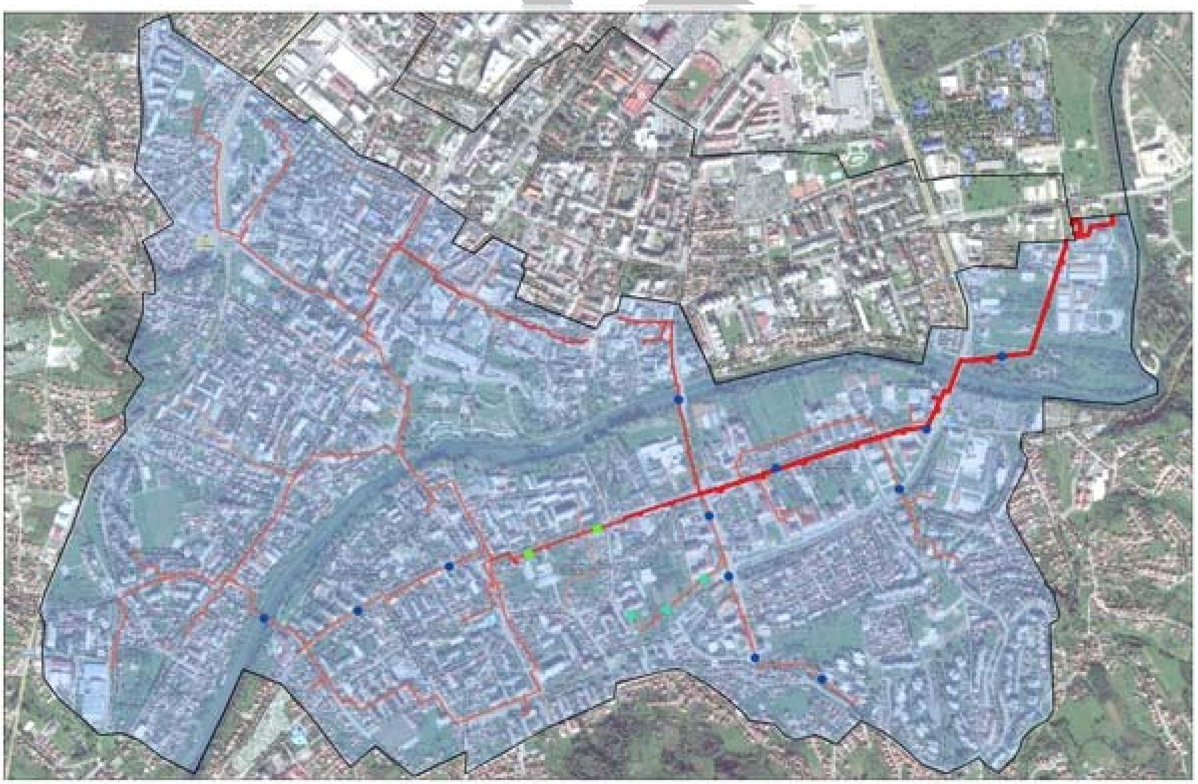


Figure 39: *Reconstructed Part of "Vrbas" Pipeline*

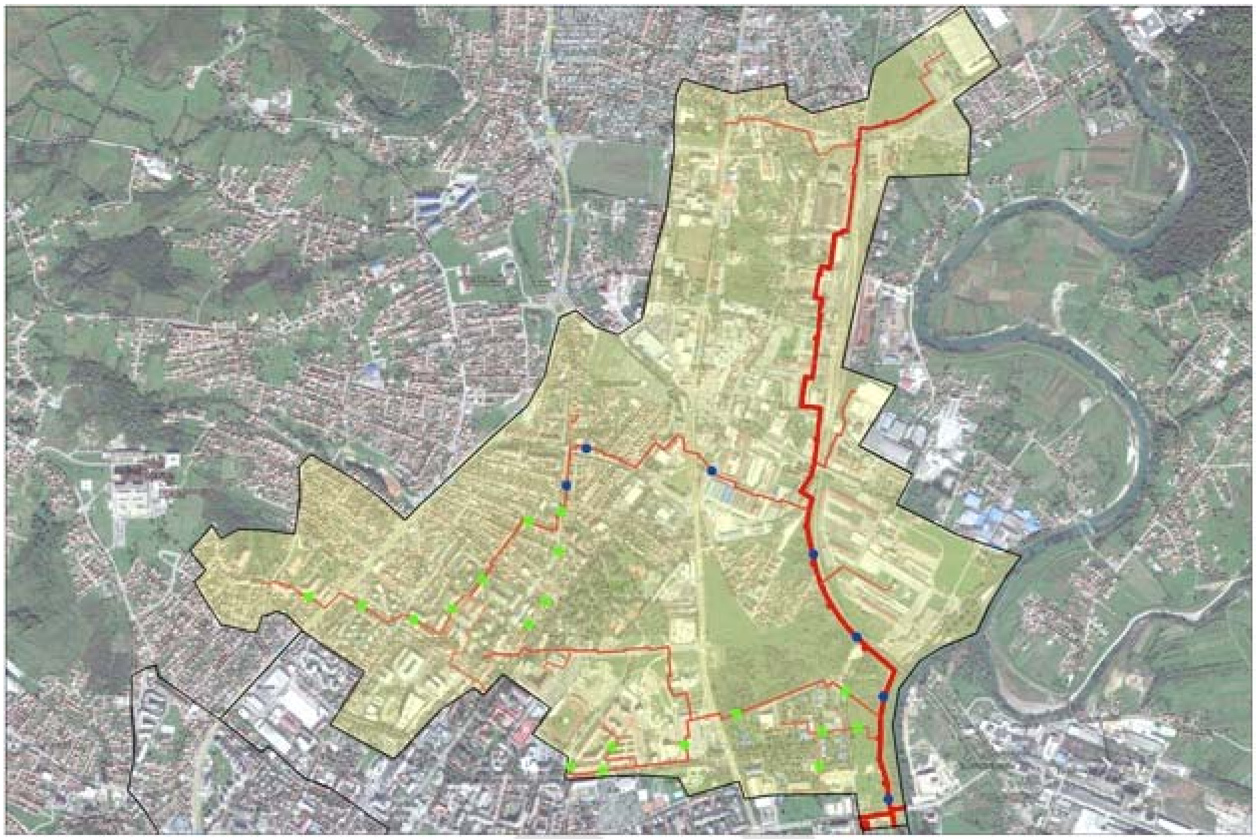


Figure 40: *Reconstructed Part of "Industrija" Pipeline*

Out of the total primary network, about 35% of pipes were replaced with new pre-insulated pipes. Existing diameters were thought to be insufficient for the required capacities, so that about 50% of replaced pipes were with larger diameter pipes. However, analysis of media flow rate through the pipes at source (heating plant) has shown that diameters were increased without need.

All other pipes are either relatively new (less than 10 years old) or older than 35 years and deteriorated. Old pipes need to be replaced within next ten years.

Identified shortcomings in distribution network (hot and warm water systems):

- Water and heat losses in the distribution network are significant;
- The insulation is damaged. Large amounts of water are pumped into the system which indicates substantial leakages in the network;
- The fact that the system is almost totally drained every year because of the maintenance work, increases corrosion and stress to the materials. Some valves are inoperable probably because of corroded or damaged parts inside the valve;
- Leaking pipes and culverts cause wetting of pipeline which results in increase of heat losses;
- There are not enough section valves on the distribution networks (in order to enable easier tracking of the leakages);
- Some parts of distribution networks especially on the branches are not isolated;
- Due to the fact that there is no frequent regulation of pumps in the central heating plant, and that all control valves in heat substations are three-way valves, the flow in the pipes is constant and much higher than required.

3.6.7 Heat Losses

A precise calculation of the heat losses is difficult to conduct since there is neither measurement of heat supplied to the end-consumer, nor the measurement of the heat supplied from the central heating plant. The Company calculates the data on heat supplied from the central heating plant on the basis of actual fuel consumption. 16,564.40 t of HFO and 15,380 t of wood chips, taking into account efficiency of the boilers in the central heating plant being 85% and in regional heating plants being 97%, returns 182,689.42 MWh of thermal energy at the outlet of the boilers.

The heat losses in the district heating network depend on pipe size, insulation thickness and the quality of supply and return water temperatures. The existing pipes are insulated with glass fibre wool with a cover of aluminium tin. Old pipes have unsatisfactory insulation which has deteriorated and lost its insulating properties. Reconstructed pipeline parts, about 35 % of the primary network, are insulated by polyurethane insulation in pre-insulated constructions. Estimated losses result from insulation in the culverts being wet to a certain extent. A greater extent of wet insulation results in higher heat losses. Wet insulation is caused by leaking water, from the pipes as well as from joints in the concrete culverts.

Based on the consultant's experience and good practices data available in the literature for the district heating utilities in transition economies, losses in the distribution network range from 22% in average before modernization and gets reduced to 15% after modernization. Additionally, losses on the side of heat consumption can amount of around 12% in case of state of buildings in Banja Luka, as well as the temperature achieved within the buildings. Therefore, total losses of the distribution and consumption range from 25-32%. As certain part of primary network has already been rehabilitated, total efficiency of distribution and consumption parts of the DH system is estimated to 71% (losses 29%) making it about 130 GWh of thermal energy being supplied to the end-users.

Total heat losses from the pipeline systems are estimated to 35.3 GWh annually based on the assumption that parts of the insulation on the pipelines are wet, damaged or missing.

Based on this analysis, efficiency of the entire DH system is estimated to 60.35% which can certainly be considered as quite inefficient. This results in the heat losses of around 63.7 GWh from the burner until the end-users.

3.6.8 Water Losses

Filling up of water to the DH system only takes place in the boiler station. The volume of fill up water is recorded on a regular basis by the technical staff. Filling up of secondary networks is performed automatically from the primary network. Also the volume of filling water for all secondary networks respectively is recorded by the Company.

Summarized data for the water consumption in m^3 during last seven years is shown in the following diagram.

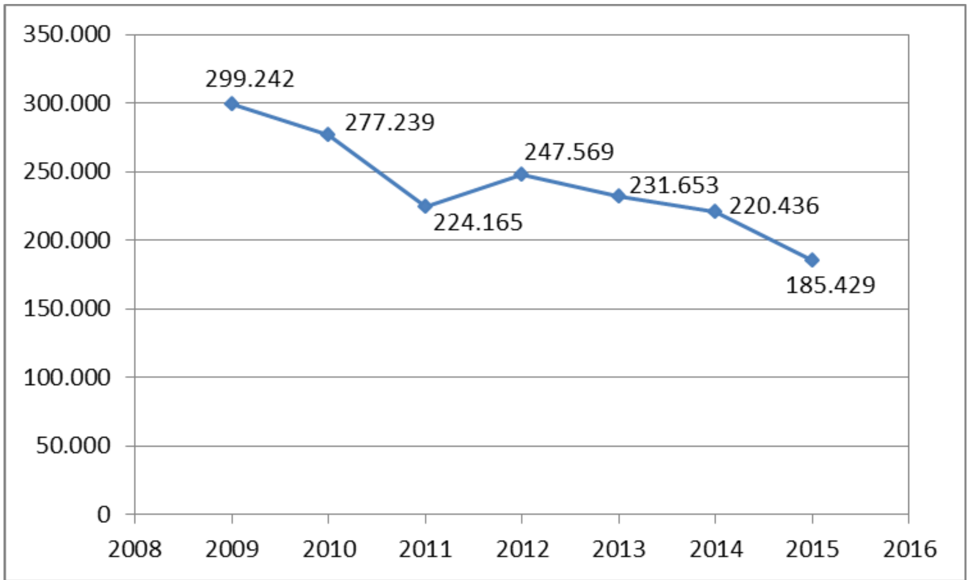


Figure 41: *Feed Water to the DH System*

During 2009 a volume of 299,242 m^3 of water was fed into the DH system in the boiler plant. If the filled Banja Luka DH system contains about 7,500 m^3 of water, this implies that the water in the DH system was changed 40 times during that year. During 2015 a volume of 185,429 m^3 was fed into the system implying equivalent of nearly 25 times during the year. However, the water losses have a stable decreasing trend.

According to European standards, the water loss within the DH system during one heating season is approximately equal to the quantity of water contained within the filled system. Therefore, the water loss in this DH system is enormous compared to the European standard. The reason for such a large loss lies in poor state of the distribution network, which is still deteriorating.

The calculated heat loss caused by heating of makeup water was calculated to approximately 9,71 GWh during 2015. This is equivalent to 1,029.13 tons of fuel oil or 716,871 BAM excluding VAT, taking the average procurement HFO price in 2015 in the amount of 696.58 BAM/t.

3.6.9 Heating Substations

Hot water is pumped through the primary network to substations. The heat exchangers in the substations supply secondary pipes which enter into the buildings. There is no exact record about the number of substations, which adversely affects the function of the DH system itself. The system is believed to include 283 operational heating substations (according to the DH system maps obtained from the Company) with capacity of 100 kW up to 10 MW, out of which 95 substations are currently not in possession of the Company (35 in households and 60 in commercial buildings). On the other hand, Company representatives claim that the number of substations is 330.

District heating system in Banja Luka uses both types of stations: direct and indirect. Principal part of primary station is heat exchanger, which is device enabling heat transfer from one to another media. They are made in several shapes and forms. There are two types in use at stations in Banja Luka: panel and pipe heat exchangers.

The pipe heat exchangers have been mostly used in stations installed prior to 1990, although there were also several panel exchangers. In stations installed after 90's, panel heat exchangers are mostly used.

Standard circulation pumps from various manufacturers are used for circulation of water in system. Circulation pumps are installed on supply side. Each line (duct) has two pumps, one for work and one for backup. If station is used to supply heat for more lines (two, three or more buildings), it is equipped with splitter and joiner. In such case, circulation pumps and accompanying fittings are mounted on splitter or joiner.

Ventilation of station space is mostly natural. Air inflow comes from adjacent rooms through grille at lower part of doors, while air outflows through grille mounted in an outside wall. Following figure depicts heat transferring station installed and in use in district heating system of Banja Luka.

Following figures show stations with panel heat exchanger, splitter and joiner, and circulation pumps. It is clear that equipment is in good condition and that entire pipeline is insulated. These stations are recently reconstructed, in the period from 2000 onwards. Command panel for electricity with regulatory equipment (enabling normal and uninterrupted work of station) is also shown. Equipment for automatization is installed in certain number of stations. However it is not fully integrated in the system and therefore out of use. The equipment is in good condition and it can be operated.

Figure 42: *Installations in Substations*

It is visible that equipment has been recently reconstructed, circulation pumps in particular. Motor and pump body are different colours, meaning the motor has been changed while the body stayed the same. Fan for air circulation in station is mounted on the outside wall, while the window is closed.

The station with the original equipment installed is shown in the lower right Figure, back to time when district heating system in Banja Luka has been built. Only certain parts, e.g. dirt separator, are changed in the meantime. Other equipment is quite old, e.g. circulation pumps of this type are not manufactured for long time.

All the substations are designed using the same principle. They only differ in terms of system for pressurizing where there are three options:

- Pressure control by pumps and relief valves
- Closed system with pre-pressurized expansion tank(s)
- Open system with expansion tank located on top of the building.

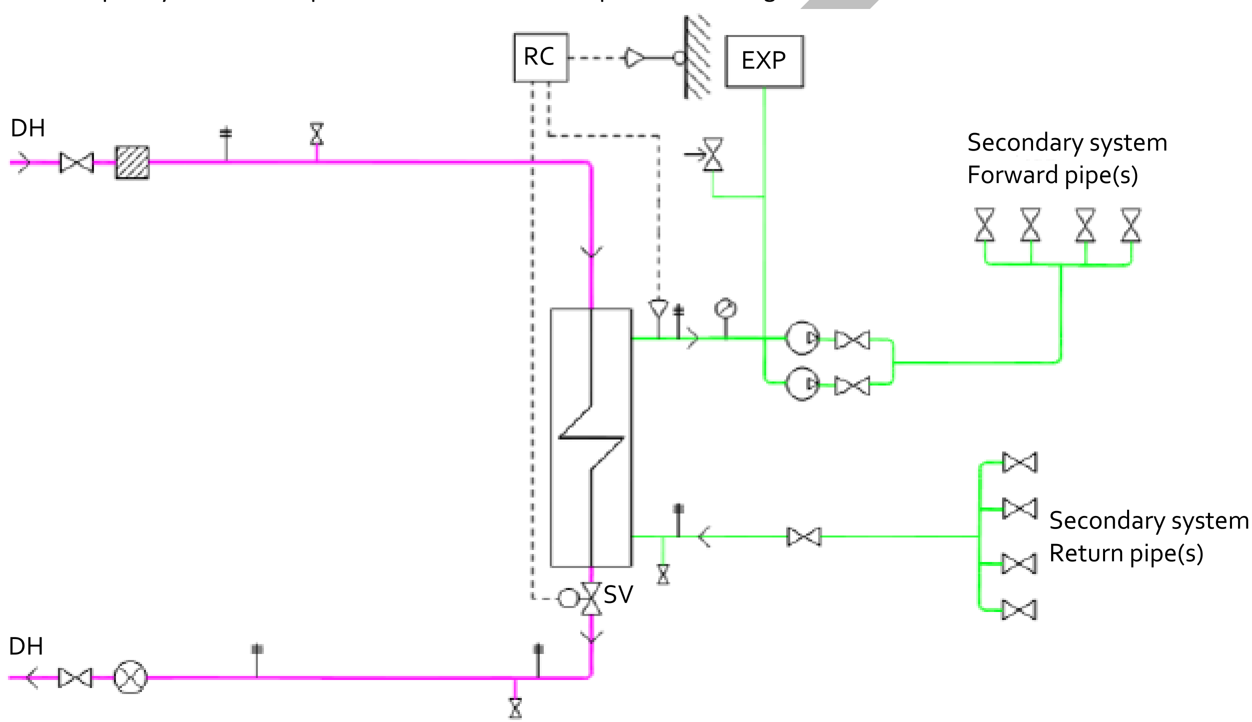


Figure 43: Principle *Layout of Substation*

Recent installations are equipped with temperature control using outside temperature sensor. Older substations have (if any) possibility to regulate the forward line temperature only. At present all of the control systems are disabled and the system is only regulated from the production plant. As the control systems are disabled and control valves are fully opened, flow is regulated by hand to maintain differential pressure on the primary side. On the secondary side there is a pump, in most cases without speed regulation, feeding the different branches of pipeline connecting buildings. Inside the building heating is distributed through vertical raisers and radiators. Recently constructed buildings are equipped with horizontal heating systems. Whether or not radiators are fitted with thermostatic valves is not assessed but it is assumed that the use of such valves is very limited.

Substations not owned by the Company are managed by unqualified persons to whom, by all regulations, access to such facilities should be denied. There are examples in which the residents, attempting to introduce proper heating, force circulation (flow system) through installations by connecting the system using a hose or similar to a sewerage. This leads to the direct loss of the media, and thus to unnecessary cost and disruption of established hydraulic balance, leading to improper functioning of the district heating system. Setback of such a management is directly reflected in non-functionality in terms of the distribution of heat and customer dissatisfaction, the consumption of energy and other resources and ultimately unnecessary emissions.

Most of the substations are constructed during the same period as main parts of the pipelines and have reached an age of over 40 years which is more than the expected technical lifetime for this type of equipment. These installations have also been out of commission during at least six years during the war, thus in need of refurbishment.

Heating substations installed after 2005, about 45 of them, possess an automatic control system, which is 16 % of total number of substations in the DH system. Therefore, considerable investments are required in this field.

Identified shortcomings in heating substations:

- The pumps with motors in a conventional performance are installed in substations, with no frequency electronic speed control;
- In most heat substations automatic control of secondary water temperature dependent on the outdoor temperature is not in operation, hence it operates mostly on manual control. In some cases, temperature control devices are not installed, and in some cases equipment is obsolete and impossible to repair due to spare parts for this type of the equipment not being produced anymore;
- In the substations with automatic regulation, three-way valves are installed; the flow in the hot water system is constant and by far higher than required;
- In certain substations parts of the pipes are uninsulated;
- Substitution of certain vital parts of the plant, as well as the elimination of defects as a result of leakages, is performed when necessary and not for prevention purposes;
- There are no balancing valves on primary and secondary branch of substations installed, hence the system is unbalanced according to the flow rates;
- There are no heat meters on the primary side of the substations;
- There is no remote management and control system in substations;
- Out of the total number of 335 heating substations, 95 substations are not managed and maintained by the Company, therefore overall condition of these substations may not be determined.

3.6.10 System Regulation

Required design parameters and economical operation of the entire system is achieved with the automatic operation for cascade work of boilers, type VITOTRONIK 300 K, MW1S. Automatic operation is driven by the weather conditions and it controls the operation of boilers in cascade. The controlled variable is the temperature of the water flow, which is a function of the outside temperature. When the heat is needed, first boiler starts the operation and modulates its power until the full capacity is reached. In case the required temperature is not achieved, the second boiler also starts the operation modulating the power until the required water flow temperature is achieved. Boilers have a minimum return temperature set to 60°C. They are equipped by transient motor flaps, managed by the boiler automatics, preventing the flow through the boiler which is not in operation, as well as a low temperature of returning water.

Currently there is no system of automatic regulation, control and management of district heating. The equipment installed in the central heating plant in the period of its construction is enabling only partial semi-automatic regulation. In order to achieve efficient and economical operation of the entire system, it is primarily necessary to install full automatic control in the central heating plant. In this way, the operation of boilers would be fully automated with cascading guidance of individual units depending on the outside temperature. Operation of circulation and other pumps in the heating plant would be automatically managed by variable frequent regulation. In this case, the district heating system would have hot water parameters which at any time correspond to the needs of consumers.

All heat substations would be connected to the central control, management and monitoring system. This would enable continuous monitoring of all relevant parameters of the system and also allow an access to the data on the thermal energy demand in the substations.

3.6.11 Barriers for Demand Side Management

The identified shortcomings in internal installations are as follows:

- Buildings with two-pipe installations are constructed in the period from 1970 to 1985 mainly, and have poor energy efficiency (poor thermal insulation);
- Individual measurement of heat consumption may be performed in approximately 6,000 apartments with a one-pipe system, while the other residential units (approximately 15,000) have no technically feasibility for direct measuring heat consumption;
- The radiators are mainly equipped with manual valves, not thermostatic, which prevents local regulation of the heated area;
- Manholes in front of the buildings and connection points are not equipped with the necessary equipment (valves are often of the old type and not in accordance with the modern standards);
- There are no balancing valves installed, hence the required flow rates in installation may not be controlled;
- There are no heat meters installed in buildings, therefore the data on the actual heat consumption of buildings is unavailable;
- A large number of apartments (heating installations) voluntarily disconnect from the district heating system. For these residential units, indirectly consumed heat remains unpaid. The same pertains on the costs of fixed energy production. In addition, these apartments have a negative impact on the comfort level of neighbouring units. There is a heat theft noticeable in some units, not paying the bills for supplied heat.

3.6.12 Benchmarking of Key Figures

Based on the information given above an indicative benchmarking in relation to information from various databases[116] has been performed. The benchmarking is intended to give an idea about the status of the district heating utilities in Banja Luka compared to other large district heating utilities in transition economies and in Nordic market economy countries. Analysis is focused on the central heating plant and corresponding pipeline as it is evident that this part of the DH system desperately requires modernization.

***Table 36**: Benchmarking the DH System in Banja Luka against DH systems in Transition and Market Economies*

Indicator	Unit	Banja Luka	Transition economy		Nordic market economy
			Before rehabilitation	After rehabilitation	
Energy efficiency in total	%	56-65	56	69	84
Heat generation efficiency	%	85	75-85	80-88	85-92
Heat distribution efficiency	%	75-87[117]	78	85	92
Heat consumption efficiency	%	88	68	91	99
Water economy	Times/year	25	59	7	<1
Heat prod./Number of staff	GWh/staff	1.25	0.9	1.0	>10

The table indicates the potential for efficiency improvement to be obtained in the process of rehabilitation. The reference figures are indicative but rather typical.

Taking into account that no measurement is performed on the end-users' side as to quantity of the heat supplied, it is realistic to expect any amount of heat between 120-140 GWh to be supplied to the end-users. Regarding the

[116] Energy Charter Secretariat, Cogeneration and District Heating – Best practices for municipalities, Brussels 2005
[117] Estimation, Chapter Heat losses

efficiency of the distribution and consumption, scenario 1 with minimum heat supplied results in 65.7 % efficiency, whereas scenario 2 with maximum heat supplied results in 76.6 % efficiency.

3.6.13 Tariff Model

The current tariff models include billing based on a fixed price per square meter of heated space size and billing based on heat consumption measurement in MWh. Estimated annual revenues from customers using the billing per square meter of space is 16.62 BAM (without VAT), while the same square meter heated for the customers that use the billing option based on heat consumption is estimated to be 6.26 BAM (without VAT). Therefore, the Company is making 63% lower revenues per square meter of living space on billing model based on heat consumption then on the model based on the fixed price per square meter of the heated space. The following table provides a comparative overview of the annual consumption of MWh and revenue per m^2[118].

Table 37: *Overview of Annual Consumption of MWh and revenue per m^2*

No.	Year	Customers per m^2		Customers per Mwh	
		Estimated annual consumption of MWh/m^2	Revenue per m^2 in BAM	Annual consumption per MWh/m^2	Revenue per m^2 in BAM
1	2012	0.14	16.92	0.055	6,31
2	2013	0.14	16.92	0.055	6,26
3	2014	0.12	16.92	0.043	4,97
4	2015	0.15	16.92	0.065	7,50
Average		0,14	16.92	0.054	6.26

The Company intends to introduce the new adopted tariff calculation system[119] as soon as possible. The new tariff system proposes the calculation of fixed fees for all consumers for which the calculation is made per m^2 during each month of the year, and for consumers with calorimeters installed (heat consumption measurement tariff model), the fixed fees portion will also be introduced during the heating season. The average share of the fixed part of the fee for households which use the heat consumption mode would be up to 33% of the bill while the fixed fee for households using the tariff model per m^2 would be 17% of the bill.

The fixed fee would also be charged to the consumers which had disconnected from the DH system and are living or doing business in the buildings that are connected to the DH system. The table below provides the price of heating according to the new tariff system proposed by the Company[120].

Table 38: *Overview of Heating Prices According to the Adopted Tariff System*

No.	Customer	Variable part of the price with VAT	Fixed part of the price with VAT (BAM/kW)	Price with VAT (BAM/m^2)
1.	Residential consumers billed per m^2	1.42	2.45 (=0.29 BAM/ m^2)	1.71
2.	Residential consumers for which consumption is calculated on the basis of MWh of heat energy supplied	133	2.45 (=0.29 BAM/ m^2)	-
3.	Business consumers for which consumption is calculated on the basis of MWh of heat energy supplied	199	3.71 (=0.44 BAM/ m^2)	-

[118] *Ibid.*
[119] http://www.bltoplana.com/index.php?option=com_content&view=article&id=76&Itemid=72&lang=Lat
[120] Business Report for 2015 – "Toplana" Banja Luka

4.	Business consumers for which consumption of heat energy supplied is calculated on the basis of installed capacity – MW	28.5	3.71 (=0.44 BAM/ m^2)	-
5.	Disconnected residential consumers which have the DH network in the building	-	2.45 (=0.29 BAM/ m^2)	0.29
6.	Disconnected business consumers which have the DH network in the building	-	3.71 (=0.44 BAM/ m^2)	0.44

3.6.14 Financial Assessment

The financial position of the Company is presented in the balance sheets below[121]:

Table 39: *Abridged Version of Assets in Balance Sheet as of 31 Dec 2015*

No.	Position	31 Dec 2014	31 Dec 2015
A	FIXED ASSETS	42,621,042	45,455,867
1	Intangible assets	12,384,998	12,026,640
2	Buildings and equipment	30,236,044	33,429,227
B	CURRENT ASSETS	20,822,284	23,627,101
1	Inventories of materials and other resources	3,190,583	2,540,904
2	Cash and receivables	17,631,701	21,086,197
C	Losses over equity and reserves	19,979,304	24,047,795
D	Off-balance sheet assets	15,238,923	15,238,923
	TOTAL ASSETS	**98,661,553**	**108,369,687**
A	EQUITY	0	0
1	Basic equity	29,648,609	29,648,609
2	Legal reserves	0	0
3	Revalorization reserves	22,086,445	22,129,460
4	Unallocated profit	26,981	303,835
5	Accumulated losses up to the level of equity and reserves	51,762,035	52,081,904
B	LIABILITIES	83,422,630	93,130,764
1	Long-term liabilities	32,651,446	27,601,838
2	Current liabilities	50,771,184	65,528,927
C	Off-balance sheet liabilities	15,238,923	15,238,923
	TOTAL LIABILITES AND EQUITY	**98,661,553**	**108,369,687**

The overall current financial situation in the Company may be described as unfavourable. Total accumulated losses in 2015 amounted to 76.129.699 BAM with 24.038.923 BAM of losses over the amount of equity and reserves.

Current assets in 2015 increased by 13.5% compared to 2014, due to the increase in receivables from customers. The customer receivables accounted for 67% of the total current assets. At the same time, current liabilities increased by 29%, which additionally strained the Company's liquidity. The receivables turnover ratio is calculated very low at 1.43, which means that from the time of providing the service to the collection of payment from customer it takes 8.5 months in average.

The annual cash flow of the Company is presented below[122].

Table 40: *Cash Flow Overview*

[121] *Ibid*.
[122] *Ibid*.

Position	1 Jan – 31 Dec 2013	1 Jan – 31 Dec 2014	1 Jan – 31 Dec 2015
A. CASH FLOWS FROM OPERATING ACTIVITIES			
I CASH INFLOW FROM OPERATING ACTIVITIES (1-3)	26,409,701	24,202,368	24,087,051
1. Revenues from sale and received advance payments	26,125,646	21,089,624	22,428,489
2. Revenues from premiums, grants, assistance and similar.	11,403	5,122	7,600
3. Other revenues from operating activities	272,652	3,107,622	1,650,962
II EXPENDITURE FROM OPERATING ACTIVITIES (1 do 5)	26,428,966	15,520,648	20,335,807
1. Payments to suppliers	20,542,505	10,070,866	14,670,099
2. Payments for employee wages, salaries and other employee benefits	3,536,970	2,896,734	3,079,026
3. Payment of interest rate	2,291,614	2,452,681	2,192,799
4. Payments for income taxes		9,277	252,912
5. Other payments of operating activities	57,877	91,090	140,971
III NET CASH FLOW FROM OPERATING ACTIVITIES (I-II)	0	8,681,720	3,751,244
IV NET OUTFLOW OF CASH FROM OPERATING ACTIVITIES (II-1)	19,265	0	0
B. CASH FLOWS FROM INVESTING ACTIVITIES			
I CASH INFLOW FROM INVESTING ACTIVITIES (1 do 2)	69,544	19,420	2,185
1. Revenues from short-term financial investments		8,759	0
2. Revenues from interest rate	69,544	10,661	2,185
II NET OUTFLOW OF CASH FROM INVESTING ACTIVITIES (1 do 2)	2,794,180	12,654,250	0
1. Outflows of cash from short-term financial investments	0	122,804	0
2. Outflows of cash purchase of intangible assets, property, plant, equipment, investment property and biological assets	2,794,180	12,531,446	0
III NET CASH INFLOW FROM INVESTING ACTIVITIES (I-II)	0	0	2,185
IV NET OUTFLOW OF CASH FROM INVESTING ACTIVITIES (II-1)	2,724,636	12,634,830	0
V. CASH FLOWS FROM FINANCING ACTIVITIES			
I CASH INFLOW FROM FINANCING ACTIVITIES (1 do 2)	10,000,000	9,000,000	0
1. Revenues from increase in capital	10,000,000		0
2. Revenues from other long-term and short-term liabilities		9,000,000	0
II NET OUTFLOW FROM FINANCING ACTIVITIES (1 do 3)	7,590,373	4,436,407	4,052,252
1. Outflows from purchase of own shares		120,840	0
2. Outflows long term loans	2,834,033	4,027,820	3,949,752
3. Outflows from other long-term and short-term liabilities	4,756,340	287,747	102,500
III NET CASH INFLOW FROM FINANCING ACTIVITIES (I-II)	2,409,627	4,563,593	0
IV NET OUTFLOW OF CASH FROM FINANCING ACTIVITIES (II-1)	0	0	4,052,252
B. TOTAL CASH INFLOW	36,479,245	33,221,788	24,089,236
C. TOTAL CASH OUTFLOW	36,813,519	32,611,305	24,388,059
D. NET CASH INFLOW	0	610,483	0
E. NET CASH OUTFLOW	334,274	0	298,823
F. CASH AT BEGINNING OF PERIOD	487,573	153,299	763,782
G. CASH AT END OF PERIOD	153,299	763,782	464,959

The net cash outflow for 2015 amounted to 298.823 BAM; therefore, cash at the end of 2015 was decreased for the same amount. In 2014, there was a significant net cash outflow from investing activities in the amount of 12,634,830 BAM, attributed to the construction of two biomass thermal plants at Starčevica and Kočićev Vijenac. This investment was financed by 10 and 9 million BAM of the cash inflow from financing activities in 2013 and 2014. As aforementioned, the Company faced liquidity issues in 2015, as the cash generated from the revenues was not sufficient to buy the needed heavy fuel oil. Therefore, it is obvious that the capital injection of 10 million in equity provided by the City of Banja Luka to the Company in 2013 was not sufficient to stabilize the operations in the long term.

Profit and Loss Accounts for the period from 2012 to 2015 are presented in the following table[123].

Table 41: *Profit and Loss Accounts*

No.	Position	Year			
		2012	2013	2014	2015
A	TOTAL REVENUES	25,516,025	25,386,382	28,026,598	23,594,118
1.	Revenue from sale of heating energy	24,716,481	23,657,311	21,300,548	21,835,153
2.	Other revenue (financial and others)	799,544	1,729,071	6,726,050	1,758,965
B	Charged operating income from the sale of heat	20,761,844	19,872,141	17,892,460	18,341,529
V	TOTAL EXPENDITURES	53,543,533	39,226,367	34,849,577	28,009,459
I	BUSINESS EXPENDITURE (1+2)	43,280,533	34,111,273	28,851,680	22,140,360
1.	Price of electricity and water	29,668,658	26,055,059	20,387,615	15,582,674
2.	Other business expenditure	13,611,875	8,056,214	8,464,065	6,557,686
II	FINANCIAL EXPENDITURES	2,526,204	2,281,514	2,356,858	2,938,083
III	OTHER EXPENDITURES	7,736,796	2,833,580	3,641,039	2,931,016
	LOSS	28,027,508	13,839,985	6,822,979	4,415,341

In 2015, revenues from the sale of heating energy amounted to 23,594,118 BAM. Given that the receivables collection rate in 2015 was 82%, the collected revenues in 2015 amounted to 19,347,176 BAM.

The operating expenses have been significantly decreasing since 2012, which was primarily influenced by the reduction in the hot water losses in the network as well as the decrease of costs of heavy fuel oil; hence total financial losses have also been decreasing since 2012 when the losses at the end of the year amounted to over 28 million BAM.

Long-term liabilities amounted to 27,601,838 BAM as of 31 Dec 2015, and compared to 2014, they decreased by 5,049,446 BAM. Long-term liabilities decrease is a result of rescheduling the tax liabilities which was arranged with the Tax Administration Office of RS, as well as restructuring of the long-term loans with commercial banks. In addition, the Company also managed to restructure the repayment of its long-term bonds issuance[124].

Table 42: *Outstanding Loans*

No.	Creditor	Credit amount	Payment start	Debt state 31/12/2015	Repayment deadline	Yearly interest %
1	Hypo bank	602,066	01/11/2006	58,971	01/10/2016	8
2	Hypo bank	1,500,000	01/11/2006	146,922	01/10/2016	8
3	Hypo bank	355,409	01/11/2006	34,812	01/10/2016	8
4	Hypo bank	1,442,525	01/11/2006	141,292	01/10/2016	8.25
5	Hypo bank	3,000,000	01/06/2009	178,321	01/06/2016	6.25

[123] *Ibid*.
[124] *Ibid*.

No.	Creditor	Credit amount	Payment start	Debt state 31/12/2015	Repayment deadline	Yearly interest %
6	Hypo bank	4,750,000	01/11/2011	2,159,270	01/11/2018	8.04
7	Nova banka	5,000,000	01/01/2012	3,214,286	15/12/2024	5.1
8	Nova banka	20,000,000	01/09/2011	15,704,182	01/09/2021	8.17
	Total	36,650,000	-	21,638,056	-	Average 7.48%

The following table shows the structure of the accounts payable[125].

Table 43: *Structure of Accounts Payable*

Accounts payable	Amount	%
Optima Grupa	25,624,345	58.34
Heavy fuel oil (heating season 2015/2016) Banja Luka City Authority	7,945,763	18.09
Brod Oil Refinery	4,804,638	10.94
Electricity Distribution Company (no interest rate included)	2,916,747	6.64
Other suppliers	2,633,515	6.00
Total	43,925,008	

Total current liabilities amounted to 65,528,927 BAM as of 31 Dec 2015, and compared to 2014, they increased by 14,757,743 BAM. This increase in short-term liabilities in 2015 was mostly related to the increase in the accounts payable to suppliers and additional liabilities towards the Banja Luka City Authority for borrowed heavy fuel oil. As discussed in the section related to fuel supply, the situation with securing the oil fuel supply for 2015/2016 was resolved by the Banja Luka City Authority's decision to buy the fuel directly from new suppliers and borrow it to the Company. The reason for the borrowing arrangement was that the Company was not able to directly make purchasing and financing arrangements with suppliers in this period.

The following table provides an overview of invoiced and collected claims[126].

Table 44: *Overview of Invoiced and Collected Accounts Receivable*

No.	Structure	Invoiced in 2014	Invoiced in 2015	Collected in 2014	Collected in 2015
1	Customers - business consumers and reschedules	6,562,670	7,584,072	3,752,659	4,466,188
2	Customers - residential consumers (apartments)	17,066,595	15,944,632	15,708,873	14,794,741
3	Customers - residential consumers (calorimeter)	1,223,790	2,068,017	1,068,820	1,576,973
4	Customers – Others	117,806	64,405	119,658	88,367
5	Connection fee	102,930	197,170	101,353	174,774
	Total	25,073,791	25,858,297	20,751,363	21,101,043

The average level of receivables collection during the period 2012-2015 was 84% of the amounts invoiced to customers. At the end of 2015, short-term receivables from customers amounted to 15,483,019 BAM.

In the period from 1999 to 2015, the Company filed a total of 33,951 lawsuits against residential consumers, totalling 29,170,840 BAM (13,623,555 BAM has been paid from the lawsuits).

125 *Ibid*.
126 *Ibid*.

On the basis of an analysis of the liquidity of the Company and its ability to settle its liabilities at the time of their claim, it is evident that the Company is facing liquidity issues[127].

***Table 45:** Liquidity Analysis*

No.	Position	2014	2015
1.	Short-term receivables , investments and cash	17,631,701	21,086,197
2.	Current asset	20,822,284	23,627,101
3.	Short-term obligations	50,771,184	65,528,926
4.	Percentage of risk realization of short-term receivables and short-term investments	17.24%	18%
5.	Optimal liquidity ratio (100/(100-17))	1.2	1.2
6.	Quick liquidity ratio (1/3)[128]	0.35	0.32
7.	General liquidity ratio (2/3)[129]	0.41	0.36

According to accounting records, the total assets of the Company amount to 69.082.968 BAM, whereas total liabilities amount to 93.130.764 BAM, and the accumulated losses exceed the amount of equity by 24.047.796 BAM. The following table provides an overview of the Company's solvency ratio - the possibility of the Company to pay all the debts that can be claimed. Considering that the solvency ratio in 2015 was 0.74, it may be concluded that the Company is facing insolvency issues[130].

***Table 46:** Solvency Ratio*

No.	Position	2014	2015
1.	TOTAL ASSETS – accounting value	63,443,326	69,082,968
2.	TOTAL LIABILITIES– accounting value	83,422,630	93,130,764
3.	Solvency ratio (1/2)	0.76	0.74

All the business performance indicators of the Company are also negative given the negative business results.

***Table 47:** Company Performance Ratio*

No.	Position	Year		
		2013	2014	2015
1	Operating revenues	24,249,846	21,659,392	22,275,177
2	Financial revenues	81,248	3,281	492,390
3	Business and financial revenues (1+2)	24,331,094	21,662,673	22,767,567
4	Loss of regular activities	12,061,693	9,545,865	2,310,316
5	Ratio of performance	0.5	0.44	0.10

However, if the business results in 2015 are compared to the previous years, it is evident that the losses were significantly reduced from 12 million BAM in 2013 to 9.5 million BAM in 2014 and 2.3 million BAM in 2015. It is important that those trends are continued towards sustainably profitable business performance.

[127] *Ibid*.
[128] Quick liquidity ratio should be more than 1.20 in order to be liquid
[129] Generally, the liquidity ratio should be around 2 or between 1 and 2 in order to maintain liquidity
[130] Business Report for 2015 – "Toplana" Banja Luka

3.6.15 Overview of Investments

In the period from 30 June 2012 - 31 Dec 2015, the Company invested 21.975.352 BAM in its fixed assets[131].

Table 48: *Overview of Investments in 2015*

No.	Description	Amount without VAT (BAM)
1	Investment in rehabilitation and reconstruction of distribution network	2,665,136
1.1.	Investment in material and work on distributive network	1,880,111
1.2.	Investment in machine work and material on distributive network	785,025
2.	Source investment	837,794
2.1.	Investments in machine work and material on the source	183,375
2.2.	Investment in equipment on the source	654,419
3.	Total investment	3,502,930

Investments made in the past three years were necessary in order to improve the condition of the distribution network primarily to cut the losses in the heat distribution as well as hot water leakages. Reconstruction of the old distribution network pipeline enabled the Company to dramatically reduce its fuel consumption and therefore stabilize its costs and decrease the losses in 2015. Furthermore, investments into the new biomass thermal plants are significant initial steps towards the replacement of the expensive heavy fuel oil with cheaper and locally available biomass fuel.

3.6.16 Description of Decision Making Process

3.6.16.1 Organizational Structure of the Banja Luka City Authority and Decision Making Process

The City of Banja Luka is a local self-governance unit, and has competences based on the *Law on Local Self-Government of RS*. Its authorities are:

- City Council,
- City Administration,
- Mayor.

The organizational structure of the Banja Luka City Authority is presented in the following graph[132].

131 *Ibid*.
132 http://www2.banjaluka.rs.ba/static/uploads/kategorije1/administrativna_sluzba/GUBL-sema.jpg

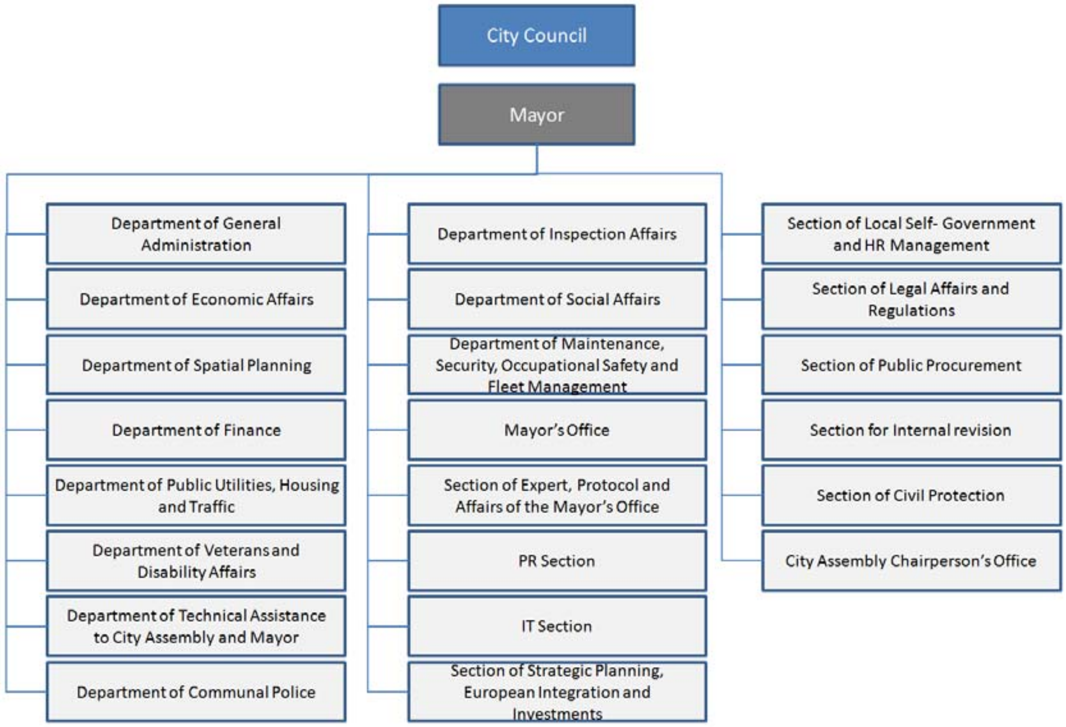


Figure 44: *Organizational Structure of the City of Banja Luka*

3.6.17 Overview of Main Revenues and Expenses of the City

Analysis of the City budget includes an analysis of budget revenues and expenditures for the past three years. Table below shows the budget structure of the City of Banja Luka for the period 2013. -2015.

Table 49: *Budget of the City of Banja Luka for the Period 2013-2015*

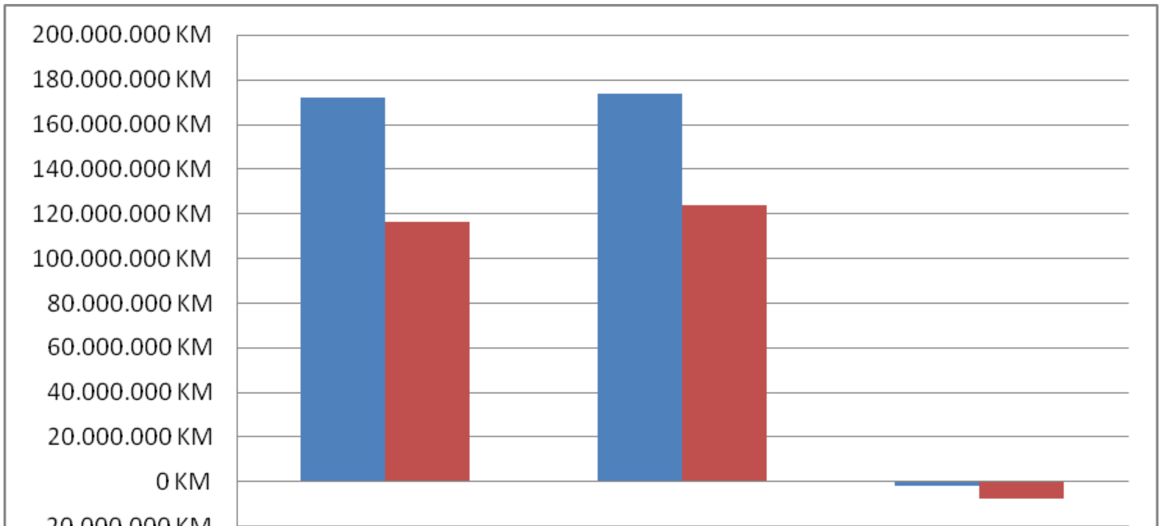
Description	Execution	Execution[133]	Plan[134]
	31/12/2013	31/12/2014	2015
A. BUDGET REVENUE (I+II+III+IV)	110,086,970.77	107,359,901.34	107,870,000.00
I Tax revenue	69,265,157.20	65,618,069.66	64,088,000.00
Revenues from taxes on income and profits	0.00	1,276.83	1,000.00
Taxes on personal income and income from self-employment	17,062,530.50	14,790,721.67	14,457,000.00
Property tax	5,720,601.90	5,549,323.23	5,553,000.00
Taxes on goods and services (arrears)	313,009.45	356,083.58	427,000.00
Indirect taxes allocated from UIO	46,126,770.15	44,887,216.95	43,600,000.00
Other taxes	42,245.20	33,447.40	50,000.00
II Nontax revenue	37,897,788.76	38,154,188.73	40,562,000.00
Income from financial and non-financial assets			
and exchange rate gains	5,717,003.30	5,328,253.77	5,913,000.00
Fees, taxes and income from public services	28,610,282.91	28,136,389.03	30,570,000.00
Fines	227,772.00	209,275.80	189,000.00

[133] Consolidated Report on Budget Execution of the City of Banja Luka for the period 01/01-31/12/2014
[134] Revised Budget of the City of Banja Luka for 2015

Description	Execution	Execution[133]	Plan[134]
Other nontax revenue	3,342,730.55	4,480,270.13	3,890,000.00
III Grants	9,160.80	386,362.22	20,000.00
Grants	9,160.80	386,362.22	20,000.00
IV Transfers	2,914,864.01	3,201,280.73	3,200,000.00
Transfers between budget units of different government levels	2,914,864.01	3,201,280.73	3,200,000.00
B. BUDGET EXPENDITURE (I+II+III)	90,975,538.02	90,198,925.86	87,916,610.00
I Current expenditure	90,975,538.02	89,991,300.51	87,692,110.00
Expenditure for personal income	36,650,484.95	36,503,569.88	36,642,900.00
Expenditure for goods and services	28,725,569.29	25,998,428.02	24,963,310.00
Financing expenditure and other financial expenditure	7,462,345.47	8,445,166.43	7,655,900.00
Subsidies	1,908,559.09	1,190,475.21	1,555,000.00
Grants	5,066,271.05	4,180,061.29	4,768,800.00
Remittances to individuals who are paid from the state budget and the City	11,162,308.17	13,673,599.68	12,106,200.00
II Transfers between budget units	0.00	207,625.35	124,500.0
Transfers between budget units of different government levels	0.00	207,625.35	124,500.00
III Budget reserve	0.00	0.00	100,000.00
V. GROSS BUDGET SURPLUS/DEFICIT (A-B)	19,111,432.75	17,160,975.48	19,953,390.00
G. NET EXPENDITURE FOR NONFINANCIAL ASSETS (I-II)	-19,718,588.45	-10,441,495.84	-9,782,390.0
I Invoice for non-financial assets	3,496,973.75	3,535,868.43	4,579,000.00
II Expenditures for non-financial assets	23,215,562.20	13,977,364.27	14,361,390.00
	-607,155.70	6,719,479.64	10,171,000.00
D. BUDGET SURPLUS/DEFICIT (V+G)	-1,024,867.47	-13,959,330.53	-10,171,000.00
	-9,926,357.10	57,585.90	21,000.00
Đ. NET FINANCING (E+Ž)	73,642.90	57,585.90	71,000.00
E. NET REVENUE FROM FINANCIAL ASSETS (I-II)	10,000,000.00	0.00	50,000.00
I Financial assets revenue	8,901,489.63	-14,016,916.43	-10,192,000.00
II Financial assets expenditure	58,094,155.43	5,513,505.22	6,210,000.00
Ž. NET BORROWING (I-II)	49,192,665.80	19,530,421.65	16,402,000.00
I Revenue from debts	-1,632,023.17	-7,239,850.89	0.00

According to the "Consolidated Report on Execution of the 2014 Budget"[135], the total accumulated deficit of the City of Banja Luka amounted to 10,413,621.06 BAM as of 31 Dec 2014. The deficit in 2014 consisted of uncovered deficit of the City from 2012, and uncovered deficit from 2014 in the amount of 7,239,850.89 BAM. During 2014, funds from loans were used to cover the budget deficit in 2013.

[135] Consolidated Report on Budget Execution of the City of Banja Luka for the period 01/01-31/12/2014



	Revenues	Expenditures	Deficit
2013	171.751.743 KM	173.383.766 KM	-1.632.023 KM
2014	116.466.861 KM	123.706.712 KM	-7.239.851 KM

Figure 45: *Overview of Revenues, Expenditures and Deficit of the City of Banja Luka in 2013 and 2014*

The structure of budget revenues consists of tax and non-tax revenues, grants and transfers. Looking at the percentage of the shares in total revenues, tax revenues accounted for 61% of realized revenues of the City in 2014.

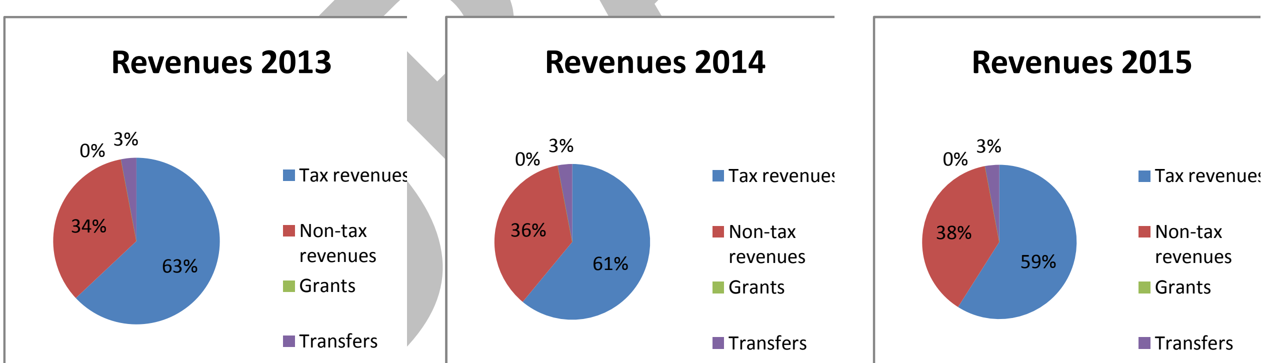


Figure 46: *Share of Revenues in the Total Budget of the City of Banja Luka for the Period 2013-2015*

The structure of budget expenditures consists of current expenditures (expenditures for personal income, expenses from the use of goods and services, financing expenses and other financial expenses, subsidies, grants), transfers between budget units and budget reserve. Expenditures in 2015 are planned in total amount of 87,916,610.00 BAM and are for 3.4% less than in 2013.

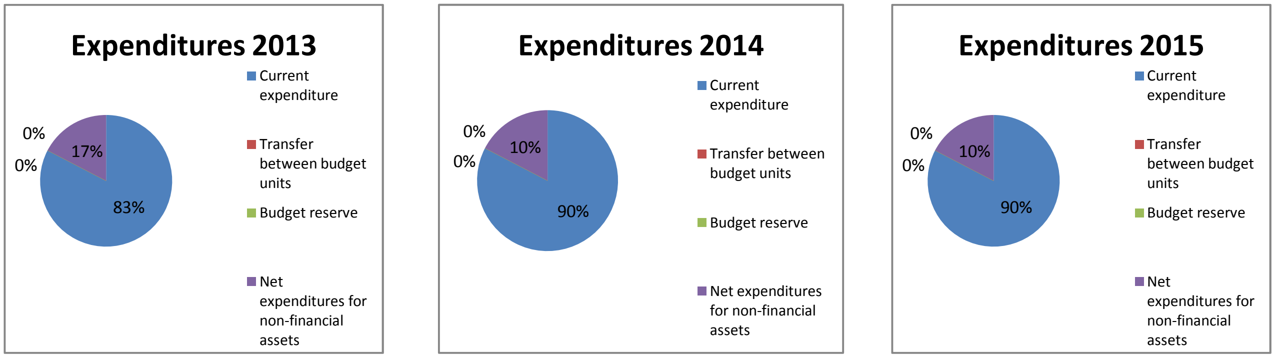


Figure 47: *Share of Expenditures in the Total Budget of the City of Banja Luka for the Period 2013-2015*

By the end of 2014, the total debt[136] of City of Banja Luka amounted to 114,089,130.40 BAM. Long-term liabilities accounted for 111,352,575.76 BAM (debt to domestic creditors 98,053,207.36 BAM and debt to foreign creditors 13,299,368.40 BAM), and the debt on short-term borrowings was 2,736,554.64 BAM[137].

[136] The stock of debt is expressed as the difference between the amount of credit drawn down and the amount of principal repayment

[137] Consolidated Report on Budget Execution of the City of Banja Luka for the period 01/01-31/12/2014

Table 50: *Overview of Debts of the City of Banja Luka as of 31 Dec 2014*

No.	Description	Principal amount	Out of which		Interest rate	TOTAL
			Amount of credit withdrawn	Amount of credit undrawn		
1.	Long-term borrowing from domestic commercial banks	98,053,207.36	98,053,207.36	0	31,035,902.98	129,089,110.34
2.	Long-term borrowing from foreign creditors	17,897,757.85	13,299,368.40	4,598,389.45	2,071,325.06	19,969,082.91
3.	Short-term borrowing from domestic commercial banks	2,736,554.64	2,736,554.64	0	57,152.85	2,793,707.49
	Total	118,687,519.85	114,089,130.40	4,598,389.45	33,164,380.89	151,851,900.74

The City of Banja Luka has not issued any guarantees in 2014 to legal entities whose majority owner is the City itself. According to the *Law on Borrowing, Debt and Guarantees of RS*[138], local self-governance units (municipalities/cities) can be indebted up to 18% of their annual revenues. The total exposure of local government on guarantees issued must not exceed 30% of their annual revenues.

Local authorities may issue guarantees based on the decision of the Municipal Assembly or City Council. In accordance with the above principles and limitations of debt local governments in RS, it is possible to estimate the credit potential of Banja Luka, as presented in the following table:

Table 51: *Overview of the Credit Potential of the City of Banja Luka*

Description	Amount
The amount of revenue for the calculation of the potential according the Law on borrowing, debt and guarantees [139]	118,660,000.00
Short-term	5,933,000.00
Long- term	21,358,800.00

The City of Banja Luka has invested significant resources in the development and modernization of the heating system in the last 20 years. According to the Business report for 2015[140], the City invested 73,904,363.00 BAM in the Company, and the funds were distributed through the following phases:

Table 52: *Investments of the City of Banja Luka in the Company*

Phases	Description
Restoration of heating system and putting DH in operation	City has invested 10,000,000.00 BAM to restore system, the rehabilitation and reconstruction of manufacture and electrical equipment, distribution networks, substations, installation of central heating, as it was out of function after the war.
Purchase of heavy fuel oil (HFO) in the period 2003 -2012	In this period City has allocated 43,385,130.00 BAM for the purchase of HFO in order to maintain regular and continuous heating of the City. In 2012, loans funds of the City revenue were in the amount of 27,800,000.00 BAM. This money has largely been used to pay for HFO, which was previously purchased, and in small part for the purchase of

[138] Law on Borrowing, Debt and Guarantees of RS ("Official Gazette of RS", No. 25/11)
[139] Budget of the City of Banja Luka for 2016
[140] Business Report for 2015 – "Toplana" Banja Luka

Phases	Description
	HFO for the heating season 2012/13.
Recapitalization in 2013	The city invested 10,000,000.00 BAM in recapitalization and the entire amount was used to pay for heavy fuel oil, which was acquired in 2011.
HFO borrowing in 2003-2007	During this period, the City purchased and loaned HFO to the Company in the value of 10,519,233.00 BAM. To this date, borrowed fuel oil has not been repaid in full.
Pensioner heating subsidies in 2013	City allocated 1,000,000.00 BAM to the Company for subsidizing part of the heating costs for pensions' population.
City guarantee for debt repayment	In the period from 2006 to 2011, the City of Banja Luka gave a guarantee to banks in total amount of 23,900,000.00 BAM in order to repay debts that Company had for purchasing heavy fuel oil.
City of Banja Luka guarantee in 2015	Banja Luka signed a loan agreement in the amount of 7,800,000.00 BAM from the Fund for Development and Employment of RS, together with the Company. The purpose of the credit line is the purchase of heavy fuel oil.

The following tables provide the information on total investment of the City of Banja Luka in the Company and overview of loans for which the City of Banja Luka is co-borrower or guarantor for the repayment[141], [142].

Table 53: *Total Investment of the City of Banja Luka*

No.	Period of investment	Form of investment	Amount in BAM
1.	Until 2001	Rehabilitation of the heating system and put back into operation.	10,000,000
2.	From 2003 to 2007	Borrowing of HFO	10,519,233
3.	From 2003 to 2012	Purchase of HFO	43,385,130
4.	2013	Recapitalization (10,000,000 shares)	10,000,000
Total			73,904,363

Table 54: *Overview of Loans from Commercial Banks*

No.	Creditor	Loan amount (BAM)	Mortgage over the property of the Company	Co-guarantees of City of Banja Luka	Guarantees of the City of Banja Luka
1.	Hypo Bank	1,442,525	Yes	Yes	No
2.	Hypo Bank	602,066	Yes	Yes	No
3.	Hypo Bank	1,500,000	Yes	Yes	No
5.	Hypo Bank	355,409	Yes	Yes	No
6.	Hypo Bank	3,000,000	Yes	No	No
7.	Hypo Bank	4,750,000	Yes	No	No
9.	Nova Banka	5,000,000	Yes	No	No
10.	Nova Banka	20,000,000	Yes	No	Yes
	Total	36,650,000	-	-	-

3.6.18 Review/Analysis of Existing Studies and Identified Shortcomings

The study of the European Investment Bank (EIB) prepared in 2007 at the request of the City of Banja Luka contains estimates of the necessary investments in the Company.

Table 55: *Overview of Necessary Investments in the Company According to the 2007 EIB Study*

[141] *Ibid*.
[142] *Ibid*

No.	Description	Amount (in EUR)
1.	Modernization of the boiler room	4,700,000
2.	Investments in environmental protection	1,300,000
3.	Improving the primary network	10,500,000
4.	Improving the secondary network	15,000,000
5.	Modernization of substations	3,600,000
6.	Installing heat meters in buildings	2,600,000
7.	Total	37,000,000

Considering the above elaborated financial position of the Company, it is possible to identify several key long and short term priorities with the aim of improving the economic and financial aspects of the Company. The legal and financial capabilities of the City of Banja Luka have also been taken into consideration for possible improvements.

Table 56: *Key Priorities*

No.	Priority	Description	Time of implementation	Responsibility
1.	Implement tariff calculation system	Determined by the Decision on general conditions for heat delivery	In the short term	Company/City of Banja Luka
2.	Installation of common and individual calorimeters	Installation of common and individual calorimeters can reduce use of fuel for 5-10%	In the long term	Company
3.	Create operational strategy of increasing the number of customers	Conduct a satisfaction survey about existing heating system within customers and customers who voluntarily disconnected from the network, to determine the reasons for arbitrary exclusion of consumers in shared facilities, and determine the potential extent of new customers	In the short term	Company
4.	Prevent heat theft	In accordance with Article 9 of the Municipal Police Law this is in their jurisdiction. The possibility of additional 3 million BAM revenues.	Continuously	Company/City of Banja Luka
5.	Reschedule existing long-term liabilities	Rescheduling obligations incurred in the past that are continually increasing.	In the short term	Company/City of Banja Luka
6.	Ensure own current assets	These funds would allow the purchase of fuel oil during the off-season or when the price on the world market is the lowest. (Capacity of the tank for crude oil is 11,500 tons and is sufficient for storage of half of the oil necessary during the heating season).	In the long term	Company/City of Banja Luka
7.	Analyse the possibilities of raising the percentage of collection of sale revenues (target 95-98% from the current 84%) in the next three years	Could be achieved through subsidies for heating for various categories of customers (introduction of proportional rate subsidies according to the income level)	Continuously	City of Banja Luka
8.	Shorten the collection period of receivables from	Ensure efficiency in the work of the Basic Court in Banja Luka and the	Continuously	City of Banja Luka

No.	Priority	Description	Time of implementation	Responsibility
	8.5 months to a maximum of 3 months	period of solving utility cases		
9.	Subsidies to households on the implementation of energy efficiency measures	Subsidize interest costs	Continuously	City of Banja Luka

According to most studies performed, the district heating sector in Bosnia and Herzegovina is generally described as being in bad conditions, poorly maintained and obsolete, requiring considerable modernisation.

The most complete and the most important study performed for the district heating system of Banja Luka is the „Feasibility Study for the Banja Luka Hot Water Leakage Prevention and Environmental Enhancement Project“, funded by European Commission under its programme for the Environment Project Preparation Facility for Western Balkans. The European Investment Bank (EIB) initiated this Study in order to assess the viability of the project and its impact on the beneficiaries. The study was completed in July 2007.

The Study reviewed the general profile of City of Banja Luka including a brief description of physical features and socio-economic characteristics of the City followed by a legal and institutional framework for the provision of district heating services. An assessment of the existing status of heating services and infrastructure has been performed, setting the basis for proposed actions and investments needed for the future. The current environmental conditions in the City of Banja Luka and the current environmental performance of the Company are considered together with the analyses of the current financial situation. This analysis highlighted the specific financial position of the Company in terms of profitability and financial sustainability of operations. Recent heat supply, demand forecast and an analysis of the future supply of heating services for the City are described and evaluated, as well as alternative development options for supply of heating services for both short and long term requirements, and the options for regulatory compliance achievement. The strategic long term investment plan, which brings together the least costs development option for heating services, is presented, discussing the proposals for priority investment needs for heating services with cost estimates.

This Study proposed the ways to improve the level and efficiency of heating services in the City and to make them financially sustainable in the long term. It contained components yielding towards high economic and financial rates of return, reduction in energy consumption and efficiency improvement in the provision of heating services. The implementation of the Project predicted the achievement of important environmental objectives and improvements for the City including reductions in pollution levels and improved environmental protection.

The City was found to be concerned with the continuous deterioration of the heating infrastructure and the costs and high usage of energy in the provision of services. At that time, the City set as a priority the improvement in efficiency of operations by rehabilitating the heating infrastructure. A number of operational problems were persisting:

- high energy usage as a result of inadequate regulating and control systems,
- high hot water losses,
- old and deficient network, which reduces operating efficiencies.

The Study identifies that the network is generally in bad condition and suffers from external and internal corrosion. External corrosion is due to damaged insulation coatings that allow outside water from the ground to penetrate into the pipeline structures and corrode the steel pipes. In addition, the outside water damages the heat insulations, increasing heat losses and increasing the corrosion speed. Internal corrosion is due to inadequate quality of the makeup water. Substantial amount of make-up water is added to the network continuously. The make-up water contains oxygen, as the current water treatment processes do not include any removal of gases from the water. Furthermore, the pH value of the make-up water is slightly too low (about 8,0-8,5) instead of the more optimal value of 9-10 that would minimise the corrosion rate. The environmental consequences for the surrounding ground and groundwater in the vicinity of leaks from the network is unlikely to be significant. The water does not contain corrosion inhibitors or other substances of concern. Of greater concern is the inefficiency and waste of heat energy which arises from this loss.

There is some indication that a number of the heat exchangers within the substations are leaking. Moreover, the automatic control systems fitted to many of the substations are not operational. As with the primary network, the consequences of the water leakage and the poor control systems are of greatest concern in terms of energy efficiency.

The Study eventually concluded that the heat supply system in Banja Luka suffers from a number of problems, including high heat and water losses, relatively high electricity consumption, operational problems, inadequate quality and quantity of heat supply to the customers, and relatively high costs of heat supply. Modernisation of the current heat supply system, involving heat production, transmission and distribution systems represents the Least Cost Option, as compared with the other potential development options for heat supply to the central districts of Banja Luka. Complete modernisation of the heat supply system would contribute to about 27% savings in fuel consumption; 93% savings in water consumption and 70% savings in electricity consumption. Due to the high costs of investments, modernisation should be undertaken in several phases, allowing for financial sustainability of the operations. The investments should be prioritised, starting with the most urgent needs to achieve the highest rates of return.

Apart from these recommendations, the Study recognized further future development options such as introduction of variable flow operation in the network, introduction of individual heat measurement, either at the substations or at the individual buildings, introduction of flow meters at the substations between primary and secondary networks, to monitor the water consumption at secondary networks and extension of the network to supply new customers at the existing heat supply areas, or close to them.

Main findings from the existing situation review were as follows:

- The total annual efficiency of the Company operations, defined as heat supply to customers vs. fuel use, is about 60%;
- Due to the lack of metering and controlling equipment, the amount of heat and water losses in different parts of the system cannot be exactly defined;
- Heat supply from the Company boiler house has large variations over the day, which causes unstable temperature conditions for customers, networks and boilers;
- Heat supply is insufficient for all customers in some parts of the network;
- In the coldest periods, all four the Company's boilers are in operation;
- Water consumption for the Company's system is about 45 times higher than in typical Western European district heating systems;
- Water leaks occur both in the primary and secondary networks;
- Water treatment capacity employed by the Company is sufficient. Removal of gases from the water would further enhance the water quality and prevent corrosion;
- The substations owned and operated by the Company are generally well maintained and operative, but some of them are old and outdated;
- Demand management of heat in Banja Luka can best be promoted by installing automated controls and heat meters at substations and customer buildings.

The following observations and recommendations were made:

- Modern substations for each building or group of buildings should be installed to allow customer buildings to regulate their heat use according to the actual heat demand;
- If invoicing is not based on the actual heat consumption, or heat tariffs do not promote efficient use of heat in the buildings, the building control systems should be equipped with return temperature regulation;
- Make-up water from the primary network to the secondary networks should be measured and monitored. If most of the water consumption in the district heating system originates from leaks in the buildings installations, higher water consumption tariffs could be introduced;
- The Company would have to be radically changed if its responsibilities are extended to cover renovation of buildings as has been suggested in the past. Most commonly, passive retrofits are implemented for each building separately, in connection with the overall renovation of building surfaces. Such programmes for renovations could be implemented by the City administration or the building owners themselves.

The proposed priority investment programme comprised improvements in operations and management practices for heating services. These included:

- modernisation of the boiler house,
- environmental improvements,
- modernisation of the Borik heat transmission line,
- modernisation of the substations,
- technical assistance,
- consultancies costs.

A total investment package of around 44.7 million BAM was proposed (VAT inclusive). These values were in current prices at that time (including provision for inflation) and included provision for supervision, taxes and contingencies. This was expected to be made up of a loan from the EIB of 38 million BAM (85%) and Local Equity of 6.7 million BAM (15%). The proposed investments would improve the efficiency of the Company's operations and as such significantly reduce the demand for fuel, water and energy, which will result in significant environmental benefits. Specifically the investments would reduce CO_2 emissions which would alone yield an annual benefit of around 400,000 BAM per annum.

„The City of Banja Luka Sustainable Energy Action plan – SEAP“, completed in November 2010, in terms of the DH system, mostly relied on Feasibility Study for the Banja Luka Hot Water Leakage Prevention and Environmental Enhancement Project. Significant energy savings and the associated carbon dioxide emission reduction are expected in the district heating sector, where special attention is to be paid to the modernization of distribution networks, heat substations and the boilers in the heating plant. Particular attention is to be paid to the activities related to the use of geothermal energy. Series of activities around geothermal exploration works should provide a response to the potential use of this renewable energy resource, whose involvement in the energy balance of the City would result in achievement of the most significant reduction in carbon dioxide emissions.

Currently DH system work is largely inefficient due to the lack of control and the large leakage from the network. Complete modernization of the system would contribute to saving of about 27% of fuel, 93% in water consumption and 70% in electricity consumption.

This document outlines a modernization plan for the boiler room, primary and secondary distribution networks and substations, as well as the installation of the heat meters in buildings. Total investment needed for the DH system, in order to achieve planned reduction in CO2 emissions by 2020, amounts to 36.5 million euros. As a result of this Action Plan implementation, the district heating system will in 2020 achieve reduction in the consumption of fuel oil of about 4,500 tons compared to a scenario without the implementation of the proposed measures. This corresponds to 50,293.88 MWh of thermal energy or 14,020.92 tons of CO_2 emission reduction.

„Study of Energy Sector in BiH, module 9“, pertaining to district heating sector, included a review of all existing district heating companies in BiH. Available data on existing district heating systems and their competitiveness were collected and analysed. This Study gave only basic overview of the Company, such as production, metering, transport and distribution system characteristics, as well as the heat prices and collection share. This Study was funded by The World Bank and completed in March 2008.

„Strategy of Energy Development of Republika Srpska until 2030“, completed in August 2010, finds the district heating sector to me in difficult and complex position. Main problems are the age low efficiency and poor maintenance of the production capacities, poor state and high losses in networks, difficulties in metering and payment of delivered heat, low prices of heat and difficult economic position of DH companies. The Strategy predicts DH sector activities to be directed to a construction of new and rehabilitation of existing capacities, with the conversion from the fuel oil to a natural gas. It also considers reduction in heat distribution losses and collection share increase. Gasification of this region will affect the DH sector development. All the scenarios predict the development of high efficiency gas CHP plant in Banja Luka with a gradual conversion of fuel oil with the gas in DH plants.

„Rural Development Strategy of the City of Banja Luka 2010-2015“, completed in February 2010, mentioned reduction of energy consumption and fossil fuels negative impacts, as well as the increase in renewable energy sources, as one of the main goals of the City. As a signatory of the Covenant of Mayors, Banja Luka is committed to work towards the increase in energy efficiency, the use of energy from renewable sources and reduction of greenhouse gases emissions compared to those defined by EU policies.

Banja Luka region may have geothermal resources relatively close to the earth’s surface. The issue has been discussed in some theoretical studies, but no actual geothermal investigations have been carried out to verify the potential for exploitation of geothermal resources. At this stage, geothermal
energy remains as a distant future possibility for district heating production. If geothermal energy becomes available in the future, the Company’s centralised heat transmission and distribution network would provide an ideal solution for supplying the heat energy to the customers.

Natural gas is currently not available in Banja Luka. There are plans to construct a natural gas pipeline to the region, but no actual decisions have been made so far. If natural gas becomes available in Banja Luka in the future, the Company’s heat production could be converted from HFO to natural gas with only small investments.

3.6.19 Environmental Assessment of Current DH Operations

3.6.19.1 Analysis of Impact of Current DH Operations on Air Pollution

The energy supply sector is the largest contributor to global greenhouse gas (GHG) emissions. In 2010 energy supply sector was responsible for 49% of total GHG emissions, and for approximately 35% of total anthropogenic GHG emissions. According to EDGAR (Emission Database for Global Atmospheric Research) and IEA (International Energy Agency) in the period 2000 – 2010 GHG emissions from energy sector increased by 37.1% with tendency of growing approximately 1% per year. Despite the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, GHG emissions grew more rapidly between 2000 and 2010 than in the previous decade. Annual GHG-emissions growth in the global energy supply sector accelerated from 1.7% per year from 1990–2000 to 3.1% per year from 2000–2010.

In 2012 emissions of GHG from energy sector have increased for more than 6% in comparison with emissions in 2010.

From 18 Gt of emitted CO_2 in 2010, 43 % of CO_2 emissions originated from coal combustion, 36 % from oil combustion, and 20 % from combustion of natural gas[143].

[143] IPCC-Climate Change 2014: Mitigation of Climate Change

Greenhouse gases maintain an average temperature of the earth at 15 ° C. Without their impact, or „ greenhouse effect“, the average temperature on Earth would be around 18° C below zero, and life on Earth would not be possible.

Human activities have contributed substantially to climate change. Increasing concentrations of CO_2 by 34%, NO_x by 15%, whereby the concentration of CH_4 has doubled, leading to changes in the thermal balance of the system the Earth - the atmosphere. These greenhouse gas emissions have increased the greenhouse effect and caused Earth's surface temperature to rise[144].

It is estimated that in order to stop the human impact on climate change, GHG emissions should be reduced by 40 % by 2030[145]. Main characteristic of CO_2 is that after the emission it remains in the atmosphere for the next 100 years. Because of this, even if emissions of CO_2 cease, it would take years before the atmosphere is purified from this GHG. But, taking into account the population growth and use of fossil fuels it is inevitable to expect increased emissions of CO_2, which will lead to higher temperature on Earth.

The latest report of *Intergovernmental Panel on Climate Change* – IPCC, emphasizes the danger that is emerging with the global warming of the planet. Eleven out of last twenty years are the warmest years since weather recording began. IPCC states that human activities and use of fossil fuels are the only ones to blame for climate change and by reducing GHG emissions, global warming can be reduced.

3.6.19.2 Analysis of CO_2, SO_2, NO_x and Solid Particles Emissions from Current DH System

An overview and analysis of CO2, SO2, NOx and solid particles emissions from current DH system in Banja Luka is provided in this chapter. The analysis includes current capacity and infrastructure of the existing DH system.

3.6.19.3 Calculation of CO_2, SO_2, NO_x and solid particles emissions

The City of Banja Luka is heated from traditional thermal plant using heavy fuel oil as energy source. Typical pollutant emissions for traditional thermal plant systems are given in Table 57. Real level of emissions depends of exact technology used, year of construction, condition that the plant is in, installed capacity, type and quality of used fuel, emissions reduction equipment that is being used etc. Considering the above, Table 57 provides general, but valid referent parameters in accordance with EU standards[146].

***Table 57**: Typical Emissions Values for Heating Boilers ($\eta_t \approx 80\%$)*

System	Fuel	Specific emissions [g/kWh]					
		CO_2	CO	NO_X	HC	SO_X	Particles
Warm water and hot steam boiler	Natural gas	252.55	0.03	0.39	0.02	≈0	0.02
	Diesel 0.2 % S	322.94	0.06	0.25	0.02	0.37	0.03
	Coal	439.50	0.08	1.36	0.02	2.32	0.20
	HFO	343.73	0.06	0.57	0.02	1.55	0.20
Industrial hot steam boiler	Coal 2% S	439.50	0.16	1.12	0.08	5.65	0.98
	HFO 1%	343.73	0.06	0.78	0.02	2.03	0.30
	Natural gas	252.55	0.03	0.33	≈0	≈0	0.03

[144] http://www3.epa.gov/climatechange/science/causes.html
[145] Trends and Projections in Europe 2015 - Tracking progress towards Europe's climate and energy targets, European Environment Agency
[146] Educogen. The European Educational Tool on Cogeneration. EC SAVE Programme Contract n.XVII/4.1031/P/99-159, second edition, 2001

The quantification of emissions is performed by internationally accepted methods and guidelines of the EU that were obtained through practice, and in accordance with the technical standards (based on IPPC Methodology)[147]. Emissions of pollutants are proportional to the mass of the used fuel that causes the emissions, or mass of the products in whose production emissions occurred. This proportionality is called the emissions coefficient. Pollutant emissions, as a result of heating, depend on the climatic conditions (difference between indoor and the outdoor temperature), while emissions from industry and transport are independent of climatic characteristics of the area, but depend on the capacity of the plant, technology used etc.

Pollutant emissions are being calculated using following formula:

$$E = k * M \qquad (1)$$

Where:

k – Emission coefficient [kg/t] or [g/kWh] which depends on the type of equipment (combustion chamber or technology), capacity and type of fuel, and is determined by combination: calculation and taking into account the data obtained by measuring and using literature data;

M – Fuel mass, type of fuel, energy output (emission coefficient depends on type and mass of the fuel).

3.6.19.4 Pollutant Emissions from DH System in Banja Luka

Thermal energy for heating in Banja Luka is supplied by the Company. Heating energy is supplied only during the heating season, which usually starts around the 15 of October and lasts until the 15 of April. The heating season on average lasts about 188 days. During the heating season, heat is delivered daily from 6 a.m. to 10 p.m. During that time the plant maintains the temperature in the apartments around + 19 ° C (+/- 1 ° C).

The Company has three separate boiler plants. The central boiler plant uses HFO as energy source. Two small boiler plants use wood chips as energy source.

The central boiler plant supplies heating energy to the biggest part of the City. The boiler room has four equal hot water boilers with capacity of Q = 58 MW, which in total provides 232 MW of installed power.

Two small boiler rooms have installed biomass boilers using wood chips as energy source, with total capacity of 16 MW. Biomass boilers have been in operation since 2014.

Data on fuel consumption for the period 2012 - 2015 is provided in Table 58 below.

***Table 58**: Fuel Consumption for the Period 2012 - 2015*[148]

Year	Medium temperature during heating season [°C]	Heavy fuel oil [t]	Wood chips [t]
2012	5.96	22,019.2	-
2013	5.97	21,307.8	-
2014	7.86	17,250.2	1,671.4
2015	6.23	16,564.4	15,382.3

Table 59 provides the main characteristics of heavy fuel oil used in the central boiler plant.

***Table 59**: Main Characteristics of Heavy Fuel Oil Used in Banja Luka*

Fuel	Heavy fuel oil	
Ignition temperature in closed cup app	80	°C

[147] 2006 IPCC Guidelines for National Greenhouse Gas Inventories
[148] "Toplana" Banja Luka, Business report, Banja Luka, February 2016

Viscosity max. at 100 °C	64.5	St
Conradson test max.	15	%
Sulphur content max	3	%
Water content max	5.5	%
Sediment content max	0.5	%
Net calorific value	39,775	kJ/kg

Using formula (1) and data obtained from the Company, calculation of pollutant emissions is shown in Table 60 from combustion of HFO[149].

Table 60: *Pollutant Emissions from Heavy Fuel Oil*

	Year	Installed capacity	Fuel consumption	Pollutant emissions			
				CO_2	SO_2	NO_x	Solid particles
Heavy fuel oil		[MW]	[t]	[t/a]	[t/a]	[t/a]	[t/a]
	2012	232	22,019.2	67,460.66	880.77	344.80	14.98
	2013	232	21,307.8	65,281.13	852.31	333.66	14.49
	2014	232	17,250.2	52,849.78	690.01	270.12	11.73
	2015	232	16,564.4	50,748.68	662.58	259.38	11.27

Comparing the results from Table 60 with the values given in Table 57, which represents typical Emissions Values for Heating Boilers with ηt ≈80%, we can see that in 2015 CO_2 emissions were 50,748.68 t/a, or 324.75 g/kWh (in 2015 Company produced 156.267,92 kW of energy) which is lower than 343,73 g/kWh for warm water and hot steam boiler plants given in Table 57. Having in mind that boiler efficiency (ηt) in the Company is 0,85 it was expected that this data is lower than the data given in Table 57. In same year So_2 emissions from Central Boiler House amounted 662.58 t/a, or 4,24 g/kWh, which is considerably higher than 1,55 g/kWh for warm water and hot steam boiler plants given in Table 57. This high emission of So_2 is caused by high content of sulphur in used fuel.

Since biomass is considered to be CO_2 neutral, Table 61 provides NO_x and solid particles emissions[150].

Table 61: *Pollutant Emissions from Wood Chips*

	Year	Installed capacity	Fuel consumption	Pollutant emissions	
				NO_x	Solid particles
Wood chips		[MW]	[t]	[t/a]	[t/a]
	2014	16	1,671.4	4.64	0.00

[149] Calculation based on formula (1)
[150] 2006 IPCC Guidelines for National Greenhouse Gas Inventories

4 ANALYSIS OF DH SYSTEM REHABILITATION AND MODERNISATION

4.1 Stakeholder Analysis

Stakeholders of the “Rehabilitation and Modernization of DH System in the City of Banja Luka” Project are persons or groups who may be directly or indirectly affected by the Project, as well as those who may have interests in the Project and/or the ability to influence its outcome, either positively or negatively.

The identified stakeholders of the Project include, chiefly, the following:

- public authorities at various government levels who define the energy policies and regulations, and oversee the implementation of such regulations;
- companies in the energy system in Banja Luka (companies for energy transmission and network), primarily the Company as the main heat supply company in Banja Luka; and
- energy consumers and their organized representatives.

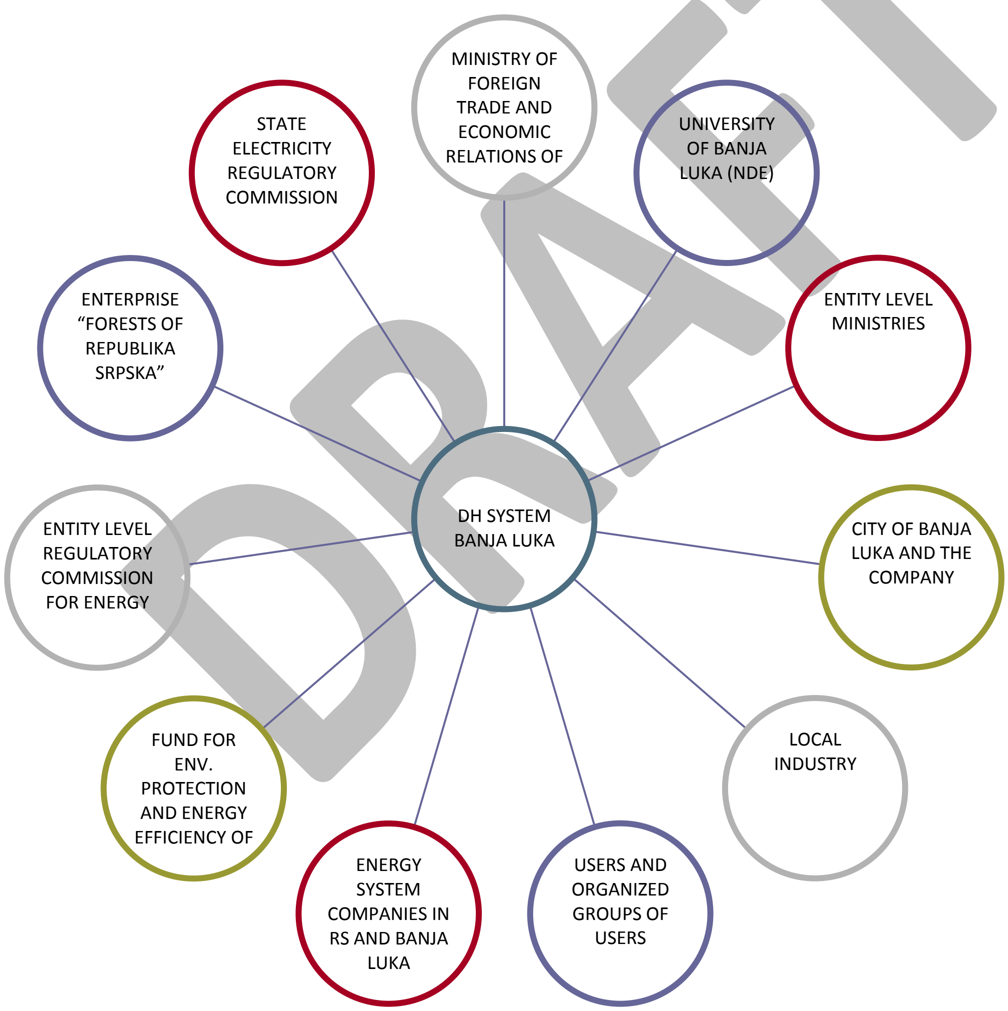


Figure 48: *Identification of Main Stakeholders*

4.1.1 List of Stakeholders

Taking into consideration the administrative complexity of the country and for purposes of practicality, stakeholders have been presented below according to the administrative level of their responsibilities, duties and operations.

4.1.1.1 Stakeholders at the Level of Bosnia and Herzegovina

4.1.1.1.1 Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina (MoFTER)

MoFTER is the main institution in charge of energy policy at the state level. It is responsible for activities and tasks within the jurisdiction of BiH related to defining the policy and basic principles, coordinating the activities and harmonizing the plans of entity level authorities and institutions at the international level in the fields of agriculture, energy, environmental protection, development and use of natural resources and tourism, according to the *Law on Ministries and Other Administrative Bodies*[151].

4.1.1.1.2 National Designed Entity - NDE (University of Banja Luka)

The nationally-selected focal point for technical assistance provided by CTCN for the Project is the University of Banja Luka. The University has been nominated to serve as the national entity for the development and transfer of technologies and act as a focal point for interacting with the CTCN regarding requests from BiH as a party to the UNFCCC about its technology needs. The University is responsible for ensuring the coordination of the support provided by the CTCN at the national level with other processes that address climate change.

4.1.1.1.3 State Electricity Regulatory Commission (SERC)

SERC is the electricity regulator at the state level. It regulates the electricity transmission system in BiH and has jurisdiction and responsibility over transmission of electricity, transmission system operations, and international trade in electricity in accordance with international norms and EU standards. It was established by the *Law on Transmission, Regulator and Operator of Electricity System in BiH*[152].

4.1.1.2 Stakeholders at the Level of Republika Srpska

4.1.1.2.1 Ministry of Industry, Energy and Mining (MIEM)

MIEM was established by the *Law on Ministries of RS*[153] and has jurisdiction over energy policies and the use of natural resources. MIEM is responsible for, inter alia:

- exploitation of resources for electricity production,
- promotion of renewable energy sources,
- production and promotion of the use of biofuels,
- monitoring of the impact of economic policy measures on trends in industrial production, energy production and mining.

4.1.1.2.2 Ministry of Spatial Planning, Civil Engineering and Ecology (MSPCEE)

MSPCEE was established by the *Law on Ministries of RS*[154] (Article 15), and is the competent authority for:

- integrated planning and spatial planning,
- development and implementation of the Spatial Plan of Republika Srpska,
- revision, supervision and approval of the spatial planning documents of cities, municipalities and special areas,

[151] Official Gazette of BiH, No. 5/03, 42/03, 26/04, 42/04, 45/06, 88/07, 35/09, 59/09 and 103/09
[152] Official Gazette of BiH, No. 07/02, 13/03, 76/09 and 1/11
[153] Official Gazette of RS, No. 70/02, 33/04 and 33/06
[154] Official Gazette of RS, No. 70/02, 33/04 and 33/06

- urban development planning and construction,
- development of civil engineering, housing construction and its financing, housing cooperatives, housing relations, maintenance and management of buildings and apartments,
- public utilities,
- protection of the environment, as well as natural and cultural heritage,
- matters regarding the energy performance of buildings,
- issuance of Environmental, Urban and Construction Permits.

4.1.1.2.3 Ministry of Administration and Local Self- Governance (MALSG)

MALSG was established by the *Law on Ministries of RS*[155] (Article 12) and is responsible for tasks related to, inter alia, the following:

- monitoring of local self-governance units and implementation of legal acts governing the functioning of the companies and services established by local self-government units,
- public administration system and organization,
- system of public services,
- drafting of laws and by-laws within the Ministry's jurisdiction,
- administrative fees,
- citizens' associations,
- development of reports on the implementation of policies of local self- governance units,
- implementation of laws and regulations.

4.1.1.2.4 Ministry of Agriculture, Forestry and Water Management (MOFWM)

MOFWM was established the *Law on Ministries of RS*[156] (Article 12) for tasks related to, inter alia, the following:

- improvement of forestry production, breeding, protection, development and improvement of forests, state of wood resources,
- exploitation of forests,
- forestation of degraded and sprout forests, bare mountainous terrains and karsts,
- improvement of production in forestry.

4.1.1.2.5 Public Forestry Enterprise "Forests of Republika Srpska"

Public forests in RS are managed by the public enterprise "Forests of Republika Srpska" which was established in 1995 under the jurisdiction of the above described MOFWM. It performs activities related to forestry management, forestry and forest protection, wholesale trade of wood, wholesale trade of the other semi-final products and retail trade of fuel wood. As such it is one of the main stakeholders with its annual production of forestry products of about 4 million cubic meters. A significant part of the products are cellulose wood and fire wood suitable for use as biomass after chipping to wood chips.

The enterprise is divided into Forest Management Units (FMU) which may establish Forest Management Administrations (FMA). The FMU "Banja Luka" and the FMA "Donje Vrbasko" are based in Banja Luka.

4.1.1.2.6 Regulatory Commission for Energy of RS (RERS)

Established by Article 12 of the *Law on Electricity*[157], RERS regulates and monitors the relations in the electricity, gas and oil markets, pursuant to provisions of the mentioned Law and competences assigned to it by legislation in the electricity, gas and oil sector, ensuring the application of the principles of transparency, non-discrimination, fairness, stimulating competitiveness and protection of end users.

Its responsibilities within the electricity sector include:

[155] Official Gazette of RS, No. 70/02, 33/04 and 33/06
[156] Official Gazette of RS, No. 70/02, 33/04 and 33/06
[157] Official Gazette of RS, No. 66/02

- supervision and regulation of relations between generation, distribution and electricity customers including electricity traders,
- prescription of methodology and criteria for determination of prices for the use of distribution network and supply prices for non-eligible customers as well as methodology for determination of fees for connection to the distribution network,
- development of the tariff system for the sale of electricity and the use of the distribution network,
- determination of tariff rates for distribution system users and tariff rates for non-eligible customers and issuance or revocation of production,
- distribution and trade of electricity permits.

4.1.1.2.7 Fund for Environmental Protection and Energy Efficiency of RS

Established by the *Law on Environmental Protection Fund and Financing of RS*[158], the Fund provides financial support for achievement of the objectives and measures on environmental protection and energy efficiency as defined in the strategic documents of RS and local environmental action plans of local self-governance units, in order to raise the quality of the system, protect the environment and natural communities, and ensure the rational use of natural resources and energy.

According to the *Law on Energy Efficiency*[159], the Fund serves as a financing facility for implementation of measures defined in the Energy Efficiency Action Plans[160].

4.1.1.2.8 Mixed Holding "Elektroprivreda Republike Srpske" a.d. Trebinje – holding company (MH EPRS)

Established in 2005 by a *Decision of the Government of RS*[161], MH EPRS is one of three companies in charge of electricity production and distribution in BiH. Its main activities are:

- production of electricity and coal exploitation,
- electricity distribution and supply in RS,
- electricity trade, production, optimization and provision of technical and technological unity of the system for more efficient and rational operations of the Company,
- project management and implementation of projects in the energy sector of RS.

According to the *Law on Renewable Energy Sources and Efficient Co-generation*[162], MH EPRS is authorised by the RS Government S to perform administrative, financial and other operational activities related to the system of subsidies for production of energy from renewable sources and efficient co-generation until the introduction of an Incentives System Operator. For this reason, MH EPRS keeps separate accounting records and a special banking account for the purchase of electricity produced from renewable energy sources and efficient co-generation.

4.1.1.3 Key Stakeholders at the Level of Banja Luka

4.1.1.3.1 City of Banja Luka

According to the *Statute of the City of Banja Luka*[163], the City of Banja Luka is a territorial unit of local self-governance. The City Administration ensures that all decisions and other acts that may be adopted by the City Assembly and the City Mayor are executed.

The City Administration comprises nine departments, among which is the Department for Public Utilities, Housing and Traffic, responsible for activities related to:

[158] Official Gazette of RS, No. 117/11 and 63/14
[159] Official Gazette of RS, No. 59/13
[160] Measures for improving energy efficiency are included into the Energy Efficiency Action Plan of RS as well as in SEAPs (the City of Banja Luka developed and adopted its SEAP in 2010).
[161] No. 02/I-020-60/06, of December 30, 2005
[162] Official Gazette of RS, No. 108/13
[163] Official Gazette of the City of Banja Luka, No. 25/05, 30/07 and 17/12

- the needs of public utility users (including thermal energy supply users),
- common consumption of public utilities,
- construction and maintenance of utility infrastructures in the City,
- arrangement of urban construction land in accordance with the *Decision on Urban Construction Land*,
- maintenance and use of local and unclassified roads, streets and other traffic infrastructure in the City area.

4.1.1.3.2 The Company

The Company was established in 2003 as the main heat supply company in RS which supplies the area of the City of Banja Luka. The majority owner is the City of Banja Luka (77% of shares), whereas the remaining 23% is owned by The Company (19% of shares) and other shareholders (4% of shares).

The company is organized in accordance with the *Law on Public Enterprises RS*[164]*.* The Company's bodies are the Assembly, Management Board, Supervisory Board, and Auditing Board, whose duties are described in detail in the company's Statute[165].

According to the Statute, the company's main activities are:

- production, collection and distribution of steam and hot water for heating, power and other purposes,
- construction and installation works, engineering activities and related technical consultancy,
- wholesale of metal goods, plumbing materials, devices and equipment for plumbing and heating,
- road transport of goods.

4.1.1.3.3 Dependent Enterprise "Elektrokrajina" Banja Luka

"Elektrokrajina" joint stock company (ZP "Elektrokrajina" a.d.) is part of the above described Mixed Holding "Elektroprivreda Republike Srpske". Its main activities are distribution and supply of electricity as well as design, construction and maintenance of electricity supply network and equipment. It supplies app. 47% of consumers on the territory of RS with electricity. It operates and performs its activities according to the *General Conditions for Delivery and Supply of Electricity*[166].

4.1.1.4 Other Stakeholders

4.1.1.4.1 Local Communities (LCs)

There are 57 LCs in the City of Banja Luka. According to the *Decision on Incorporation, Organization, Operations and Financing of LCs in the City of Banja Luka*[167]*,* LCs are a form of direct citizen participation in local self-governance established in an area where there is a common interest, which represents a territorial and a functional unit, where there is mutual connection between citizens and the possibility of achieving common interests and needs in different areas among which are public utilities, settlement planning, environmental protection, health and social welfare.

Each LC has two bodies: Citizens Assembly and Local Community Council. The Citizens Assembly is made up of citizens who have the right to vote and reside in the given LC. During the Assembly sessions, citizens discuss all issues falling within the scope of autonomous affairs of the City of Banja Luka, and may initiate and suggest solutions to certain issues. The Assembly decides on the initiative for the construction and maintenance of public facilities and public infrastructure (such as streets, local roads, water supply, sewerage and electricity networks) - excluding DH infrastructure.

[164] Official Gazette of RS, No. 75/04 and 78/11

[165] Statute of "Toplana" Banja Luka, document No. 04-5802-2/2011, September 23th, 2011, as amended by the Statute on Amendments to the Statute of "Toplana" Banja Luka, September 6th, 2012

[166] Official Gazette of RS, No. 90/12

[167] Official Gazette of the City of Banja Luka, No. 3/10, 17/11 and 25/14

The LC Council consists of citizens elected by the citizens of the given LC, and is responsible for the implementation of the decisions adopted by the Council or Assembly. It adopts decisions on establishing the list of priorities for the construction of utility infrastructure in the area of the LC and cooperates with the Commission for LC of the City of Banja Luka.

The needs of LC are financed by three sources:

- the budget of the City of Banja Luka, in line with the LC or City development plans and programs,
- citizens and legal entities of the LC
- international organizations and other associations.

4.1.1.4.2 Existing and Potential Future Residential and Business Consumers

There are currently 19,079 residential users (private houses and residential buildings) and 946 commercial/institutional users (companies and public enterprises, schools, hospital and other public institutions) of the existing DH supply system.

Organized groups of users include:

a) Homeowner Associations

According to the *Law on Maintenance of Buildings*[168]*,* homeowner associations are established for one or more buildings or parts (functional units) of a building. Such associations have the status of a legal entity and are responsible for matters related to the management of buildings.

Common parts of buildings are the property of flat owners (homeowner associations) who are responsible for decision making in relation to the use and maintenance of common areas, provision and use of funds for maintenance and other issues of importance to such use and maintenance.

Flat owners bear the costs of regular maintenance and investment maintenance, as well as urgent repairs on common parts of buildings. The investment maintenance of common parts includes maintenance of the roof and other structural elements, the façade and other external parts of the building and the wooden and metal parts on windows and doors in the common parts.

Energy efficiency measures could be considered as investment maintenance of common parts of a building.

b) Consumer Protection Associations (CPAs)

CPAs are regulated by the *Law on Consumer Protection in RS*[169], according to which activities related to consumer protection are performed by CPAs operating at the level of RS and local self-governance units. In RS, there are 7 CPAs, two of which are based in Banja Luka.

According to the mentioned Law, CPAs perform activities related to:

- protection of individual and collective interests of consumers,
- providing advice and other assistance for the exercise of the consumers' rights,
- informing consumers about prices, quality control and product safety and services,
- conducting tests and comparative analyses of products and services through accredited or authorized bodies for conformity assessment,
- informing the competent authorities about products or provide services that do not meet the prescribed safety and quality conditions,
- cooperation with all competent authorities including local self-governance, participation in development programs,
- representing consumers in extra-judicial proceedings for the protection of consumers' rights,

[168] Official Gazette of RS, No. 101/11
[169] Official Gazette of RS, No. 6/12 and 63/14

- providing opinions and suggestions during the adoption of legal regulations in the field of consumers.

4.1.1.4.3 Energy Service Companies (ESCOs)

Founding of ESCOs or other legal entities providing energy services on the basis of energy performance contracts is foreseen by the *Law on Energy Efficiency*[170] as one of the measures of energy efficiency improvement.

According to the aforementioned Law, ESCOs may perform energy audits, design, construction, reconstruction, energy retrofit, maintenance, consulting or management and control of energy use. The cost of providing energy services are borne by the beneficiary of energy services or energy service provider, in whole or in part, from its own resources or through third-party financing. In this case the amount that a provider of energy services invests in the provision of energy services is paid from the energy savings achieved in comparison to energy consumption before providing energy services. The provider of energy services or third party takes over all or part of the financial, technical and commercial risk in the provision of energy services in accordance with the energy service contract.

4.1.1.4.4 Assessment of Stakeholder Coordination Mechanisms

With the exception of the legally regulated coordination and reporting mechanisms between the Company and the City of Banja Luka as the majority owner of the enterprise (as elaborated above), there is no existing formalized coordination mechanism between the major stakeholders in the DH sector in the City of Banja Luka. Furthermore, there are no agencies or dedicated institutions involved in energy efficiency and renewable energy sources that may coordinate with other ministries or institutions and the entity level regulatory commissions.

[170] Official Gazette of RS, No. 59/13

4.2 Analysis of Possible Fuel Sources

When it comes to production and consumption of all forms of energy in BiH, the energy derived from coal still dominates with a share of around 45%, followed by liquid fuels (21%) and wood biomass (20.5%), while other forms of energy (hydro power, natural gas and imported electricity) account for about 13%.

The same estimated heat demand is used for all alternatives. The current heat sale in the existing district heating system as presented in the baseline study above amounts to 170 GWh/year in average. Further increase of the system is assumed to be in line with energy efficiency improvement and therefore no increase in thermal needs is expected.

4.2.1 General Availability of Heating Sources in Banja Luka

General solutions for provision of heating to residential buildings, commercial businesses and public institutions are categorised as follows:

- Centralised systems (district heating) for heating of an unspecified number of buildings,
- Decentralised systems for heating of one or several buildings in a defined area,
- Individual heating systems for heating on apartment level.

For each category different fuels can be used for provision of fuel energy to the system. Considered fuels for the DH system in Banja Luka are:

- biomass,
- coal,
- fuel oil,
- natural gas,
- liquefied natural gas (LNG),
- compressed natural gas (CNG),
- geothermal energy and
- heat industry surplus.

4.2.1.1 Biomass

While Bosnia and Herzegovina is very well endowed with biomass energy resources, and the rural population is highly dependent on wood (particularly in the form of firewood), information related to the biomass energy sector was extremely scarce in past. Current data regarding biomass residues or waste are relatively new. The annual increment is calculated to be 9.49 million m^3, which corresponds to 3.0 % of the total standing volume (317.5 million m^3). Annual allowable cut is calculated at 7.44 million m^3 and actual harvesting at 4.43 million m^3. Although annual growth seems high, annual wood increment is constrained by inadequate local forest management practices. These numbers look promising in terms of the current Banja Luka DH system conversion to biomass after identifying and overcoming possible barriers.

Biomass needs based on the current DH system consumption can be calculated taking into account the calorific value. Calorific value of firewood with 40% water content amounts to 10,280 kJ/kg or 2.86 kWh_{th}/kg. As a comparison, when converted into pellet, its calorific value amounts to 16,920 kJ/kg or 4.7 kWh_{th}/kg. Density of firewood is relatively close for both types: conifers (softwood) with 900 kg/m^3 and deciduous (hardwood) trees with 1000 kg/m^3. Out of total annual harvest, softwood accounts for 2/3 and hardwood accounts for 1/3. Taking these numbers into account, annual biomass needs amount to about 59.5 tons or 63,700 m^3.

Converting the current DH system to biomass, reduction of harmful substances into the atmosphere would be substantial, contributing to cleaner and healthier environment.

4.2.1.2 Coal

The energy derived from coal accounts for about 45% of all energy production and consumption in BiH due to being the cheapest fuel. Coal is available in sufficient quantities as a possible fuel for any DH system in the region, but it is strongly advisable to avoid any arrangements with this energy source due to its extreme pollution. Coal, due to its origin from plants, is composed primarily of the "organic" elements carbon (C), hydrogen (H), oxygen (O), nitrogen (N), and sulphur (S). Whenever coal is used, it eventually ends up being burned, either through direct combustion in boilers, for example those in large electric utility power plants, or after conversion into intermediate products like coke. Of all the oxidation products of these elements, carbon dioxide (CO_2) has become a major concern because it is a powerful greenhouse gas that accumulates in the atmosphere and is considered the primary cause of global warming. Sulphur and nitrogen oxides (SO_2, NO_x), when released into the atmosphere from power plants, become a human health hazard and lead to the formation of acid rain downwind.

4.2.1.3 Fuel Oil

Fuel oil or heavy oil is a fraction obtained from petroleum distillation, either as a distillate or a residue. Burning of fuel oil is much more polluting than burning of other energy sources. It is often used as a backup fuel for peaking power plants in case the supply of the main fuel is interrupted. In developed countries the market for fuel oil has decreased due to the widespread penetration of natural gas as well as heat pumps. The current system is using HFO as the main fuel and therefore it is included here for comparison.

4.2.1.4 Natural Gas

It can be argued that natural gas is not available as an optional fuel for heating in Banja Luka. However, there are different plans for gasification of greater parts of BiH existing and it cannot be ruled out that gas may not be available in Banja Luka within a period of 20 years. There is the gasification of the city planned in the spatial plan of the City of Banja Luka.

The initial plan was to connect to a South Stream, which was envisaged to transport natural gas of the Russian Federation through the Black Sea to Bulgaria and through Serbia, Hungary and Slovenia further to Austria. This project is now an abandoned pipeline project due to non-compliance with the EU competition and energy legislation.

Other options are connection to the gas pipeline going through Croatia or construction of the gas pipeline from Zvornik to Banja Luka, which requires considerable investments.

4.2.1.5 Liquefied Natural Gas (LNG)

Liquefied natural gas (LNG) is natural gas that has been converted to liquid form for ease of storage or transport. It takes up about 1/600th the volume of natural gas in the gaseous state. LPG is a mixture of propane C_3H_8 (about 60%) and butane C_4H_{10} (about 40%). The heating value depends on the source of gas that is used and the process that is used to liquefy the gas. The range of heating value can span +/- 10-15%. A typical lower heating value of LNG sold in BiH is 44.4 MJ/kg or 6.8 kWh/l.

Beside the boilers and auxiliary equipment, investment in LNG plant needs to include a construction of appropriate LNG reservoir. Based on annual heat demand, about 25,000,000 litres is needed during the heating season. Assuming three LNG procurement during the year, necessary capacity of the LNG reservoir at least 8,500 m^3.

4.2.1.6 Compressed Natural Gas (CNG)

CNG is made by compressing natural gas, which is mainly composed of methane (CH_4) in ratio of about 75%, to less than 1% of the volume it occupies at standard atmospheric pressure. It is stored and distributed in hard containers at a pressure of 20-25 MPa, usually in cylindrical or spherical shapes.

With 13.3 kWh/kg, energy content of 1 kg of CNG corresponds to 1.5 litres of petrol, about 1.3 litres of diesel or about 1.9 litres of LNG. Therefore, in order to satisfy the annual heat demand of Banja Luka DH system, about 12,820 tonnes is needed.

Setback of any eventual system using CNG as a fuel is a lack of bottling plants. There is only one bottling plant available in Zvornik. The price of energy obtained by CNG is slightly lower than that of LNG, but substantial transport costs would have to be added up. Therefore, this option is less realistic compared to previous options and will not be analysed further.

4.2.1.7 Geothermal Energy

Geothermal energy can be considered as an option for additional thermal energy supply to the DH system together with the main energy source. Although it is believed that there are certain geothermal energy quantities in this region, it is impossible to determine exact potentials. It is suggested to perform an investigation of the geothermal potentials through a separate feasibility study.

4.2.1.8 Heat Industry Surplus

Through the contacts with the Company management, it was concluded that there is currently no industry in the city of Banja Luka or its close proximity which would be a potential supplier of the heat surplus into the DH system.

4.3 Comparative Analysis of Heating Prices from Different Heating Sources

The analysis is made based on current fuel prices as listed in Table 53 above and assumptions regarding investments, operation and maintenance costs etc. Maintenance and service costs can be assumed to those generally applied in district heating, which is 2% of current investment costs for heat generation plants and 1% of investment for distribution networks. Higher maintenance and service costs are assumed for decentralised and individual heating systems due to considerably higher amount of equipment and possible sources of errors.

Central heating plant with HFO boilers could be converted to biomass plant with relatively low repayment period considering the difference in price of these two energy sources, given in Table 53. With regard to prices it can be assumed that the list price of the cutting plans, around 55 BAM/m^3, with an increment of 20 BAM/m^3 for transport, can be used as a basis for calculation of the biomass cost at the plant during the initial period of operation. Converted into energy price, this amounts to 0.053 BAM/kWh. The fuel prices will in reality be dependent on several different factors. It is here assumed that the price for biomass is the same in all alternatives. It could be argued that the price should be lower for a large heating plant than for firewood in general. But as the contacts with the prospective suppliers of biomass in the past haven't revealed such indications this factor is not considered in the comparison between possible options.

The price for coal of 0.044 BAM/kWh listed in Table 53 is the current price for coal used for district heating in the City of Doboj, which is the price the Company pays to the coalmine Stanari.

Fluctuation of fuel oil price is very uncertain lately with the decrease of about 33% in 2015 compared to its price in 2014 due to world political issues. Purchase price of fuel oil in December 2015 (from the Company's Business Report) was 721.07 BAM/t (VAT inclusive) which amounts to 0.0719 BAM/kWh of energy.

Price of natural gas is the price applied for the four cities in BiH where gas is currently available: Sarajevo, Visoko, Istočno Sarajevo and Zvornik. The gas price is still not regulated on the country level, but all distributors keep the same price, which is at present 724.23 BAM per 1000 Sm^3 for households, 923.13 BAM for industry and 934.83 BAM for commercial users (all prices VAT inclusive). The plan is that a regulation should be introduced in near future. With the lower calorific value of 34,075.60 kJ/Sm^3, the lowest energy price made from gas (households category) amounts to 0.0765 BAM/kWh.

Prices of LNG are highly fluctuating recently and they are difficult to predict. Latest price from April 2016 is 0.76 BAM/l in average, which makes the price of thermal energy obtained by burning LNG of 0.1122 BAM/kWh. CNG is not taken into analysis due to higher prices as explained above.

Considering the price and the degree of pollution of the analysed energy sources, biomass seems to be the most realistic option for future DH system in the city. It could also be seen as a realistic option in Banja Luka to convert the current DH substations to boiler houses, for installation of biomass boilers with auxiliary equipment, and the current secondary networks as distribution systems. In this way a decentralised system based on biomass would be created.

4.3.1 Biomass Supply

Utilization of biomass for energy production must always follow the principle of sustainable development. Therefore, only allowed cutting volumes, waste biomass and unused materials in the forestry and wood processing, as well as agricultural residual biomass, can be used. The main advantage with the combustion of biomass is extremely low emission of pollutants and the lack of CO_2 emissions. All CO_2 thus obtained is actually the same as taken from the atmosphere through a photosynthesis process.

4.3.1.1 Forestry at National and Regional Level

Availability of biomass is of course a crucial condition for a long-term sustainable district heating production based on biomass. Forests and forest land in BiH encompass an area of approximately 2,709,800 ha, which is around 53% of the territory of the country. About 2,186,300 ha or 81% of forests and forest land is under state ownership, while private ownership consists of 523,500 ha or 19%. Most of these properties are very small in size (up to 2 ha) and vastly scattered throughout the country, with outstanding issues in ownership due to population migration. According to constitutional provisions, the ownership of forests lies in authority of the entities (FBiH, RS), where ministries of forestry are responsible for administrative management of these areas through the public forest management enterprises.

In order to determine the actual available amount of forest biomass possible to be mobilized and offered to the market with minimal investment, the amount of realized production of the forest wood products in BiH for the year 2012 are analysed.

Table 62: *Structure of forest wood products (m^3) in BiH in 2012*[171]

	Logs	Other oval timber	Cellulose	Firewood	Net weight of large tree	Waster in harvesting	Gross weight of large tree
FBiH	905,830	53,952	248,017	669,375	1,877,174	306,569	2,183,743
RS	862,997	84,811	340,073	560,777	1,848,658	296,765	2,145,423
BiH	1,768,827	138,763	588,090	1,230,152	3,725,932	603,334	4,329,166

Out of the total volume of logs, softwood logs ratio totalled to 1,185,692 m^3, while hardwood logs ratio totalled to 583,135 m^3.

4.3.1.2 Forests and Forest Land in Republika Srpska

Total area of forest and forest land of the RS, according to the data from the Cadastre of Forests and Forest Land (2009) amounts to 1,282,412 ha or 51.7% of the total surface of the RS. Of the total forest area 982,893 ha (77%) is owned by the state and, whereas private forests without forest land amounts to 281,965 ha (22%). Areas of army forests and forest land cover 17,553 ha (1%). The total forest wood stock of RS amounts to 227,4 million m^3, whereof the state owned forests are estimated to about 184.5 million m^3 (81%) and the private forests cover about 42.8 million m^3 (19%). The composition of the forests in RS is presented in the following Table.

[171] Statistical Office RS, 2013; Ministry of agriculture, aquaculture and forestry FBiH, 2013

Table 63: *Wood stock and annual volume increase*[172]

Category	Forests in Republika Srpska ownership						Private forests		
	Area (x1000 ha)	Composition	Overall volume (x1000 m^3)	m^3/ha	Total volume increase (x1000 m^3)	m^3/ha	Area (x1000 ha)	Overall volume (x1000 m^3)	m^3/ha
High forests with natural renewal	462.7	Conifers	64,815		1,818		92.5	3,746	
		Deciduous	86,452		2,081			16,156	
		Total	151,267	326.9	3,899	8.4		19,902	215.1
High degraded forests	23.1	Conifers	62		4		2.3	1	
		Deciduous	4,818		103			310	
		Total	4,880	211.2	107	4.6		302	128.9
Forest cultures	62.8	Conifers	5,432		382		1.1	152	
		Deciduous	1,132		49			88	
		Total	6,564	104.6	430	6.9		240	223.3
Young forests	174.3	Conifers	81		8		179	75	
		Deciduous	18,929		593			22,326	
		Total	19,010	109.1	601	3.4		22,401	125.1
High forests ineligible for forest mgmt	12.3	Conifers	449		13		Total volume increase of private forests for all the categories together amounts to 1,161,400 m^3, which is in average 4.2 m^3/ha		
		Deciduous	1,557		31				
		Total	2,006	162.5	44	3.6			
Young forests ineligible for forest mgmt	10.9	Conifers	12		0				
		Deciduous	807		52				
		Total	819	75.4	52	4.8			
Total	746.1		185,545	247.4	5,134	6.9	275	42,864	155.8

As can be seen from the table, deciduous (hardwood) trees outweigh considerably conifers (softwood) as well as forests with natural renewal.

4.3.1.3 Forests in Banja Luka region

Data on forestry areas and forest volumes of the region of Banja Luka are presented in the following Table. The region is consistent with the organisation of the state-owned public forest company, Šume RS. More about the organisation and structure of this company is given below when main stakeholders are presented. The region encompasses the municipalities Banja Luka, Prijedor, Gradiška, Laktaši, Čelinac, Kotor Varoš, Kneževo, Mrkonjić Grad, Ribnik and Oštra Luka.

Official request was sent to Šume RS regarding actual data about forest area and respective volumes, but no answer was received. Data about Prijedor region (Prijedor and surrounding municipalities) are available from recent study for Prijedor biomass DH system. Since it is a similar area, these data are assumed to be relevant also for Banja Luka region and used below.

The distribution between conifers and deciduous forests is even more pronounced in the region than in the other areas of RS with deciduous trees representing over 90% of the forest area, which is in contrast to the situation in EU where the deciduous types represent about 35%.

The forests of the National Park Kozara (NP Kozara) are here presented separate from the other state forests in the region.

Table 64: *Ratio between public forests, private forests and NP Kozara – Prijedor region*

	Forest area		Annual volume increase (m^3)	Overall volume (m^3)	Permitted annual cutting (m^3)
	ha	%			

[172] Forestry Statistics 2009

State forests	45,021	56	301,345	9,938,191	227,214
Private forests	31,192	39	126,977	3,812,379	66,582
NP Kozara	3,494	4	37,845	1,301,780	24,409
Total	79,708	100	466,169	15,052,350	318,205

4.3.1.4 Forestry Legislation

As can be seen from the general presentation above the forest structure in BiH differs in significant extent from forest structure in most countries in Europe and from EU as a whole. The difference is significant both with regard to distribution between hardwood and softwood and with regard to proportions of publicly (state owned) and privately owned forests.

Ownership and type of forests also reflects in the forestry legislation. The authority of forestry legislation in BiH lies in the authority of the entities, where ministries of forestry (in RS this is The Ministry of Agriculture, Forestry and Waters) are responsible for administrative management of forests. Law on Forests in Republika Srpska (Official Gazette of RS 75/08) stipulates in Article 9 that the National Assembly should adopt a Strategy on Forest Development, which establishes the basis for forest management policies for forests in both public and private ownership. The general purpose of the strategy is to maintain sustainable forest and forestry management in the best possible way for the welfare of the whole community, in economic, social and environmental sense. Generally trees in forests can be felled only after selection and marking in accordance with the guidelines given in the forest management plan.

Practically, the most often used parts of the trees are the above-ground log and branches up to 7 cm thickness. All other parts (thinner branches, stubs, roots, leaves etc.) including partly rotten, damaged and for other reasons unusable parts, remain in the woods as forest residues. The procedures are not legal requirements, but according to JUS standards[173] still used in both forestry and wood processing industry.

4.3.1.5 Key stakeholders

4.3.1.5.1 The state owned forestry company Šume RS

Public forests in Republika Srpska are managed by the public enterprise JPŠ "Šume Republike Srpske a.d. Sokolac" (Šume RS). The company manages all public forests in RS. As such, it is a main stakeholder with its annual production of forestry products of about 4 million cubic meters. The production is divided on the forestry management units (FMU), which each year perform Execution Projects where the quantities related to specific assortments of forestry products together with a price list is specified. A significant part of the products are cellulose wood and fire wood suitable for use as biomass after chipping to wood chips.

4.3.1.5.2 Forest Bio Energy d.o.o.

With the purpose to increase efficient utilization of all types of unused forest residues and forestry assortments of lower quality occurring in the process of forest exploitation, reconstruction of young forests and melioration activities, there have been an agreement made between the Ministry for Agriculture, Forestry and Waters of Republika Srpska, Šume RS and the private company Forest Bio Energy (FBE). The parties have agreed on establishing the company FBE for development of renewable energy sources. The private company is the majority shareholder in FBE (80%).

The parties have agreed, according to the agreement entered into 26 July 2011 for duration of 10 years, to provide the necessary quantities of wood mass for production of biofuels and make available not less than 400,000 cubic meters per year. Based on the legally valid agreement about exploitation of forest residues for energy purposes, FBE is considered as a stakeholder in the process of biomass supply for the needs of the district heating system in

[173] Yugoslavian standard (JUS) - Classification and measuring of unprocessed and processed wood JUS D.BO.022

Banja Luka. However, the company should have started its activity in this area already in 2012. Construction works for a production plant for torrefaction pellets have started in the municipality of Ribnik.

4.3.1.5.3 Local wood processing industry

The wood processing industry in the region of Banja Luka is mainly primary processing. The majority of production is actually sawmilling production with only a few companies producing final wood products.

A number of wood processing industry and furniture producers exist in the region. The total quantities of wood residues from the companies have been estimated to substantial volumes. However, substantial parts of the residual quantities are already used for other processes (drying of wooden materials etc.) and products, as fire wood and for production of fuel pellets and fuel briquettes.

Contacts have been taken with these companies previously for the need of another DH studies in the region and the prospective possibility to deliver residues from the companies to a biomass boilers for district heating has been received favourably. It has been noted that the residues also includes materials of low quality and high moisture content, resulting in low price as well as lower demand by local buyers, which would be favourable to deliver to the prospective biomass boilers. However, all contracts for buying of wood residue and other products from the wood processing companies have to be made with individual companies, which can be painstakingly and time consuming.

4.3.1.6 Capacities and reliability of local sources for biomass supply

4.3.1.6.1 Forest industry supplies

Firewood is the product most often used for heating in households and institutions that are not connected to district heating systems. Cellulose wood is a low grade quality of wood used as raw material for the pulp industry. Both qualities are suitable as biomass for heating purposes in boilers for district heating.

Firewood and cellulose wood are products that are being bought from Šume RS as well as from the private forest owners. The required quantities can be bought by public bidding for successive delivery. All this is in accordance with the Decision on ways and conditions of selling of forest wood products, based on the Article 7 of the Law on Public Companies (Official Gazette of RS 75/04 and 78/11) and Article 37 of the Statute of JPŠ "Šume Republike Srpske" a.d. Sokolac. Meeting the conditions for ensuring the annual contract on buying of the needed amount of adequate wood products creates the competitive advantage and some security in business operations.

For private forests in the same area the annual permitted cutting amounts to approximately 70,000 m^3 according to figures from 2009. With the same distribution on product types the amount of cellulose wood and fire wood would be in the range of 50,000 m^3 annually.

4.3.1.6.2 Forest residues

According to the forest utilization, out of the total biomass of trees, the most often used part is the above-ground log and branches down to 7 cm thickness. All the other biomass (thinner branches, stubs, roots, leaves, etc.), including partly rotten, damaged and for other reasons unusable parts, remain in the woods as forest wood residues. However, the practice is often different and the quantities that remain in the forests area, as a rule, higher. From an environmental point of view of forest management, these wood residues are not detrimental, as in the process of disintegration it turns into useful substances. However, when observed from an economic point of view, it may present a decrease of the revenue from forest utilization. Limitations that occur in the production of this kind of forest biomass are most often related to the costs of collection, transport and processing. Low prices and high collection costs lead to the fact that it is not always cost effective to use wood residues after cutting, as well as other wood of a poorer quality, which may be found in the forests. More available quantities of wood residues that remain in the forests after cutting and that may be used for the production of biomass have been evaluated in the analyses on the basis of permitted scope of cutting. When compared to the present situation of the usage of biomass in Republika Srpska, it is an indisputable fact that there are certain quantities that may additionally be used for the energy needs, which now remain in the forest after the cutting. On the basis of records of performed works on the usage of forests at Šume RS, which implies recording of gross and net amounts of cut wood on the basis of assortment tables, it was established that an average forest residue is about 15% of the gross wood volume. Stated quantities are approximate and it is possible to increase the degree of utilization by improving the cutting and production technologies. The quantity of wood residues in the forests of Šume RS in Banja Luka area is estimated to be approx. 51,000 m^3 per year.

Taking into account the existing limitations related to the lack of modern technology in RS, insufficient accessibility of forests, underdevelopment of forest wood biomass market as well as other weaknesses it is considered less likely the wood residues are available in short term. Utilization of wood residues after cutting realistically cannot be achieved without substantial investments in construction of a network of forest roads, investments into forest machinery and improvement of other segments and technologies of forest utilization. However, the utilization of the wood residues for energy purposes may increase faster than expected due to newly introduced economic incentives, for example the feed in tariff system for enhanced production of electricity from renewable sources, among them biomass. With increased incentives the likelihood for development of a market with several suppliers will increase as well.

4.3.1.6.3 Residues from wood processing industry

The wood processing industry uses the wood logs that undergo phases of primary processing which results in the initial form in mechanical processing. In the procedure of mechanical processing a part of the wood cannot be used for further processing and is considered as waste wood, but basically it is the unused wood residue.

Substantial parts of the residual quantities are already used for other processes (drying of wooden materials etc.) and products, as fire wood and for production of fuel pellets and fuel briquettes. However, residues also includes materials of low quality and high moisture content, resulting in low price as well as lower demand by local buyers, which would be favourable to deliver to the prospective biomass boilers. The quantities available have been estimated to 10,000 to 15,000 m^3/year.

4.3.1.6.4 Other possible sources for biomass supply

In addition to the above mentioned local sources for biomass supply, possible deliveries of cellulose wood and fire wood from FMU in Sanski Most, situated around 60 km from Banja Luka in FBiH have also been investigated. The forestry management unit in Sanski Most is subject to the cantonal unit in Bosanska Krupa, ŠPD "Unsko-sanske šume" d.o.o. A rather positive approach was met at the local unit in Sanski Most but as the unit doesn't have the authority to make supply agreements, also the cantonal unit in Bosanska Krupa has been contacted. The general attitude from their side is that they don't make agreements for more than a year. The assessment of the possibilities for supply of biomass from the public forests in FBiH on relevant distance from Banja Luka is that it can only come in question for supplementary deliveries on irregular level as the interest for more regulated conditions seems low.

4.3.1.6.5 Energy forestry (fast-growing trees)

Apart from the sources for biomass supply, the issue of cultivation of fast growing trees and crops for harvesting as fuel supply (energy forestry) has been investigated. Areas for fast-growing trees and crops for mechanical cultivation and harvesting are likely to be available as there are agricultural land that is not used, which is up to 80% of the total agricultural land in the region according to different sources. Therefore, the option of using fast-growing trees for energy forestry purposes should not be neglected. However, the planning for utilization of fast growing trees is a time-consuming process and it is not considered probable and possible to use these fractions as fuel in the short term.

4.3.1.7 Recommendation for biomass supply

In summary biomass is assumed to be available in short term only from the public forestry Šume RS, in form of fire wood and cellulose wood logs, and from the local wood processing industries in form of wood residues from their production. The total quantity of fire wood and cellulose produced in the region amounts to about 90,000 m^3/year and the estimated quantity of residues available from the wood processing industries is 10,000-15,000 m^3/year. Former contacts indicate that around 45,000 m^3/year could be available from the public forestry Šume RS. This indicates an available quantity of maximum 60,000 m^3/year available in short term, which can produce about 136,7 GWh of thermal energy. Indicated volumes are solid volumes (logs, slabs) that have to be further processed to wood chips to be used in the biomass boiler. In order to cover entire annual needs in the amount of 170 GWh, additional volume of 14,600 m^3/year is needed for the estimated capacity of the prospective biomass boilers.

A substantial source for biomass supply is also identified in increased utilisation of forest residues that are left in the woods after logging. The challenges for improved utilization of residues from the woods after forestry activities are described in detail above. It can be concluded that there is still a path to wander before the most certainly vast quantities of biomass can be accessed. Challenges are found both in the existing legal framework and in limitations in form of insufficient accessibility, lack of modern technology and lack of market pressure. This implies that significant efforts have to be made for this source of biomass to become accessible in the short term.

The description of tentative sources of biomass supply shows that there are still uncertainties in the estimation of supply capacities of different sources. Most of uncertainties are based in the fact that no real market for biomass still exists. Given that forestry residues obtain a market value the utilization of these residues is expected to improve, enabling a biomass market to be established. During the time until then wood assortments of lower values (cellulose wood and fire wood) may be purchased given that each supplier meets the requirements set out by the legislation.

The following diagram is illustrating how the biomass supply demand is recommended to be met on short, medium and long term respectively. There are of course different alternatives for the medium and long term and the way the demand will be met in reality is mainly a question about availability and price of different supply sources. The utilization of local sources of biomass based on cultivation of fast-growing species would have a positive impact on the local employment, which is an important factor to take into consideration.

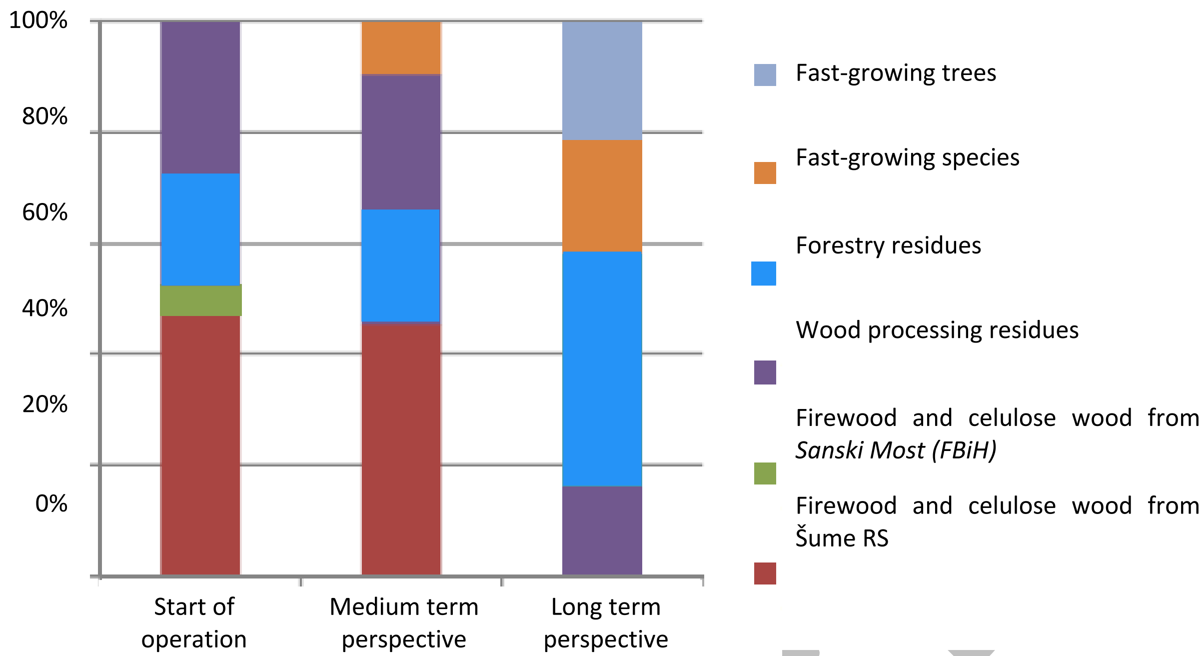


Figure 49: *Demand of biomass supply*

The medium term perspective is to be understood as a prospective possible development on five years' time, while the long term perspective should be understood as a prospective development on 10-15 years. The strategy illustrated is based on out-phasing of purchase of current wood products assortments in favour for increased utilisation of residues and sources that are not used at all today.

4.3.2 Individual Heating Alternatives

An analysis is also performed for different fuel sources for individual heating systems on apartment level, as an alternative to the DH system. Biomass, natural gas, coal and electricity are analysed. In any arrangement, the comfort level of the DH system has to be emphasized over any of the individual heating options in terms of time consumption when dealing with coal or firewood or the comfort prices when it comes to use of gas. Operation of individual stoves can never be fully comparable in heating comfort with heating services provided by centralised heating. It is assumed that the time for organising purchase of firewood, transports, storage, firing, ash handling and other necessary duties connected to the heat supply takes one hour per 48 hours during the heating season (six months) for each household equalling totally 91 hours per household.

Biomass used in decentralised as well as apartment level individual heating systems is assumed as firewood or wood pellets. This solution is considered realistic for less densely populated areas. In more densely populated areas it may be hard to find the spaces for location of boiler rooms and for storage of the fuel. A massive installation of fire wood boilers in densely populated areas would cause severe deterioration of air quality, with increased levels of urban air pollutants, especially particles, nitrogen oxides (NO_x) and carbon oxide (CO).

Using individual stoves on apartment level cannot be regarded as an adequate alternative for comparison since the comfort, fire safety and environmental impact will be significantly impaired. The heat generation efficiency of individual firewood boilers is generally significantly low and very unfavourable because of incomplete combustion, high exhaust gas temperatures etc.

Natural gas offers the highest comfort compared to all other individual heating alternatives in terms of ease of use. However, in terms of prices and achieving desired temperature in apartments it is quite costly. As mentioned earlier, the gas price is still not regulated on the country level, but all distributors keep the same price, which is 724.23 BAM per 1000 Sm^3 for households at present or 0.0765 BAM/kWh.

Although there are plans for gasification of the city of Banja Luka, it is uncertain when the natural gas will be available in this region and it cannot be taken into consideration in any analysis at present.

Coal is the cheapest fuel in the region and available in sufficient quantities. However, as explained above, it is strongly advisable to avoid any arrangements with it due to its extreme pollution of both the living space and the environment. Apart from that, it is inconvenient to use coal in apartments on higher floors due to difficulties with carrying in the coal and carrying out a waste.

Electric heating is used only for pricing comparison, as a massive conversion to electric heating would not be feasible with due care to current capacity of distribution networks. Allowing conversion to electric heating would require an immense strengthening of the networks and the interconnection and transmission capacity. However, the comparison with electric heating is considered relevant as the prices of electricity in BiH currently are artificially low compared to the neighbouring countries as well as compared to EU. It has been observed a spontaneous conversion to electricity for heating purposes and electricity is often generally regarded as an alternative or supplement to DH among the Company's customers.

The comparative electricity price listed in Table 53 is the current price for households in BiH. Considering the prices of other fuels, it is very competitive price at the moment, but with the assumption of its rise in future.

Investments in heating equipment for individual apartments are assumed to 3,200 BAM for stoves on solid fuels in each apartment and 1,600 BAM for electric radiators in each apartment. Current price of natural gas connection with boiler in other cities in BiH with natural gas availability are 950 BAM in average, VAT inclusive. These investments are split over a 10-year period repayment.

Different options for individual heating are also compared to the DH system with current tariffs for residential customers as outlined in 5.3.4.

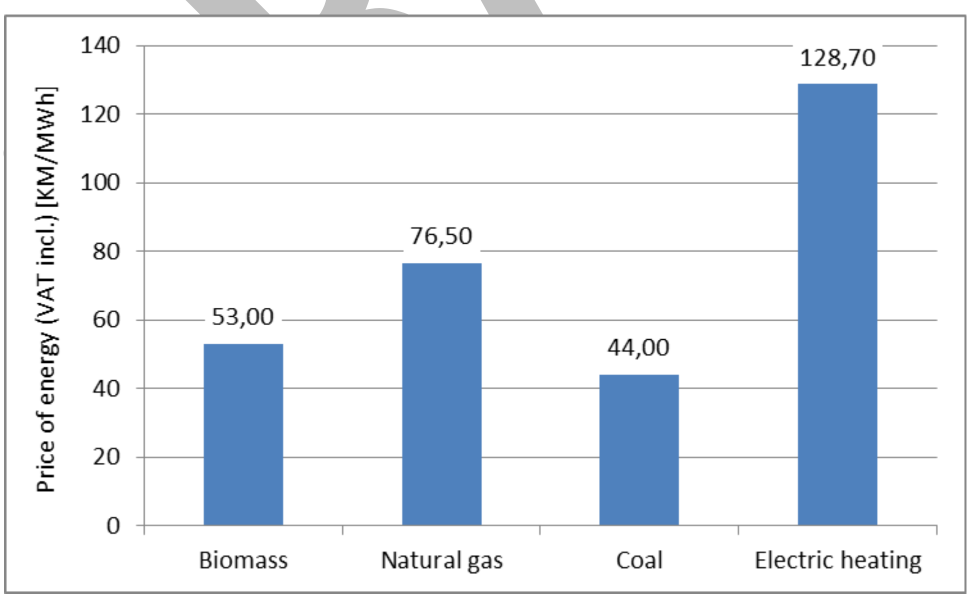


Figure 50: *Price of energy from different sources*

Taking into account these prices for an average apartment with 60 m^2 with 114.12 kWh/m^2 heat demand as elaborated in chapter 3.6, the annual heating costs are calculated and presented in Figure below.

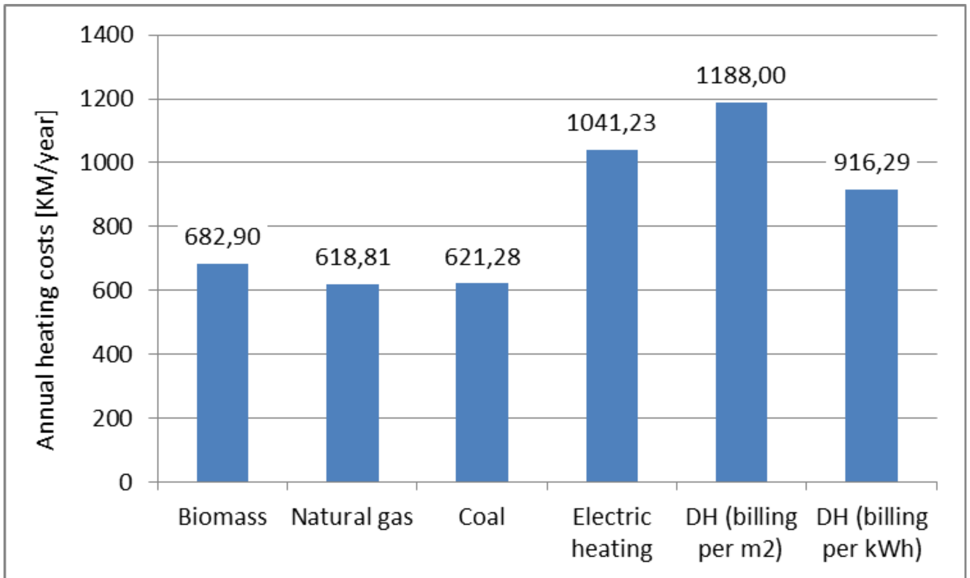


Figure 51: Annual heating costs for average apartment

It can be seen from the diagram that the natural gas based individual heating system is the least cost option. However, as natural gas is unavailable in Banja Luka as explained earlier, this option is not a viable option at present. Coal and biomass are appearing as a second best option in the analysis when it comes to annual costs, although they have certain serious setbacks as explained above. Comparing the current DH system in Banja Luka, billing per actual consumption returns better results than billing per heated area. Taking into account that these numbers are obtained for an average apartment without decent thermal insulation, it can be concluded that implementing energy efficiency measures current DH apparently has the potential of being the best option in terms of both the prices and the comfort.

4.3.3 Least Cost Analysis

In the table below the results of the least cost analysis are presented. The resulting specific heating cost is calculated based on the same estimated end use heating energy in all alternatives. Investment in heat production for centralised systems was considered through new boilers of 90 MW total capacity including all necessary equipment. The coal fired boiler is assumed to be equipped with flue gas cleaning, for reduction of sulphur emissions and particles, to comply with EU emission requirements. In analysis of natural gas as a fuel, condensing boilers were used with the possibility to be installed in the existing boiler house, i.e. no additional construction investments are included. The current system with HFO is presented for comparison.

Certain assumptions were used in this analysis. Maintenance and service costs are assumed to the generally applied in district heating, 1.2% of total annual energy costs. Higher maintenance and service costs are assumed for the individual heating systems due to considerably higher amount of equipment and possible sources of errors. The current staff of the company is assumed to remain unchanged in all options, so man power costs are not considered to be significantly influencing results. For individual heating on wood, it can be assumed that the time for organising purchase of firewood, transports, storage, firing, ash handling and other necessary duties connected to the heat supply takes one hour per 48 hours during the heating season (six months) for each household equalling totally 91 hours per household. Multiplying by number of households, this is in range of the staff costs within the company.

Table 65: *Least cost analysis results*

Heating energy costs	**District heating**				**Individual Stoves**		**Clarification**
	Current HFO	**Biomass**	**Coal**	**Natural Gas**	**Wood**	**Electricity**	**Unit**
Heat demand	102,60	102,60	102,60	102,60	102,60	102,60	GWh/ year
Production efficiency	85,00	87,00	84,00	109,00	50,00	98,00	%
Distribution efficiency	71,00	71,00	71,00	71,00	100,00	100,00	%
Fuel energy consumption	170,00	166,09	172,02	132,57	205,19	104,69	GWh
Price of main fuel	71,90	53,00	44,00	76,50	53,00	128,70	BAM/MWh
Peak and back-up fuel		HFO	HFO	HFO			
Share of peak fuel		5,00	5,00				%
Cost of peak fuel		597,10	618,43				k BAM/year
Cost of fuel	12.223,00	9.399,97	8.187,47	10.141,51	10.875,07	13.473,45	k BAM/year
Investment in heat production	0,00	12.000,00	28.500,00	3.000,00	3,20	1,60	k BAM/year
Annualization 8%	8,00	8,00	8,00	8,00	8,00	8,00	%
Cost of capital	0,00	960,00	2.280,00	240,00	0,26	0,13	k BAM/year
Maintenance costs	146,68	112,80	98,25	121,70	217,50	269,47	k BAM/year
Total heating costs	12.369,68	10.472,77	10.565,72	10.503,21	11.092,83	13.743,04	k BAM/year
Number of heated units	20.025	20.025	20.025	20.025	20.025	20.025	
Heating cost per unit	617,71	522,98	527,63	524,50	553,95	686,29	BAM
Heating cost per end-use heat	120,57	102,08	102,98	102,38	108,12	133,95	BAM/MWh
Rank in least cost	5	1	3	2	4	6	

It is seen from the table that the centralised biomass based heating system is the least cost option according to the least cost analysis performed, closely followed by centralised natural gas and coal based systems. As already indicated, coal is far from reasonable option in urban areas, whereas the natural gas is unavailable in the region at present.

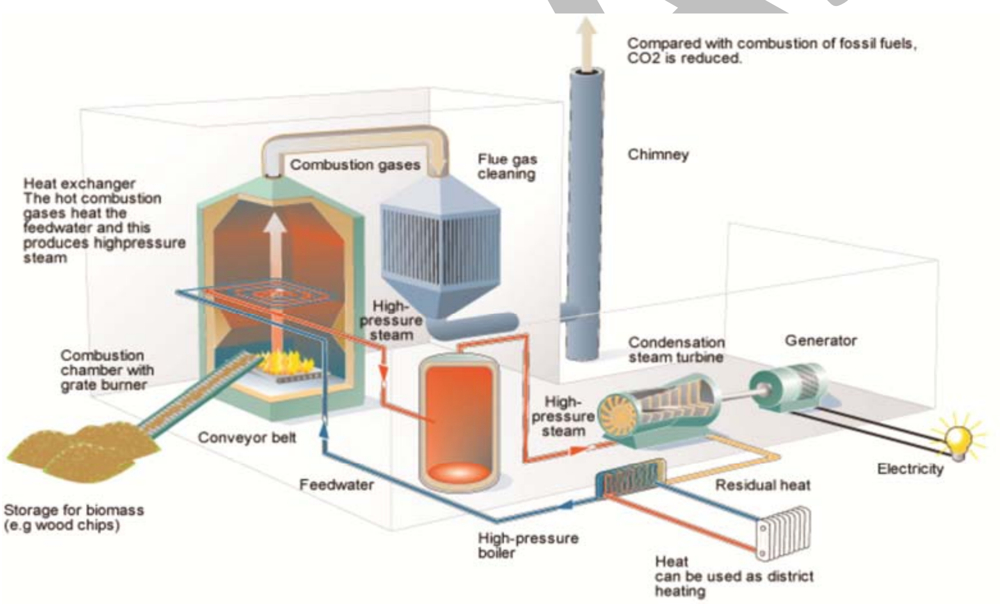
All considered options exhibit lower heat generation costs than the current HFO-based DH system, except the individual heating based on electricity, which is already characterised as impossible in practice.

4.4 Analysis of Combined Heat and Power (CHP) Options

The Company is currently considering the construction of two biomass fired heat only boilers with a total heating capacity of 24 MW. The investment costs for the 24 MW heat only boilers estimated by the company are 10 million EUR. Heat only boilers for moist wooden biomass can be delivered more or less as pre-fabricated turnkey plants, including combustion system and ash handling system, supplemented with systems for fuel supply and flue gas cleaning. The use of a flue gas condenser (FGC) is advantageous because the wet biomass gives rise to a significant amount of vaporized water. If the flue gas is cooled to a low temperature heat from the resulting condensation of water can be recovered and used for preheating of the district heating return flow.

Biomass can be used to create heat, power, or combined heat and power (CHP). If there are applications for both the heat and power outputs, a CHP system is arguably the most cost effective use of biomass. CHP biomass installations have higher capital costs, but the higher overall efficiency can significantly improve the economics.

CHP systems output more heat than power, however the proportion and grade of the heat for is dependent upon the conversion technology selected. Most of today’s biomass CHP plants are direct-combustion systems. Direct combustion involves combusting the biomass in a boiler that vaporizes steam or another working fluid. The working fluid can then be used for heating purposes, or can generate power in a turbine or steam engine. Electricity generation depends on the quantity of emitted heat. When working at nominal heat output electricity is generated at full capacity and corresponding lower amounts are produced at partial heat load. The size of the turbine is generally a result of optimization with regard to steam data and efficiency in relation to investments. For the size of boiler in question normally the steam data sets a limit corresponding to the proposed turbine size.



With the current system of feed-in tariffs in Republic of Srpska for promotion of electricity production from renewable sources, and plans of "Toplana" to increase the use of biomass through introduction of two new two biomass fired boilers it is reasonable to analyse the effects of installing a CHP system instead of regular heat only boilers.

The investment cost of biomass CHP plant consists of engineering, construction and equipment, as well as infrastructure costs (e.g., fuel supply system and grid connection). For the size of heat output of 24 MW a total of 6

MW (25%) of power output is considered as optimal. Due to the differences between a heat only boiler and a boiler for generation of steam to supply a turbine for production of electricity the investment into a CHP plant will exceed the investment into heat only boilers for the same heat output. The investment cost associated with switching from a heat only boiler to a CHP boiler per 1 MW of heat output (and corresponding 250 KW of power output) is estimated at EUR 300,000.

The *Decision on the Level of Guaranteed Purchase Prices and Premiums for Electricity Generated from Renewable Energy Sources and in Efficient Co-generation*[174] determines the amount of guaranteed feed-in tariffs and premiums for electricity generated from RES or in efficient co-generation facilities. Current feed-in tariff for power plants on solid biomass with a capacity of up to and including 10 MW is Euro 150/MWh. Annual electricity production is estimated 750 MWe per installed MW heat capacity. Annual revenue from sales of electricity per MW of installed heat capacity is therefore EUR 86,250.

The implications of electricity production are among others increased demand for biomass. The estimated increase in biomass demand per MW of installed heat output is 1200 MWh per year. Assuming a biomass price of EUR 25/MWh the total cost of additional biomass purchase is estimated at EUR 30,000 per year.

A simple payback calculation indicates that the investment can be recovered in 5.3 years from electricity sales alone. The decision to install CHP boilers instead of heat only boilers will depend on the interest of the company and their financial capacities for a higher investment. Given the favourable payback period this option needs to be analysed in further detail after receiving the response from the representatives of the DH company and the City of Banja Luka. The detailed analysis needs to take into account the availability of government quotas with guaranteed feed-in tariffs and access to additional quantities of biomass to meet the increased demand.

4.5 Energy Efficiency Measures in Buildings

According to the International Energy Agency, about 40% of global energy consumption is consumed in the residential sector, 27% in transport and only 28% in industry. Accordingly, the residential sector represents the largest potential for reduction of energy consumption. The highest percentage of erected buildings in Bosnia and Herzegovina is in the period from 1950 to 1980. These buildings have no thermal insulation and are poorly maintained, and as such provide a low level of energy efficiency (EE) and comfort.

4.5.1 Building Sector in Banja Luka

Consumers of heating energy supplied by the DH Company (central heating plant, heating plant Starčevica and heating plant Kosmos) are mostly households with app. 80% of total energy consumption, whereas the remaining 20% of consumers are companies, institutions and various handicraft shops.

Housing facilities may be divided into two groups:

- Facilities for collective housing - apartment buildings, and
- Facilities for individual housing - private houses.

The construction of residential and other buildings in Banja Luka may generally be observed in two periods: the period before and the period after the great earthquake that occurred in 1969. Intensive reconstruction of destroyed buildings and construction of new buildings was carried out after the earthquake (from 1970 to 1974), and numerous residential, public and business facilities were constructed. Most of the buildings in this period were built as four or five storey buildings.

[174] Decision No. 01-540-3/15/R-03-34 adopted by RERS on January 29th, 2016

As a result of the global economic and energy (oil) crisis in the 1970s, a major change of standards in the construction of buildings in terms of insulation and EE occurred. Buildings built in the late 1970s and mid-1980s were built with higher quality and better thermal insulation.

In the period from mid-1980s until the end of 1990s, more demanding and strict standards and norms in the construction of facilities were applied. Particular attention was paid to thermal insulation of external structural elements, high quality carpentry and general energy savings in the segment of building construction.

In the period after 2000, much attention was paid to all segments of construction, resulting in the rationalization of energy consumption, environmental protection and use of renewable energy sources.

According to period of construction, all residential buildings in Banja Luka may be categorised as follows:

- I (buildings built before 1960) – low, freestanding buildings constructed of full brick;
- II (buildings built in period 1961 - 1965) – freestanding buildings constructed of full brick without hard ceilings;
- III (buildings built in period 1966 - 1969) – multi-storey buildings built completely with prefabricated concrete panels without thermal insulation;
- IV (buildings built in period 1970 - 1975) – multi-storey buildings built completely with prefabricated concrete panels or concrete skeletal system (with incorporated mineral wool insulation or polystyrene in the facade and gable walls);
- V (buildings built in period 1976 - 1980) – multi-storey buildings constructed of monolithic concrete skeletal system with walls made of blocks (clay, foam/gas concrete and aerated concrete);
- VI (buildings built in period 1981 - 1991) – buildings constructed of monolithic concrete panel system insulated with polystyrene and thermal mortar;
- VII (buildings built in period 1992 - 2001) – buildings constructed of monolithic concrete panel system or brick blocks with or without thermal insulation of expanded polystyrene;
- VII (buildings built after 2001) – modern systems constructed of concrete lamellar or skeletal structures with infill of thermal brick or thermal insulated aerated concrete blocks. Buildings built in this period have thermal facades such as compact thermal facade, ventilated facades with stone, ceramic or aluminium coating, or continuous glass and structural facades. In the housing sector, compact thermal facades are most commonly used, whereas all other types of facades are used in the construction of non-residential buildings.

Energy consumption in buildings correlates with the above listed periods of construction.

Considering construction methods, materials and components, existing buildings do not meet the optimal energy, economic and environmental characteristics of housing in the EU. More than 40% of the total energy consumption in Republika Srpska is used for heating, which makes the residential sector the greatest potential for energy savings.

4.5.2 Energy Efficiency Measures

EE measures may consist of:

- free measures usually consisting solely of changes of the behaviour of tenants,
- simple measures which do not require significant investments, and
- complex measures requiring substantial investments.

Free EE measures imply responsible behaviour towards energy due to the fact that, in addition to the technical characteristics of buildings which are the foundation for determination of energy needs, actual energy consumption depends on users' behaviour. Free EE measures include:

- Turning off heating at night, or when the space is not being used;
- Proper ventilation of rooms (not leaving the windows open when heating is on);

- Set the proper temperature in certain areas.

Simple EE measures for residential units usually do not cost more than a few thousand BAM, with an investment return period of several years. They include improving the efficiency of the existing system or reducing the energy required to heat through simple improvements of the building envelope. Simple EE measures include:

- Thermal insulation of the ceiling towards unheated attics by placing insulation material on the floor of unheated attics. This is a simple, quick and low-cost way to reduce energy losses, and can reduce up to 10% of transmission losses;
- The insulation of radiator recesses and shutter boxes through which the greatest amount of energy in the entire window is lost;
- Sealing of loose windows and doors as well as the repair of fittings;
- Installation of thermostatic valves.

Complex EE measures include the thermal insulation of facades, replacement of windows and insulation of ceilings of unheated basements under heated areas. Thermal insulation of facades is the most profitable EE measures in buildings, as at least 20% of energy is lost through the walls.

Implementation of EE measures in the building stock in the City of Banja Luka could lead to significant savings in total energy consumption. Depending on the period of construction of buildings, potential savings that could be achieved are presented in the table below.

Table 66: *Potential Savings of Heating Energy in Residential Buildings in Banja Luka*

Year of construction	Savings kWh/m^2 per year			
	Current energy needs	Insulation of external walls	Insulation of ceilings towards attics, roofs, etc.	New windows
Before 1960	208	66.3	20.5	30.3
1961-1965	130	39.3	10	26
1966-1969	159	47	10.5	28
1970-1975	103	31.5	12	22
1976-1980	99	28	3	18
1981-1991	94	21	2	18
1992-2001	88	18	2	18

The following chart illustrates the potential savings that could be achieved by implementing EE measures in residential buildings in Banja Luka.

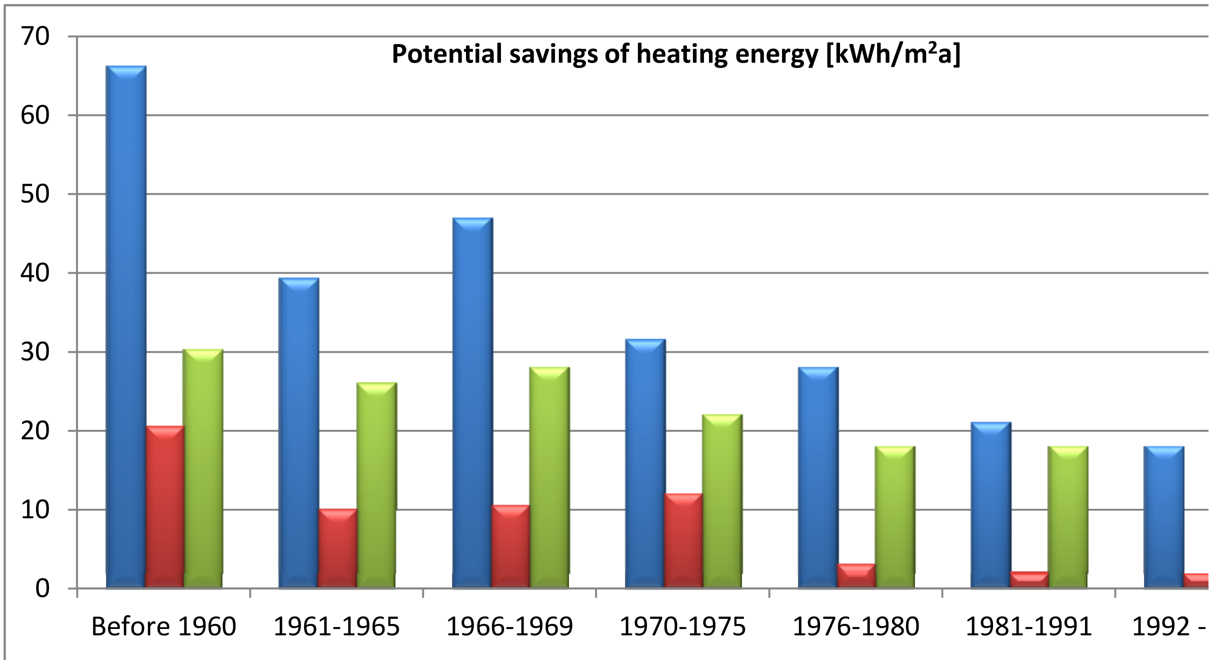


Figure 52: *Potential Savings of Heating Energy in Residential Buildings in Banja Luka*

Emission of harmful substances into the atmosphere is directly proportional to energy savings, or reduction of energy needs. Therefore, implementation of EE measures can results in the significant reduction of harmful substances into the atmosphere, contributing to cleaner and healthier environment. The table below provides an overview of the possible reduction of pollutant emissions, depending of the period of construction of buildings.

Table 67: *Potential Pollutant Reduction from Residential Buildings in Banja Luka*

Year of construction	Reduction of CO2 emissions kg/m^2 per year		
	Insulation of external walls	Insulation of ceilings towards the attic, roofs, etc.	New windows
Before 1960	30	10	20
1961-1965	20	5	2
1966-1969	20	4	10
1970-1975	10	1	5
1976-1980	10	1	4
1981-1991	10	1	4
1992 - 2001	9	1	3

The total number of buildings in Banja Luka is 1,272. There are no available data on the number of buildings in each category. Therefore, calculation of potential energy savings should be subject of a further detailed study to provide estimates of the total potential energy savings.

4.6 Possibilities for Network Expansion

4.6.1 Current Heat Consumption

According to annual reports of the Company, 1,423,720 m^2 of space in the City of Banja Luka is currently heated from all three power plants. Out of this, residential space amounts to 1,007,720 m^2 (71 %), whereas commercial space amounts to 416,000 m^2 (29 %). The average heat load for residential space is 96.48 W/m^2, 120.61 W/m^2 for commercial space, and 103.53 W/m^2 for combined residential/commercial space. Therefore, the total used heat load is 147.40 MW.

There are 7,891 disconnected users residing in buildings connected to the DH system, using alternative heat sources. Apartments are 53 m^2 in size in average, representing app. 418,223 m^2 of unheated residential space. Therefore, the heat potential of unheated spaces is app. 40.65 MW.

Taking into account unheated space, the total heat load amounts to 188.05 MW, with a total of 1,841,943 m^2 of heated space. Therefore, the average heat load is 101.93 W/m^2. Based on the aforementioned, the average heat load of app. 102 W/m^2 has been used for analysing further expansion possibilities.

Figure 53 below provides an overview of the relation between the recommended minimum and maximum heat load per square meter of area of heated space in accordance with the year of construction of the facilities and the selected heat load. The year of construction of facilities has been determined in accordance with the year of construction of the substation located within or in the proximity of the structures. The figure shows that the selected heat load for facilities built before 1990 is less than the recommended minimum load, and that the load ranges between the recommended minimum and maximum. The selected values have been derived from the assumed surface area of windows, walls, floors and roofs, and corresponding heat transfer coefficient values. Since the analysed facilities are mainly buildings, which consist of app. 4 or more floors in average, the obtained values are closer to the curve "Selected".

***Figure 53**: Heat Load Depending on the Period of Construction of Facilities*

The required heat load for the City of Banja Luka has been determined on the basis of selected values, as shown in table below.

***Table 68:** Heat Load Calculation*

Building period		Number of substations	Total space of buildings	Heat load				Energy consumption			
				Recommended	Calculation (adopted)	Total		Recommended	Calculation (adopted)	Total	
		complete	m^2	W/m^2	W/m^2	W	MW	kWh/m^2	kWh/m^2	kWh	MWh
Shape factor	0.64										
Old buildings – conventional building style until 1980	1970-1980	94	821,693.51	120-180	115.00	94,494,753.65	94.49	200-270	126,71	104,115,314.25	104,115.31
Buildings in accordance with thermal protection directive from 1982	1981-1990	80	460,094.67	120-180	93.00	42,788,804.31	42.79	140-180	102,47	47,145,155.00	47,145.15
	1990-1995	4	31,553.39	70-100	89.00	2,808,251.71	2.81	140-180	98,06	3,094,161.29	3,094.16
Buildings in accordance with thermal protection directive from 1982	1995-2000	12	25,400.05	70-100	72.00	1,828,803.60	1.83	70-140	79,33	2,014,995.06	2,015.00
	2001-2010	73	254,055.57	50-70	57.00	14,481,167.49	14.48	70-140	62,80	15,955,502.77	15,955.50
Low-energy houses	2011-2015	12	51,857.52	25-40	44.00	2,281,730.88	2.28	70-140	48,48	2,514,035.10	2,514.04
	Total	275	1,644,654.71	106,31		158,683,511.64	158.68	30-70		174,839,163.48	174,839.16
Passive houses								<15			
Average load					96,48				106,31		

Report for 2015										
Heated residential space		1,007,720.00		96,48	97,229,252.67	97.23			107,128,214.06	107,128.21
Heated commercial space		416,000.00		120,61	50,171,884.44	50.17			55,279,910.40	55,279.91
Total		1,423,720.00		103,53	147,401,137.01	147.40			162,408,124.46	162,408.12
Average load				103,53				114,07		

Disconnected during 1996-2015										
Average space of one apartment is 53 m^2	7,891.00	418,223.00		96.48	40,351,992.36	40.35			44,460,249.94	44,460.25
Buildings with disconnected part	0.29	1,841,943.00		101.93	187,753,129.46	187.75			206,868,374.39	206,868.37
Average load				101.93				112.31		

Similarly to the overview of heat load depending on the period of construction, the following figure provides an overview of the recommended values of energy requirements and energy requirements corresponding to the adequate heat load.

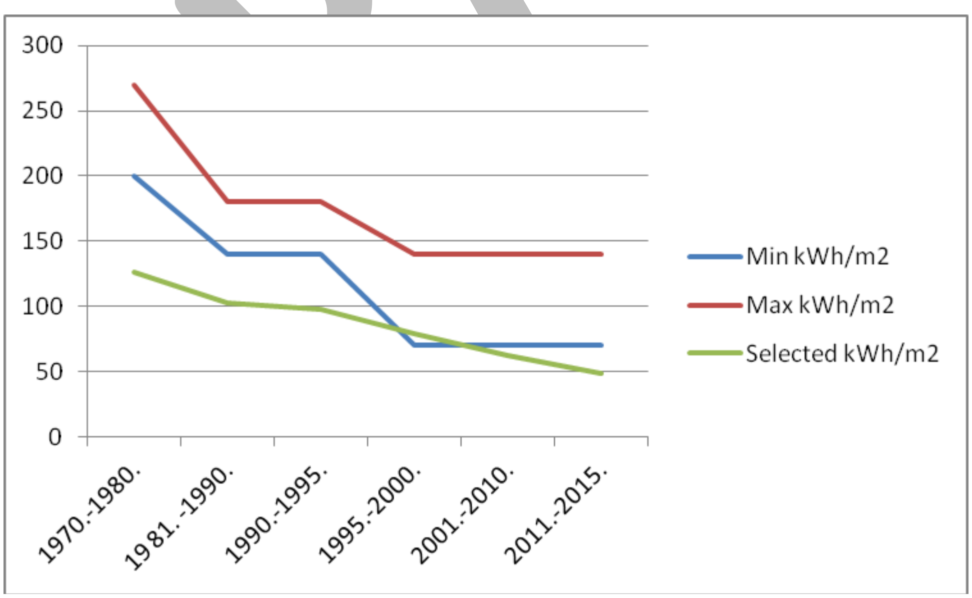


Figure 54*: Energy Needs Depending on the Period of Construction of Facilities*

On the basis of the load of hot water pipeline, velocity in design regime (130/73 °C) of up to 4 m/s (depending on pipe diameter) can be calculated. In case of designed regime change, it is necessary to check each part of the pipeline. Based on data provided by the Company, it was assessed that the DH system does not operate in line with designed regime; hence, it can be concluded that an increase in pipe diameter is required.

Three power plants are currently in use: the central power plant (heat capacity of 232 MW), and the local power plants "Starčevica" (heat capacity of 10 MW) and "Kočićev Vijenac" (heat capacity of 6 MW).

The "Starčevica" plant covers the area of its neighbourhood and substations connected to two branches of the "Vrbas" pipeline. One of these two branches stretches from Bulevar vojvode Stepe Stepanovića to Dr. V. Đede Kecmanovića. The other stretches from Bulevar vojvode Stepe Stepanovića to Srpskih ustanika and Jasenovačkih logoraša. This area consists of 18 hot water substations, 43 warm water substations and 121 buildings. The total residential space heated from this plant is 200,520 m^2, with installed heat power of 34.96 MW, according to the Company.

Total heat load of 20.45 MW can be calculated based on specific heat load of 102 W/m^2.

The "Kočićev Vijenac" plant covers the area of its neighbourhood and substations connected to "Vrbas" pipeline branch stretching from a bridge in Branka Morače street to Solunska. This region consists of 17 hot water substations, 41 warm water substations and 111 building. Total residential space heated from this plant is 130,185.30 m^2, with installed heat power of 19.50 MW, according to the Company.

Total heat load of 13.28 MW can be calculated based on specific heat load of 102 W/m^2.

The central power plant covers the rest of the consumers (apart from those powered by "Starčevica" and "Kočićev Vijenac"), constituting of 308 hot water substations, 388 warm water substations and 1,040 buildings. Total residential space heated from this power plant is 1,093,014.70 m^2.

Total heat load of 113.67 MW can be calculated based on specific heat load of 102 W/m^2.

Therefore, the total required heat power amounts to 147.40 MW.

The following table provides an overview of the current heat load, engaged power and outside temperature up to which it is possible to heat facilities at the designed temperature.

Table 69: *Overview of Parameters for Different Engaged Power*

Plant	Current heat load	Current heat load	Engaged power	Outside temperature	Engaged power	Outside temperature
	m^2	MW	MW	°C	MW	°C
Central plant	1,093,014.70	113.67	116	-18	58	0.61
Starčevica plant	200,520	20.45	10	-1.37	10	-1.37
Kočićev Vijenac plant	130,185.3	13.28	6	0.26	6	0.26
Current heat load	1,423,720.00	147.40	132.00		74.00	

The table above shows that connected heat load is greater than engaged power in the Starčevica plant and Kočićev Vijenac plant, and it is possible to engage more power than the installed power in the central plant (with two engaged boilers) and to thereby heat space at the designed temperature up to the outside temperature from the Starčevica plant and Kočićev Vijenac plant to app. 0 ° C (-1.37 and 0.26° C), and to -18 ° C from the central plant. If one boiler in the central plant is engaged (i.e. power of 58 MW), then it will be possible to heat space at the required temperature up to the outside temperature of app. 0.61 ° C.

The following figures present the relation between heat load, engaged power and outside temperatures at which it is possible to heat space with engaged power.

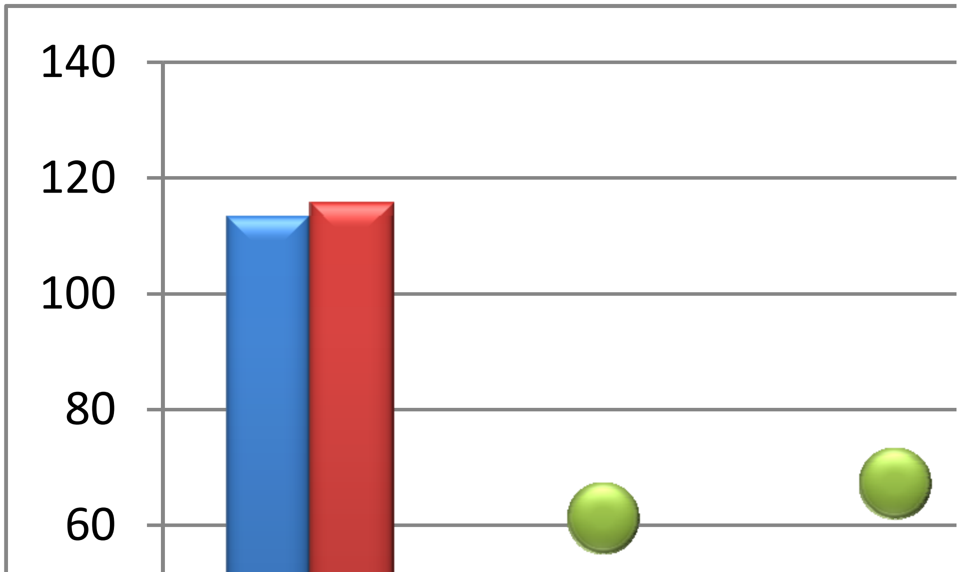


Figure 55*: Overview of Parameters for Engaged Thermal Power of 132 MW (2 Boilers in Central Plant)*

Based on the above, it may be concluded that the current heat load of 147.40 MW is heated through engaging boilers in the Starčevica plant and Kočićev Vijenac plant (capacity of 16 MW) and one boiler in the central plant (capacity of 58 MW) up to the outside temperature of app. 0 ° C, with boilers operating at night to with decreased capacity.

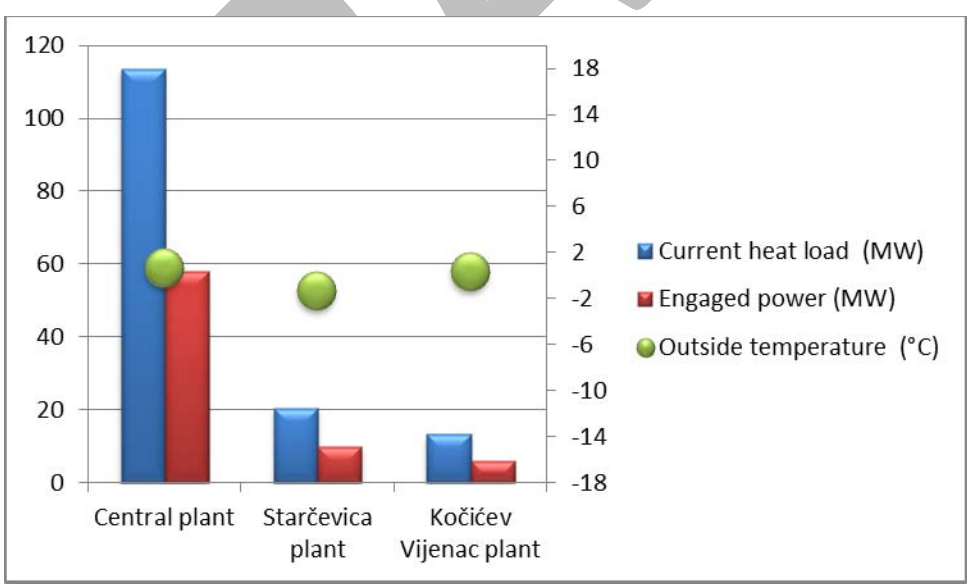


Figure 56*: Overview of Parameters for Engaged Thermal Power of 74 MW (1 Boiler in Central Plant)*

Heat Load Expansion Possibilities

Possible expansion was considered as part of the heat load analysis. The potential new consumers are divided into three groups:

- Disconnected users,
- Potential new customers (buildings) within the existing zones of heat distribution,
- Potential new customers (buildings) out of the current DH supply area.

4.6.2 Disconnected Users

Expansion which would include disconnected users without any necessary investments is recommended as the first and priority expansion. The heat load would be increased by 40.65 MW and therefore the total heat load would amount to 187.75 MW.

4.6.3 Residential Buildings within the Existing Zones of Heat Distribution

Buildings in this category may be divided as follows:

- Buildings on the right bank of River Vrbas,
- Buildings gravitating to the local heat power plant “Kočićev Vijenac”,
- Buildings near the neighbourhood of Rosulje,
- Buildings in the city centre.

4.6.3.1 Right bank of River Vrbas: Petričevac and Obilićevo neighbourhoods

There are app. 700 houses in this part of the city that are clustered into seven groups. This would require installation of seven substations with capacity of app. 1.0 to 1.3 MW. Three substations should be connected to the “Starčevica” plant (total of app. 3.0 MW, i.e. 300 houses), whereas others should be connected to the hot water pipeline from the central power plant (four substations, 1.3 MW each).

This would increase the total load for app. 8.2 MW (3×1.0 + 4×1.3 MW).

The estimated investment amounts to 9,776,600 BAM, out of which 3,900,000 BAM for household installations.

4.6.3.2 Kočićev Vijenac neighbourhood

Several private buildings are located in this neighbourhood along the left bank of River Vrbas. Since they gravitate to “Kočićev Vijenac”, there is a possibility to connect them to this plant, which would require certain investments. It is estimated that 3 residential buildings and app. 90 houses could be covered by this expansion. It would require a heat load of 1.45 MW. There are several houses in streets Duška Koščice and Solunska that could be grouped and heated from a single substation with a heat power of 1.45 MW. Similar to this, a group of buildings in streets Meše Selimovića and Braće Mažar i majke Marije would require another 1.45 MW. The total heat load of all three groups of buildings would be 4.35 MW (3×1.45 MW). These buildings are within the existing supply area.

The estimated investment amounts to 4,722,900 BAM, out of which 180,000 BAM for household installations.

4.6.3.3 Rosulje neighbourhood

There are app. 945 houses and 5 residential buildings in the Rosulje neighbourhood. All residential facilities in this neighbourhood are clustered into six groups, each requiring a separate substation. The total heat load would amount to 17.50 MW.

The estimated investment amounts to 9,887,000 out of which 4,745,000 BAM for household installations.

4.6.3.4 City centre

Certain buildings in the streets Rade Vranješevića, Grundićeva and Miše Stupara need to be connected to the closest substation. It is assumed that at least 50 % of buildings are already connected to the DH system.

The estimated investment amounts to 100,000 BAM.

Based on the above, inclusion of buildings gravitating to the hot water pipeline would expand the heat load for 30.5 MW (8.2+4.35+17.5 MW). As it is unknown which buildings are connected to the pipeline, it is assumed that recently built residential buildings are connected to the DH system and have new substations. Other buildings are assumed to have their own boiler rooms. The following figure gives an overview of possible expansion locations.

4.6.4 Residential Buildings Outside of the Existing DH Supply Area

This expansion could include neighbourhoods which are not located in close proximity of the hot water pipeline. Thus, it would be necessary to build new power plants to provide the required heat. Biomass (wood chips) fired power plants are recommended as a heat source. The location of the plants would be determined by the City, and the plants would need to be positioned centrally to the heated areas. Heat could also be provided for the "Paprikovac" Hospital, therefore the capacity would need to be increased.

4.6.4.1 Paprikovac neighbourhood

Approximately 1,600 houses in the Paprikovac neighbourhood could be included in this expansion, with heated space of app. 169,600 m^2 (1,600×2×53), which would require heat load of app. 17.30 MW. The installation of a biomass (wood chips) fired power plant with a heat capacity of 18 MW is recommended.

The estimated investment amounts to 19,487,500 BAM, out of which 8,000,000 BAM for household installations.

4.6.4.2 Lazarevo neighbourhood

This expansion would include buildings in the Lazarevo neighbourhood and its immediate surroundings. A rough estimation of heat load has been carried out following the analysis of possible loads. App. 2,250 houses with a total heated space of 238,500 m^2 could be included in this expansion. Based on specific heat load of 102 W/m^2, the total heat load of 24.33 MW may be estimated. The installation of a biomass (wood chips) fired power plant with a heat capacity of 24 MW is recommended.

The estimated investment amounts to 25,716,000 BAM, out of which 11,250,000 BAM for household installations.

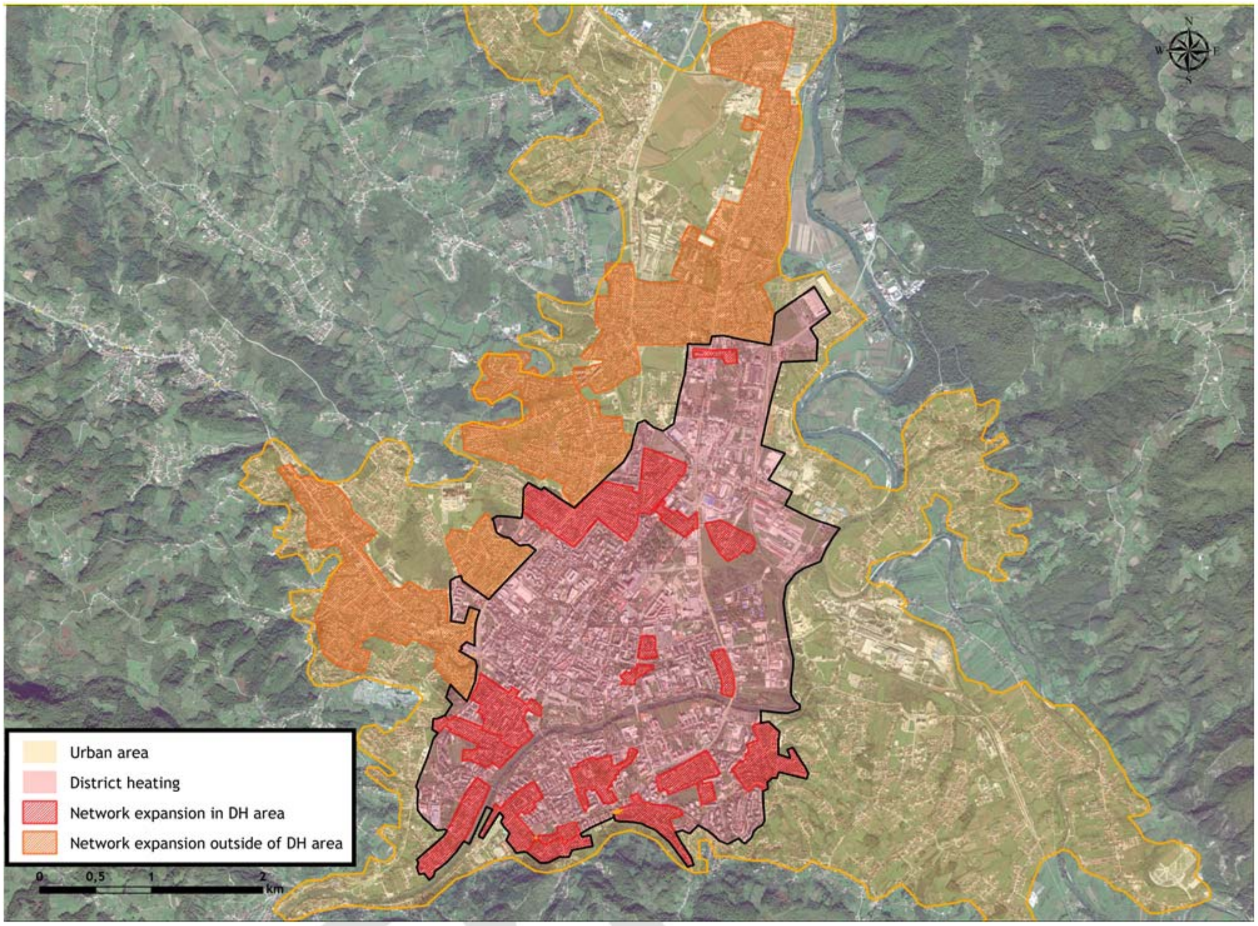


***Figure 57:** Possible Heat Load Expansion Zones*

A separate study should be performed in order to analyse and describe in detail the feasibility of expansion in the abovementioned areas.

Environmental benefits expected from network expansion are substantial, since the network expansion involves individual houses or multi-apartment buildings with individual heating systems which mostly use coal and wood as fuel, causing significant emissions of various pollutants.

Even though biomass is CO_2 neutral and burning wood as a form of biomass has no harmful impacts on air quality, efficiency of the systems in which it is being burned is often very low, causing energy losses.

Expansion of DH network and installation of biomass fuelled boilers would cause a significant reduction of harmful substances in the atmosphere by eliminating the use of coal, and increasing energy efficiency through the installation of high efficient biomass boilers. The following table provides information on current pollutant emissions.

***Table 70:** Emission of Pollutants from Individual Heating Systems*

Fuel	Current Pollutant Emissions			
	CO_2	SO_2	NO_x	Solid particles
	[t/a]	[t/a]	[t/a]	[t/a]
Coal	19,863.75	616.82	43.35	12.58
Wood	-	-	37.84	1.52

Expansion of the DH network and heating supplied from new biomass boilers would reduce the current emissions of pollutants. Estimates of emission of pollutants from new biomass boilers are presented in the following table:

Table 71: *Emission of Pollutants from New Biomass Boilers*

New fuel	**New pollutant emissions**			
	CO_2	**SO_2**	**NO_x**	**Solid particles**
	[t/a]	[t/a]	[t/a]	[t/a]
Biomass	-	-	75.690	3.03

Table 72: *Reduction of Pollutants in area of network expansion*

New fuel	**Reduction of pollutant emissions**			
	CO_2	**SO_2**	**NO_x**	**Solid particles**
	[t/a]	[t/a]	[t/a]	[t/a]
Biomass	19.863,75	616.82	5.70	11.07

5 GENERAL RECOMMENDATIONS AND PRIORITY INVESTMENT PROGRAM

5.1 General Recommendations

General recommendations on all segments of operation of the Company are listed below. It is advised, that these recommendations are taken into consideration by the Company when determining the strategic objectives and business plans of future operations.

5.1.1 Strategic Planning

Apart from much needed technical improvements of the entire DH system, the Company needs to adopt set of strategic and planning documents in order to define strategic priorities and improve effectiveness of the existing DH system. The adoption of these strategic documents and plans will help the Company to accelerate the transition from current way of operations (on case-by-case basis depending on the urgency of the problems) to more systematic and planned way of operations.

The most important documents that Company has to adopt are:

- The Strategic plan of the Company;
- Development plan of the Company;
- Short-term dynamic operation plans;
- Long-term dynamic plan.

It is advised that the Company should adopt the above listed strategic planning documents before undertaking any activities on the implementation of the priority investment program.

5.1.2 Increasing the Use of Biomass as a Fuel

In order to avoid further spending of the Company's resources on expensive HFO, the Company has to increase usage of other available fuel sources such as biomass, which is considered as the most acceptable energy source for the future operations of the Company. Since the Company had very positive experience with operations of the two existing biomass plants (10 MW + 6 MW), construction of additional biomass plants with significant thermal power should be considered as a top priority for the Company.

The strategic objective of the Company should be to construct the biomass plants with sufficient thermal power to cover the base load, while the existing boilers on HFO will be used to cover peak loads in case of lower outside temperatures. Biomass and HFO boiler plants should operate in parallel, and in case of higher external temperatures, if it is economically justified, they can operate separately.

New biomass fired boilers can be installed at the location of the existing HFO central heating plant. The new biomass boilers can be placed at the location of the old HFO boilers (two boilers 7 MW each) so the existing boiler room can be used for placing the new biomass boilers. Based on preliminary rough estimates the optimal thermal power of two new biomass-fired boilers is 12 MW each, with a total output of 24 MW.

Existing two HFO boiler units (56 MW each) together with the existing installed capacity of the biomass fired boilers are sufficient to cover daily needs for heat supply to consumers. The current installed capacity of the biomass boiler houses is 16 MW, which represents 10.85% of the total engaged power. Since biomass boiler houses operate on a 24 hours regime, they meet more engaged heat power than installed. Following the construction of two new biomass boilers (24 MW), the overall installed power of biomass will be 40 MW, which will represent 27.13% of the total engaged power.

In further development and investment plans the Company should also focus on additionally increasing the use of renewable fuels instead of existing HFO with the aim of eventual complete replacement of HFO with renewable fuels primarily the biomass.

5.1.3 Existing Central Boiler Plant

The existing central boiler plant is over 40 years old, and significant reconstruction of parts that are vital for its functional operation had not been made. The reconstruction of the existing HFO central boiler plant is necessary to secure stable and efficient production of thermal energy, even that only limited capacity of the HFO boilers will be used (after the construction of the biomass boilers) to cover peak loads. Current operational practice of the Company, largely influenced by continuous lack of finance, is focused on emergency maintenance rather than on preventive maintenance which should be the case. The most important recommendations related to the operation of the existing HFO central plant are summarized below:

- Reconstruction of the boiler assembly boiler - burner, with the switch from the two-stage to the modulating burner (variable speed control);
- Installation of circulation pumps with electronic motors (frequency speed control) can have significant impact on savings in total electricity consumption (estimated savings range from 30%-40% of the existing consumption)
- Procurement of HFO with lower SO_2 content is mandatory in order to comply with the domestic and EU standards and legislation;
- Defining the norms of fuel consumption depending on the outside temperature and the introduction of consumption monitoring procedures (daily)
- Installation of heat meters on the installations in the central boiler plant in order to monitor the actual production of heat;
- To develop operational manuals is considered of significant importance taking into account envisaged parallel operation of the existing HFO and new biomass plants.

5.1.4 Distribution Network

As described in the Chapter 3.6.6, distribution network is in considerably bad shape, and only partial reconstruction of mainly primary network had been done in the previous years. The Company does not have a database of the entire system of hot water and hot water pipes in the GIS system (or similar) which is a basis for proper planning and maintenance of the distribution network. Significant investments are needed in the reconstruction of the entire distribution network (approximately 45M KM in reconstruction of the primary distribution network and 46M KM in secondary distribution network).

Taking into account financial capability of the Company, it is clear that the reconstruction of the distribution network can be made only in the long-term period if the Company adopts a proper plan for network reconstruction. This plan will have to take into account urgent reconstruction of the most critical parts of the network that have to be made (on the basis of the pre-determined criteria's focused on reduction of heat and water losses with direct impact on the financial performance of the Company).

In order to secure adequate monitoring and maintenance of the distribution network, installation of the section valves on the primary network is necessary. Furthermore, since the leak detection system does not exist, it is necessary to install it in all sections of the network that will be reconstructed as well as in newly constructed parts of the distribution network.

On the secondary network, installation of the equipment such as heat energy meters, balancing valves, thermometers and manometers is necessary. This will enable the Company to monitor the consumer consumption and to introduce billing per actual consumption on a much larger scale. Without installation of these cumulative meters, it will not be possible to measure heat consumption at apartment level, particularly in buildings with two-pipes systems, and if thermostatic valves are not installed, expected savings with installation of pumps with frequent regulations will not be achieved.

5.1.5 Heat Substations

Since most of the substations were constructed during the same period as the distribution network (40 years ago), practically most of them have reached end of their operational lifetime and need urgent refurbishment/reconstruction. As described in the Chapter 3.6.9, only 16% of the total number of substations is equipped with automatic control system, while others are operated manually.

Given the overall technical condition of the existing heat substations considerable investments are needed in this regard, however before the investments in improvement of heat substations are made, the Company has to create a database on heat substations that will enable the Company to monitor implementation of defined procedures and maintenance program.

General recommendations for improvement of this segment of the DH system are given below:

- Replacement of existing circulation pumps and installation of circulation pumps with variable speed control pumps;
- Installation of balancing valves on the primary and secondary sides;
- Installation of equipment for automatic control of secondary supply temperature depending on the outdoor temperature;
- Installation of heat meters on the primary side;
- Where technically and economically justifiable, 2 way electromotive valves have to be installed. In the heat substations where automatic control is already in place, convert two-way valve into the three-way valves. This will enable installation of the frequent regulation pumps in the central boiler house;
- Installation of remote management and control system for management of the entire DH system.
- Insulation of the pipes in the substations that are currently non-insulated.

5.1.6 Reconnection of Disconnected Customers

Since the Company lost about 13% of the customers since 2011 one of the key strategic goals is to ensure the return of the lost customers. As described the network improvements planned in PIP will significantly improve the quality of service namely the consistency of delivering required amount of heat to the customers. Under the current conditions the absence of network balancing and regulation equipment results in uneven distribution and delivery of heat in the network which means that some customers are undersupplied and heated below the required temperature level and that some customers are oversupplied and therefore overheated. This was one of the main reasons for the disconnections since some customers were simply not receiving the needed amount of heat during the season.

The projected network improvements will effectively address this problem and enable the even delivery of required heat therefore removing the underlying reason for the disconnections. Considering the improvements in the quality of service it is realistic to expect the return of the disconnected customers over the next period. Reconnection of the disconnected customers should remain the top strategic priority of the Company since the feasibility of the priority investment program depends on the sales growth projections based on the assumption that the majority of the disconnected customers will reconnect by 2021. This will also significantly improve the liner heat density of the Company as well as its financial performance.

5.1.7 Implementation of Consumption Based Billing System

As presented in Chapter Implementation of Consumption Based Billing System the billing system based on actual consumption of each individual consumer is proscribed by the domestic legislation as well as the international standards therefore the Company should make steps towards achieving this goal. Apart from legal obligations consumption based billing provides a higher level of transparency to customers and increase their confidence in the DH system. However considering the current financial position of the Company and the required size of the investment into achieving entirely consumption based billing system it is not realistic to recommend the full implementation of this measure in the short run. However with the implementation of other recommended measures which will result in savings and increased revenues it is recommended that the Company should start investing into the individual metering equipment in accordance with its financial capacities.

5.1.8 Network Expansion

As discussed in section 8 there are significant possibilities for the network expansion which would result in the increased revenues of the company. Considering the assessed technical priorities as well as financial position of the company the Priority Investment Program made focus on achieving the financial consolidation of the company by improving the efficiency of operations. By increasing the use of biomass as the alternative fuel the company will cut the costs of fuel and improve its environmental impact. Also by the implementation of recommended network improvements the company will get into position of ensuring the return of the disconnected customers which is its first priority.

The required total amount of investment as well as the required scope of investments works that is needed to implement the recommended measures will be overwhelming for the company in its current condition. For that reason additional investments into network expansion were not included in the PIP. However the projected implementation of PIP will result in considerable savings and growth of revenues coming from reconnected customers. Therefore it will be financially possible to plan additional investments into network expansion after 2018.

5.1.9 Combined Heat and Power Generation

Future network expansion plan should also be based on the increased use of biomass fuel and consider Combined Heat and Power generation options. As discussed in Chapter 4.4 the introduction of CHP would result in higher fuel efficiency and enable production of electricity during the entire year thus resulting in higher financial results particularly under the current local feed in tariffs for electricity produced from biomass.

5.1.10 Network Management Improvement Measures

5.1.10.1 Creation of GIS databases

During the technical assessment of the Company operation, it was observed that the updated documentation of the network is not in place, particularly the documentation related to the secondary network.

This documentation is crucial to identify the location of the pipelines, and to determine the cost and measures necessary for rehabilitation and maintenance of the network. Setting up GIS database includes on site survey to physically locate, determine the type and size of the pipes and other objects, i.e. valves, chambers, elbows, compensators etc. and to determine geographical coordinates for all objects and pipelines. Once the pipes and other objects are identified, data are transferred to a GIS-system where characteristics for all objects in the DH system are kept. Computerized system for documentation enables improved planning of maintenance, hydraulic as well as economic calculations, and most importantly the location of the pipelines.

5.1.10.2 Implementation of Measuring and Evaluation Procedures

During the technical assessment of the Company, a notable lack of measuring devices was observed (in addition to the lack of updated designed documentation on the networks), as a result of which it is not possible to measure any of the important parameters such as temperature, pressure, heat energy drop, water drop and flow. Most importantly, it is not possible to determine the critical points on the pipelines both in terms of leakage (water loses) and in terms of heat losses in the pipelines.

It was also observed that there no preventive maintenance is currently carried out, and only emergency maintenance that provides a minimum of quality and security in terms of functionality is in place.

For that reason, the instalment of sectioning valves based on realistic criteria, together with measuring devices (thermometers, manometers), is proposed as an urgent measure. In that manner, it would be possible to measure the key parameters and enable the proper rehabilitation of the network without draining the whole pipe system, which would lead to significant reduction of water losses. In addition, the pressure testing of certain sections proposed for the purpose of identifying priorities.

Installation of heat meters in front of buildings would bring additional advantages in creating possibilities to manage the entire secondary system. Furthermore, the application of other measures in the substations and in central boiler house would contribute to better network management. Data obtained by measuring will represent the basis for the DH Company to develop a long-term plan of reconstructions.

5.1.10.3 Improvement of reporting and control procedures

As already described before, the Company lacks the documentation for monitoring the basic process of heat distribution, as well as for proper and regular maintenance of the system. After the installation of sectioning valves and related measuring instruments, heat meters and balancing valves, the Company will be able to properly manage the entire distribution system. In that sense, it is necessary to adopt adequate procedures, forms of reports, authorizations, responsibilities, and timing of certain operations. All these activities should be described in detail and associated with job descriptions and tasks for specific jobs. Following computerization and introduction of a GIS system with a proper database, planning and maintenance will be improved, and, more importantly, it will be possible to monitor all planned tasks and operations, and undertake necessary measures.

5.2 Priority Investment Program

The assessment of the Company elaborated in Chapter 3 confirmed that the current status of almost every aspect of district heating business is unfavourable which results in serious financial shortcomings for the company. As a result of the inconsistencies in the quality of service (supplying heat) the company lost 13% of the customers since 2011. At the same time DHC system using HFO as fuel remained the main source of pollution in the city of Banja Luka. Based on the above mentioned assessment conclusions the main goal of the Priority Investment Program (PIP) is to secure environmentally, technically and financially sustainable DH operation in the City of Banja Luka and to improve the quality of the service in order to ensure return of the lost customers.

Implementation of PIP will create conditions for enabling the Company to transform into a modern, well-organized, profitable and efficient company. In order to contribute to the better quality of life in Banja Luka, the Company should aim to harmonize its business with the European and global adopted standards in the technical, technological, personnel, organizational and environmental point of view. In that respect the main long term measures include:

- Increasing use of biomass as environmentally friendly, renewable, locally available and cheaper fuel;
- Modernization and rehabilitation of the existing HFO boilers to cut costs of fuel and electricity;
- Rehabilitation and priority replacements in the distribution network to cut heat and water losses;
- Switching to consumption based metering and billing for improved quality of services and customer confidence.

Above listed measures will result in the significant savings of heat and electricity including the savings in fuel, improved network efficiency and the savings at the end user level. Estimated savings that will result from the implementation of PIP are presented in the table below:

Table 73: *Estimated savings of heat and electricity*

Priority investment program	ESTIMATED SAVINGS

	Heat energy savings in the network	**Heat energy savings in the fuel**	**Heat energy at the consumers**	**Heat energy TOTAL**	**Electric energy savings**
	MWh_{heat}	MWh_{heat}	MWh_{heat}	MWh_{heat}	MWh_{el}
New biomass boiler house		2,165		2,165	
Central boiler house rehabilitation		4,436		4,436	689
Substations modernization	4,872			4,872	3,135
Primary network improvements	3,168			3,168	
End users measures			27,609	27,609	
Total	10,498	6,601	27,609	44,709	3,824

Investment into rehabilitation of the existing HFO burners will improve its efficiency from current 85% to 92% which will result in decrease of fuel consumption for the same amount of heat produced. Also the network improvement measures will result in cutting the heat losses in the network from currently estimated 11% to about 6% improving the network efficiency to total 94%.

5.2.1 Installation of New Biomass Boilers in the Central Heating Plant

In addition to the currently installed four boilers, two boilers with a capacity of 7 MW each were installed in the central boiler room. They have been dismantled and put out of function. Considering that currently used HFO represents the most expensive fuel source available, as well as it is one of the major sources of pollution in the City, the primary focus of the Company should be to increase the percentage of renewable fuel sources in total fuel consumption. Construction of additional biomass boilers is expected to have significant impact both on financial and environmental aspects of Company operations. Based on preliminary rough estimates of optimal heat power that needs to be supplied to customers, construction of additional two new biomass-fired boilers (each with a heat power of 12 MW, with a total output of 24 MW) is recommended. Upon the installation of these new boilers, the overall installed power of biomass plants will be 40 MW, which will represent 27.13% of the total engaged power of the DH system. It is envisaged, that these two additional biomass boilers together with existing HFO boilers, can meet the existing head demand (including the disconnected customers), as well as additional heat demand planned for future expansion of the DH network.

The planned biomass boiler house will consists of two hot water biomass fired boilers (chips) with all necessary equipment for the fuel delivery, handling of the flue gases, two heat accumulators with a capacity of 50 m^3, the expansion module, circulation pumps and the associated equipment. The circulation of hot water will be performed with the new circulation pumps for the new biomass boilers in combination with the new frequency controlled pumps in the central boiler house.

Boiler plants should operate in parallel, and in case of higher outdoor temperatures, if economically and technically justifiable, they can operate separately.

The main purpose of the proposed measure is:

- To increase percentage of renewable fuels (biomass as a domestic fuel) in total fuel consumption of the Company;
- To significantly reduce the cost of fuel due to substantial differences in fuel price between HFO and biomass and higher efficiency of new boilers compared to existing HFO boilers;
- To cover the base load with biomass boilers (the existing boilers on HFO will serve to cover peak loads in the cases of low outside temperatures);
- To improve functionability and reliability of DH system;
- To improve air quality in the City of Banja Luka;

The increase in the efficiency of new biomass boilers in relation to the efficiency of the existing HFO boilers of approx. 6% is expected to result in reduced total energy consumption on an annual basis of app. 2.527MWh_{heat}.

5.2.2 Repair of Central Heating Plant Boilers

5.2.2.1 Repair and Automation of Existing Burners

The existing burners built on HFO boiler units have already been in use for over 20 years which is a standard life-time for high-power burners. They are also single-stage burners, which means that they do not allow the modulation of burner operation and therefore they can only operate at full load. Thus, the overall efficiency level of the existing HFO boiler - burner assemblies are much lower than the modern technological solutions. The fuel consumption is higher and they have higher emissions of the exhaust gases. The maximum efficiency coefficient of the boiler – burner assembly is about 85% which means that from 1 ton of HFO the boilers produce about 9,43MWh of heat.

In order to increase efficiency and to cut emissions it is necessary to invest into repairing and automation of existing burners. Efficiency coefficient can be increased by installing the so called modulating burners, whose output, within their operating range, is continuously regulated to match the needed heat demand. Modulating burners are designed to control the burners output (size of flame) to match the boilers variable heat load requirements. During this process the burner is designed to stay at the correct fuel air ratios across the complete firing range therefore ensuring the maximum combustion and boiler efficiencies.

This measure includes the repair of the boiler - burner assembly, with the transition from the two-stage to the modulating burners (with variable burning speed control), as well as the introduction of frequency regulation for recirculation boiler pumps.

The main goals of proposed measures are:

- Increase of boiler-burner assembly efficiency from 85% to 91%;
- Reduction in fuel consumption by 5-7%;
- Reduction in electricity consumption for boiler-burner assembly and recirculation pumps;
- With regard to the installation of new equipment, ensuring the proper heat delivery in the long term.

The table below represents the required investment into reconstruction of boiler - burner assembly, with transition to a modulating burner and installation of frequency regulation for boiler recirculation pumps.

Table 74: *Reconstruction of boiler - burner assembly, installation of frequency regulation for boiler recirculation pumps*

Description	Unit	Number of units	Unit price	Investment BAM
Burners (2 pieces) type SKV 300, SAACKE, Germany intended for combustion of heavy fuel oil (crude oil). Capacity of each burner is G = 3000 kg / h	pcs	2	225,000	450,000
Estimated total investment				**450,000**

The estimated effects of the implementation of these measures are:

- Fuel consumption reduction between 4-7 % (out of app.122,125 MWh), which means saving app.4,885 to 8,548MWh_{heat}) per year
- Electricity consumption for boiler-burner assembly and recirculation pumps should be reduced by 30%, which means 100MWh less than before reconstruction

5.2.2.2 Reconstruction of the Main Circulation Pumps System

The total installed capacity of the pumps in the central heating plant is 1,915 kW. Two largest pumps have 560 kW of installed capacity each. All pumps are equipped with motors without frequency regulation, considering that they are over 30 years old. All pumps operate with constant flow; hence they operate in full load even when maximum flow in the system is not required.

Since the entire DH system is overdimensioned, only one main circulation pump is considered sufficient to provide functional circulation for most of period of operation of the plant. For this reason, only the reconstruction of the pumping system on one main pump is considered as a priority.

This measure comprises the complete replacement of one existing main circulation pump with a new pump with approximately the same characteristics, less power (app. 10-20%) and variable frequency regulation.

Table below represents estimated bill of quantities with accompanied investments for reconstruction of the main circulation pumps.

Table 75: *Total investments in reconstruction of main circulation pumps system*

Reconstruction of the main circulation pumps system	**Unit**	**No**	**Unit price (BAM)**	**TOTAL (BAM)**
Dismantling of existing pump, delivery and installation of a new main circulation pumps (TYPE RDL 350-500, Q=2.000m^3/h, H =80 mVS, Pe=560 kW) with adoption to the existing installation	pcs	1	100,000	100,000
Delivery and installation of complete frequency regulation for a new pump	pcs	1	160,000	160,000
Estimated total investment				**260,000**

The main goals of the proposed measures are:

- To create possibilities for balancing of the entire primary system, and achieving optimal and functional operation of the primary system (required total flow for each substation);
- To create possibilities for instalment of automatic regulation in heat substations and, in that sense, to ensure functionability and reliability of the DH system;
- To achieve significant reduction in electricity consumption for main circulation pumps.

The estimated effects:

- Electricity consumption of main pumps should be reduced by 30-40%, which represents 505 to 674 MWh less than before reconstruction (current electricity consumption of main pumps is 1,685 MWh).

5.2.3 Secondary Network Improvements

5.2.3.1 Consumer Connection Shafts (Shafts, Balancing Valves, Meters, and Other Equipment)

The existing secondary system equipment does not allow the proper management of the DH system. The proposed secondary network improvement measures include:

- Construction of the new connecting shafts in front of buildings,
- Installation of measurement and control equipment in shafts (cumulative meters, balancing valves, thermometers, pressure gauges, ball valves, drain valves according to the principal scheme).

All shafts need to of appropriate dimensions in order to enable the proper installation of all equipment. The planned heat meters which will be installed in shafts will be ultrasonic in order to enable remote reading.

The Figure below shows the proposed design of shafts:

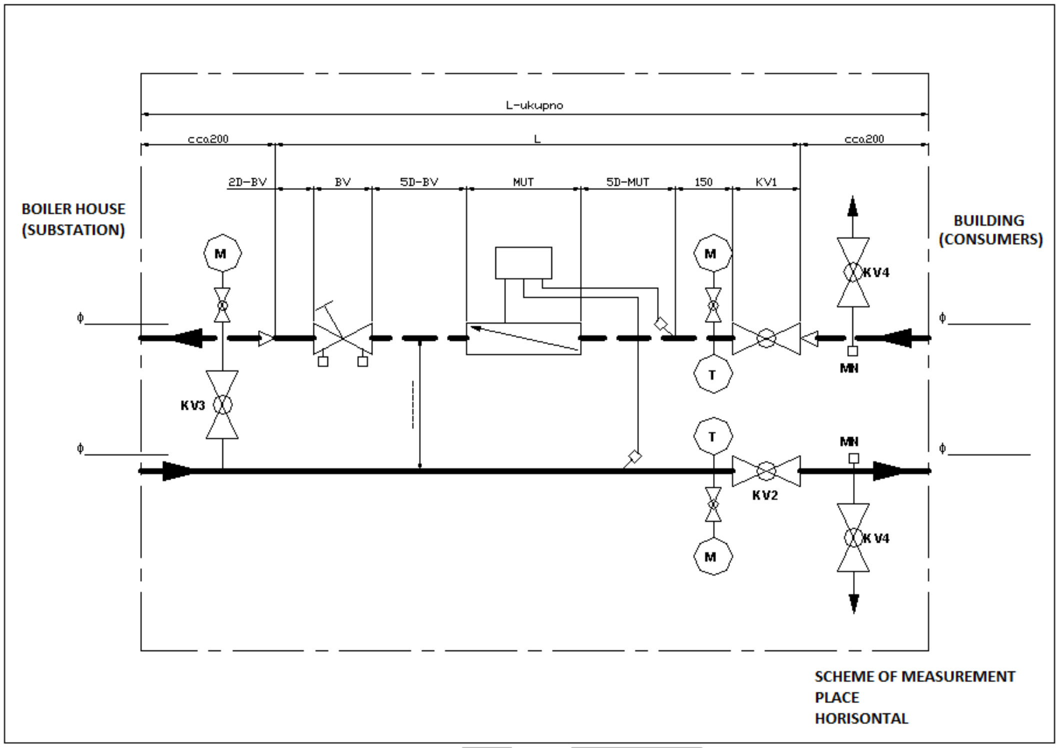


Figure 58: *Shaft design*

The main goals to be achieved by the introduction of the above described measures include:

- Enabling the measuring of the total cumulative consumption of thermal energy for each building, which is the basis for individual consumption measuring;
- Creating possibilities for the complete management of the secondary system, which is also the basis for the complete management of the entire system;
- Regulating the heated water flow required for each building;
- Creating possibilities for balancing of all the individual secondary networks; ensuring the adequate distribution of required amount of heat to all buildings
- Achieving the functional and reliable heating of entire buildings;
- Achieving the greater heating comfort in all buildings, thus increasing the consumers' confidence and trust in the Company;
- Reduction of possibilities for overheating and underheating of certain buildings;
- Better and more efficient service and maintenance of the secondary network.

The table below shows investments required for the connecting shafts in front of buildings:

Table 76. *List of required investments for the shafts in front of buildings*

Description	Unit	Quantity	Unit price	Total BAM
Civil works				

Materials and works required for the construction of shafts with prescribed size depending on the size of mechanical equipment	Bulk	1,286.00	1,050.00	1,350,300.00
Mechanical works				
Delivery and installation of:				
Ball valves	Pcs	2,572.00	559.00	1,436,940.00
Drain valves	Pcs	2,572.00	45.00	115,740.00
Balancing valves	Pcs	1,286.00	279.00	358,641.00
Ultrasonic meters	Set	1,286.00	2,618.00	3,366,558.00
Measuring instruments				
Thermometers	Pcs	3,858.00	24.00	92,592.00
Pressure gauges	Pcs	3,858.00	24.00	92,592.00
Estimated total investment		**1,286.00**		**6,813,363.00**

All the listed measures are required for bringing the DH system in a properly operational and balanced state. These measures are also a precondition for the introduction of the metering and billing system based on actual consumption. Full implementation of the billing system based on the consumption will require installation of measurement equipment at each consumer. As it will be explained in the section on End User Measures, the size of the investment required for the individual heat consumption metering is beyond the current financial capacities of the Company. Therefore, it is recommended that those measured are implemented over the next twenty years. However, since the construction of shafts in front of buildings together with installing heat meters is necessary for all the above listed reasons, it will enable the metering of consumption on the level of individual buildings as a first phase of introducing the consumption based billing system. System of measuring the cumulative consumption in buildings based on the surface area of apartments is used in many countries such as Finland, Slovenia, Croatia and Germany; therefore, it is a viable step forward towards the full consumption based billing system.

The estimated effects of the recommended investments include reduction of the total annual heat energy consumption at the level of buildings-consumers which is approximately 2 - 3 % or 3,248 – 4,872 MWh_{heat}

5.2.3.2 Replacement of Existing Pipes

As described under the section General Recommendations, the Company needs to develop a long-term operational plan for the replacement of the entire secondary network, focusing primarily on the most deteriorated parts of the secondary network. Based on the analysis of the secondary network, the replacement of the parts of the secondary networks in facilities where the quantity of water consumption is the most significant is proposed.

This measure comprises the dismantling of the existing secondary pipeline network (including the network from heat substations to buildings connected to them) and the installation of new pre-insulated pipes. In addition to the mechanical equipment and works, this measure also envisages necessary civil works. The pre-insulated pipe system should be equipped with a leak detection system. Such leak detection system currently does not exist in the DH system in Banja Luka.

Replacement of the most critical parts of the secondary network is expected to decrease total water consumption and decrease heat losses in the secondary network. Furthermore, the reconstructions of the most critical parts of the secondary network will contribute to much safer and reliable heat supply, and total energy efficiency of the DH system.

The table below represents the total amount of investment needed for implementation of this measure.

Table 77: *Reconstruction of secondary network pipeline*

	Reconstruction of secondary network pipeline	Unit	Length	Average price BAM	Investment BAM
	Pressure testing				25,000

	Rehabilitation of the most critical parts	m	3.000	192.66	575,000
	Estimated total investment				**600,000**

The estimated savings that are expected to be reached with implementation of this measure are:

- Reduction of water losses of approx. 20 – 40% of current water losses (42,203 m^3 in 2015) and approx. 8,440 to 16,881 m^3 of water and approx. 442 to 884 MWh_{heat}
- Reduction of heat losses of approx. 2% of current heat losses in the amount of 19,612MWh (approx. 392MWh_{heat})

5.2.4 Substation Modernization

5.2.4.1 Installation of Frequency Regulated Pumps

This measure consists of the replacement of existing circulation pumps and installation of circulation pumps with variable speed control pumps. The existing circulation pumps are single with a built-in check valve. The new pumps are designed with the same characteristics, but with lower power (and thus with lower power consumption) as double pump units. This technology solution enables easy operation and automatic switch from one pump to the other.

The main goals that are expected to be achieved with the implementation of the above described measures include:

- Creating possibilities for the installation of thermostatic valves;
- Creating possibilities for balancing of entire secondary system, and achieving optimal and functional operation of the secondary system;
- Efficiency increase;
- Energy savings;
- Cost reductions;
- Reduction of noise levels in substations.

The table below provides the total amount of investment needed for implementation of this measure.

***Table 78**: Investments in installation of frequency regulated pumps*

Installation of frequency regulated pumps	pcs	Average price	Total BAM
Dismantling of existing circulation pumps and installation of new replacement electronic circulation pumps (double pump units with variable frequency)	327	4,155.86	1,358,640.00
Estimated total investment			1,358,640.00

Estimated effects of implementation of this measure are:

- Approx. 20 - 40% of decrease in electricity consumption,
- Reduction of total annual electrical energy consumption (out of 7,838 MWh_{el}) - app. 1,567 – 3,135 $MWh_{el.}$

1.3.2. Hydraulic network balancing (installation of balancing valves)

This measure consists of installing manual balancing valves on primary parts of each heat substation, to provide a rather good hydraulic balance of the primary system.

The main goals to be achieved by these measures include:

- Reliable hydraulic balance of the primary system, which means that each heat substation is provided with proper and required water flow;
- Achievement of functional and reliable heating in the system as a whole;

- Reduction of possibilities for overheating and underheating of certain substations and thus overheating and underheating of certain buildings.

Investment into the delivery and installation of balancing valves on the primary side is presented in the table below:

Table 79: *Delivery and installation of balancing valves on the primary side*

	Quantity	Average price	Investment (BAM)
Diameter 25 to 300	325	454.44	147,691.00
Estimated total investment			**147,691.00**

The estimated effects of implementation of these measures are achieving higher quality and more reliable heating function.

5.2.4.2 Automatic Regulation

This measure includes the replacement of devices for automatic regulation of the heat temperature supplied to consumers in relation to the outside temperature (where such devices exist) or installation of new devices in substations (where such devices do not exist). Automatic regulation devices include: transient control valves, actuators, electronics and sensors.

The main goals to be achieved by these measures include:

- Optimal regulation of the heat supply temperature for each consumer (building), in addition to the required flow rate;
- Efficiency increase;
- Energy saving;
- Cost reduction;
- Achievement of functional and reliable heating in entire buildings;
- Reducing the possibility for overheating and underheating of certain buildings.

Automatic regulation investment is presented below:

Table 80: *Automatic Regulation Investment*

Description	Unit	No	Average price	TOTAL (BAM)
Delivery and installation of automatic regulation (valves, actuators, electronics and sensors) on the primary side	Set	317	3,419.74	1,084,056
Estimated total investment				**1,084,056**

Estimated effects of the implementation of this measure include approximate savings of heat energy consumption of 3-5 % or approx. 4,872 – 8,120 $MWh_{heat,}$

5.2.5 Primary Network Improvements

5.2.5.1 Reconstruction of Primary Network Pipeline

This measure consists of:

- Installation of sectioning valves on the existing primary network. This measure is considered as a strategic emergency measure due to the fact that the existing primary network does not have any functioning sectioning valves which would enable the maintenance of the network sections without draining of the entire pipeline system. In addition to the sectional valves to be installed in new shafts, pressure gauges and thermometers should be installed for the purpose of easier measurement and testing.

- Pressure testing of the certain critical sections of the primary network. This testing should be performed before the heating season in order to determine the parts of the primary network which need to be replaced in order to prevent the water leakages.
- Rehabilitation of the most critical parts of the primary distribution network system. The Company needs to replace the most deteriorated parts of the primary network. Rehabilitation of pipelines includes the dismounting of the existing pipes and installation of new pre-insulated pipes. Pre-insulated pipes are steel pipes with polyurethane (PUR) thermal insulation and outer casing of high-density polyethylene (PEH).

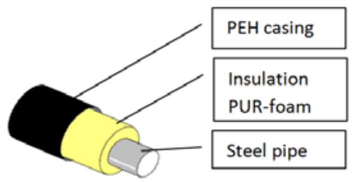


Figure 59: *Pre-insulated pipes*

The pre-insulated pipe system should be equipped with a leak detection system that indicates if water penetrates the insulation. The system makes it possible to measure where the leakage has occurred. The described detection system does not exist in the current DH system in Banja Luka.

The main goals of the proposed measures are:

- Reduction of water losses;
- Reduction of heat losses;
- Efficiency increase;
- Energy saving;
- Cost reduction;
- Achieving the functional and reliable heating in the whole system.

Investment into the reconstruction of primary network pipeline includes the following:

Table 81: *Reconstruction of primary network pipeline investment*

Description	Unit	Number of units	Average price	Investment (BAM)
Installation of sectioning valves	pcs	26	3,846	100,000
Pressure testing				50,000
Rehabilitation of the most critical parts	m	2,450	428	1,050,000
Estimated total investment				**1,200,000**

The estimated effects include:

- Reduction of water losses for approx. 20-40 % of current water losses (185,429 m^3 in 2015) which amounts to approx. 37,085 to 74,171 m^3 of water and approx. 1,500 to 3,000 MWh_{heat}
- Reduction of heat losses for approx. 2 % of current heat losses of 8,419 MWh amounting to approx. 168MWh_{heat}

5.2.6 End User Measures

5.2.6.1 Metering at the Level of Individual Consumers (Individual Meters, Allocators and Thermostatic Valves)

Heat metering and consumption-based billing are generally considered as important steps towards the improving of governance and affordability in the DH sector. The implementation of consumption based billing at the level of individual consumers requires the installation of individual heat meters at each consumer's premises. This measure also implies the replacement of the existing manual valves and installation of new thermostatic valves on all heating bodies (radiators) as well as installation of measuring devices.

In buildings with so-called one-pipe systems (approximately 6,000 apartments), old heat measurement meters are installed, enabling the heat metering and consumption-based billing. Due to the fact that such meters cannot be certified in accordance with the applicable regulations, they also need to be replaced with new ones. This replacement is very simple because the dimensions of new ultrasonic meters with remote reading are the same as the existing ones.

In buildings with so-called two pipe systems (approximately 16,000 apartments), indoor installations are designed as vertical systems, which means that each flat is supplied by heat through multiple vertical pipelines installed through the entire building. As multiple vertical pipes supply the entire building with heat, it is not possible to measure energy consumption for individual apartments with only one heat meter. However in such buildings it is possible to install so-called Heat Cost Allocators (HCA) on each radiator for the allocation of heating costs at the level of each radiator which enables heat consumption measurement for each apartment individually. HCA are commonly used in EU countries and the technology is considered well-developed. In addition to the described equipment which needs to be installed in each apartment it is also required to install additional equipment communication and IT equipment (routers, GSM/GPRS modems) in order to enable remote reading of consumption.

The main goals to be achieved by the introduction of the above described measures include:

- Consumption-based billing, which provides a higher level of transparency to customers, thus increasing their confidence and trust in the DH company;
- Efficiency increase;
- Energy saving;
- Cost reduction;
- For the DH company, the introduction of thermostatic valves will also mean the introduction of variable flow in the secondary system which will enable quick response to the changes in heat demand as well as balanced hydraulic pressure in the entire system and correct temperature, flow and pressure in relation to the heat demand;
- As customers' heating bills will be based on the actual level of heat consumed determined by meter reading, this provides incentives for consumers to save energy and implement EE measures both at apartment level as well as at the level of building;
- In general, customers are more willing to pay prices which better reflect the cost of heat services. Willingness to pay directly impacts the financial sustainability of the DH Company;
- Improved efficiency and the ability to adjust production to meet demand provided by heat metering also improves the quality of service;
- Reduction of the total emission of harmful gases due to reduced consumption of fuel.

Investment required into end user measures include:

Table 82: *Required end user measures investment*

For one-pipe system buildings	Unit	Number of units	Unit price	Total (BAM)
Replacing manual radiator valves	pcs	30,000.00	60.00	1,800,000.00

Installing ultrasonic meters	pcs	6,500.00	650.00	4,225,000.00
For two-pipe system buildings				
Dismantling of existing radiator valves, and delivery and installation of new thermostatic valves and sub-valves	pcs	122,220	55.00	6,722,100.00
Delivery and installation of Heat Cost Allocators	pcs	122,220	55.00	6,722,100.00
Routers	set	4,000.00	500.00	2,000,000.00
GSM/GPRS modem	set	500.00	1,000.00	500,000.00
Estimated total investment				**21,969,200.00**

Based on the experience in similar projects a significant savings may be expected in the reduction of total annual heat energy consumption at the level of buildings-consumers (which currently amounts to 162.408 GWh):

Estimated effect of installation of thermostatic valves: Approximately 1-3 % 1,624–4,872 MWh_{heat}

Estimated effect of application of individual measuring: Approximately 10-20 % 16,241– 32,482 MWh_{heat}

Considering the size of the required investment into end user measures, the Company would not be financially able to implement those measures over a short period of time. As explained in section "Implementation of Consumption Based Billing System", the implementation of consumption-based billing is a prerequisite set by the existing legislation, and considering the above described expected positive effects, gradual implementation of this measure in line with the Company's financial capacities is recommended – the Company would need to invest into the implementation of this measure over a period of the next 20 years. The annual amount that would need to be invested starting from 2018 is 1,098,460 BAM.

5.3 Financial Analysis of PIP Measures

5.3.1 Summary of Financial Analysis

The aim of the financial analysis of the proposed PIP is to assess the financial impact of identified priority capital investments on the future operations of the Company. Implementation of PIP measures would lead to a decrease in costs of fuel and electricity. In order to assess the financial sustainability of the PIP, the cash flow projections and the main project performance indicators. The cash flow projections include the bank model of loan financing with a return period of 10 years and interest rate of 5%.

As presented in Chapter Financial Assessment the current financial position of the Company is unfavourable with total accumulated losses at the end of 2015 amounting to 76,129,699 BAM and with 24,038,923 BAM of losses over the amount of equity and reserves. At the same time the current liabilities were 65,528,927 BAM and together with the long-term liabilities of 27,601,838 BAM it makes the total liabilities amounting to 93,130,764 BAM. Since the accumulated losses exceed the amount of its equity the Company is insolvent and it is also currently facing liquidity problem.

Considering the current financial situation of the Company the financial analysis of the proposed PIP is based on the project financing model excluding the actual liabilities and losses of the Company. In this way it was possible to assess the effects of PIP separately from the existing financial situation. However for the implementation of PIP it is also necessary to make restructuring plan for the existing short and long term loans and liabilities.

5.3.2 Capital Expenditures

The implementation of PIP measures involves the following capital expenditures:

Table 83: *Capital Expenditures*

Description	Total (BAM)
Installation of the new biomass boiler in the central heating plant	20,000,000
Repair and automation of existing burners	450,000
Reconstruction of the main circulation pumps system	260,000
Consumer connection shafts	6,813,363
Priority replacements of secondary network	600,000
Substations modernization	1,506,331
Automatic regulation	1,084,056
Reconstruction of primary network pipeline	1,200,000
Metering at apartment level	21,969,200
TOTAL CAPEX	**53,882,950**

5.3.2.1 Investments into the Central Heating Plant

Dependency on HFO as the only source of fuel resulted in substantial accumulated losses for the Company due to fuel price escalations over the previous period. For those reasons, the Company introduced biomass as an alternative fuel by installing two additional biomass heating plants in Starčevica and Kočićev Vijenac with total 16MW of installed capacity. Apart from the positive environmental effects, biomass as locally available renewable fuel also secures price stability.

As proposed in PIP, the installation of two new biomass fired boilers at the location of the central heating plant with a total output of 24 MW together with existing two biomass boilers with 16 MW of output will result in total

40 MW of installed capacities in biomass-fired boilers. With the installation of these boilers, 27.13% of the total engaged power in the entire DH system will be generated from biomass. The total investment cost of installing two additional biomass fired boilers is 20 million BAM. The key positive effects of this investment include:

- Reducing air emissions;
- Reducing dependency on imported HFO;
- Reducing vulnerability to HFO price fluctuations;
- Reducing the total annual costs of fuel per MWh.

Considering that the HFO fired boilers will remain in use particularly for covering the peak loads during the periods of low temperatures during the heating season, the current efficiency of the HFO burners will need to be increased. Repair and automation of existing HFO burners will lead to an increased efficiency of producing heat from HFO, from the current 9.43 MWh per ton of HFO to 10.17 MWh per ton. Total investment in repair and automation of the existing burners amounts to 450,000 BAM.

In addition to the repair of the existing HFO burners, PIP also foresees the reconstruction of the main circulation pumps system. This investment will result in considerable electricity bill savings for the Company, and will allow automatic regulation and balancing of the network. The planned investment in the main circulation pumps system amounts to 260,000 BAM.

Installation of new biomass boilers and investments into repair of the existing central heating plant are planned during 2016 and 2017.

5.3.2.2 Priority Network Improvements

In order to decrease heat losses in the network and to additionally reduce fuel costs, the Company needs to make significant investments in the reconstruction of priority network. Such measures will also result in reducing electricity costs and subsequently improve service quality, in order to stimulate the gradual reconnection of the disconnected customers.

According to PIP, priority network improvements include investments in:

- Installation of consumer connection shafts (shafts, balancing valves, meters),
- Substations modernization (installation of frequency regulated pumps and hydraulic network balancing),
- Priority replacements of primary network,
- Priority replacements of secondary network,
- Investments into automatic regulation system.

The total investment in priority network improvements amounts to 11,056,059 BAM, and are planned to be implemented during 2016 and 2017.

5.3.2.3 Investments in End User Measures

In order to enable consumption-based billing, it is necessary to implement a set of measures at the end user level in apartments and business spaces. Such measures include replacement of manual radiator valves, installation of ultrasonic meters, thermostatic valves and heat allocators. Investments in communication and IT equipment including routers and GSM/GPRS modems are necessary for enabling automatic measuring. Investments into the aforementioned measures amount to 21,969,200 BAM. Given the financial condition of the Company, these measures could be implemented during the period of the next 20 years. It is envisaged that 500,000 BAM in average will be invested on an annual basis starting from 2018, when the Company is expected to achieve positive cash flow from its operations.

5.3.3 Capital Expenditures

Operating expenses that will be incurred as a result of PIP include costs of producing heat energy (from HFO and biomass), costs of electricity and other fixed costs. The projection of operating expenses is given for the period 2017-2027. In 2017, investments into the central heating plant and priority network improvements will be implemented; hence, cost savings are expected to be achieved starting from 2018.

Table 84: *Capital Expenditures*

Description	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total heat energy produced in MWh	183,111	181,578	191,004	200,429	209,855	209,855	209,855	209,855	209,855	209,855	209,855	209,855	209,855	209,855
Heat produced from heavy fuel oil in MWh	156,199	116,920	126,345	135,771	145,196	145,196	145,196	145,196	145,196	145,196	145,196	145,196	145,196	145,196
Heavy fuel oil in tons	16,564	11,497	12,423	13,350	14,277	14,277	14,277	14,277	14,277	14,277	14,277	14,277	14,277	14,277
Average price of heavy fuel oil BAM/ton	714	714	714	714	714	714	714	714	714	714	714	714	714	714
Total cost of heavy fuel oil BAM	11,826,978	8,208,705	8,870,453	9,532,201	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950
Cost of heavy fuel oil BAM/MWh	75.72	75.72	75.72	75.72	75.72	75.72	75.72	75.72	75.72	75.72	75.72	75.72	75.72	75.72
Electricity spent in MWh	15,700	12,759	12,759	12,759	12,759	12,759	12,759	12,759	12,759	12,759	12,759	12,759	12,759	12,759
Price of electricity BAM/MWh	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Total cost of Electricity BAM	1,256,000	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720
Heat produced from biomass in MWh	26,912	64,658	64,658	64,658	64,658	64,658	64,658	64,658	64,658	64,658	64,658	64,658	64,658	64,658
Biomass in tones	15,098	36,274	36,274	36,274	36,274	36,274	36,274	36,274	36,274	36,274	36,274	36,274	36,274	36,274
Price of biomass BAM per tone	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Cost of biomass BAM	1,811,780	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885
Cost of biomass BAM/MWh	67.32	67.32	67.32	67.32	67.32	67.32	67.32	67.32	67.32	67.32	67.32	67.32	67.32	67.32
Fixed costs	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687
Amortization	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991
Total OPEX BAM	**19,761,453**	**18,449,006**	**19,110,754**	**19,772,502**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**

As a result of investment into rehabilitation of existing HFO burners, efficiency of burning HFO will be improved from current 85% to 91% which means that the burners will produce the same amount of heat energy with less fuel starting from 2018.

The average price of HFO in 2015 was 714 BAM per ton, and it was projected to remain at the same level during the remaining planning period. Given the volatility of HFO prices on the market, it may realistically be expected that the price will change over the next 10-year period. However, due to many unpredictable factors influencing the price of oil, it is not possible to reliably predict the price changes in this period.

The price of biomass was projected to remain at the level of 120 BAM per ton during the entire planning period. Compared to the price of HFO, it is realistic to expect that the price of biomass will be more stable considering that it is locally available.

The cost of heat production from HFO is 75.72 BAM per MWh, whereas the cost of heat production from biomass is 67.32 BAM per MWh; therefore, the difference in price is 8.4 BAM per MWh or 11% less for biomass compared to HFO. Accordingly, the financial result of the Company will improve with the expected increase in share of biomass starting from 2018. The new biomass boilers will be put into operation in 2018, using 36,274 tons of biomass per year at optimal capacity. With the expected reconnection of disconnected consumers, heat consumption is expected to increase in the period from 2018 to 2021. Since the biomass boilers will already be functioning at optimal capacity, the increased heat demand will be covered by HFO. Consequently, the total operating expenses as well as the average cost of heat production will increase in the same period.

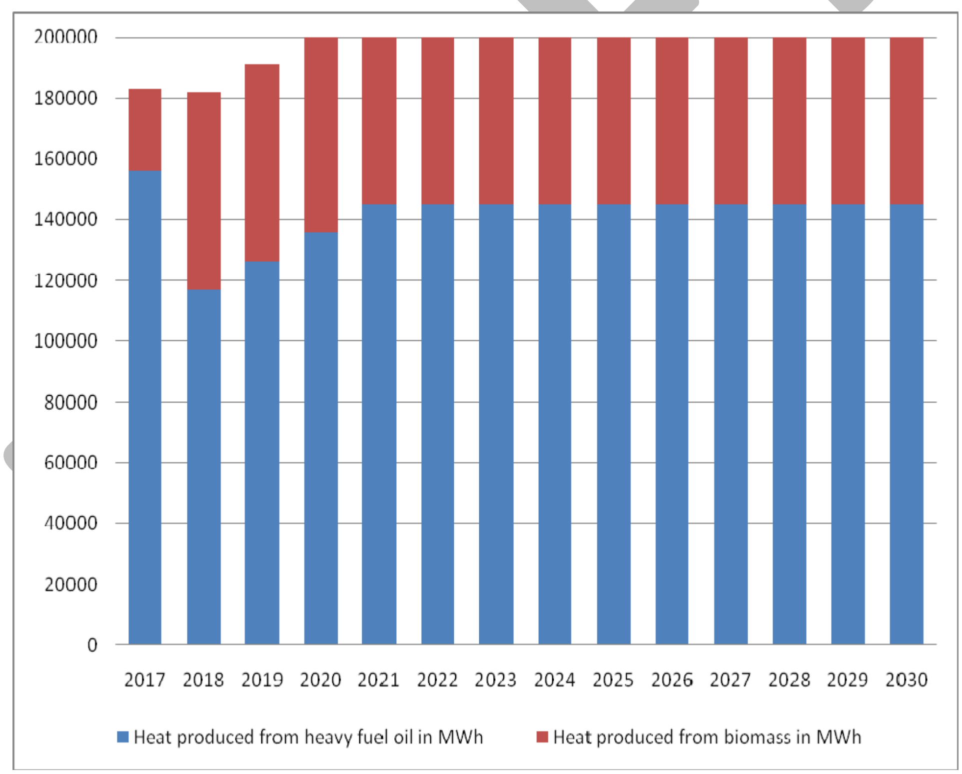


Figure 60: *Heat energy production in MWh*

The planned investments into rehabilitation of the distribution network will considerably improve network efficiency resulting in the reduction of water and heat losses, which will in turn impact fuel consumption. Currently, heat losses in the total network amount to over 11%, which is expected to be reduced to 6% following the implementation of PIP (from 2018), resulting in decrease of costs of fuel supplied to the customers on an annual basis.

In addition to fuel savings, electricity spending will also significantly decrease as a result of planned investments into installation of frequency regulated pumps, from 1,256,000 BAM in 2017 to 1,020,720 BAM in 2018 (18.7%), projected to remain at the same level during the rest of the planning period.

5.3.4 Revenue Growth Projection

The network improvements planned in PIP will significantly improve the quality and consistency of service provided by the Company.

The total heat potential of disconnected customers is estimated at 40.35 MW requiring 44,460 MWh of heat supply. It is estimated that 80% of disconnected customers will reconnect over the period of 4 years and that 20% may decide to permanently switch to other sources of heat. As described in Chapter Tariff Model according to the new adopted tariff calculation system the disconnected residential customers will have to pay the fixed fee per square meter of their apartment space. Therefore the projected remaining 20% customers that may decide to permanently disconnect from the DH system will have to pay a fixed fee resulting in the additional revenues to the Company. However since it is not possible to estimate the amount of space to which the fixed fee will be billed during the planning period this potential revenue was not included in the revenues growth projection.

As shown in the table below the total level of heat supplied to consumers will increase from 2018 to 2021 reflecting the described reconnections of disconnected customers. Total revenues from sale of heat will also increase accordingly.

Table 85: *Unit price of heat per MWh*

Description	2016	2017	2018	2019	2020	2021
Current level of heat energy supplied to consumers in MWh	162,408	162,408	162,408	162,408	162,408	162,408
Reconnection of disconnected consumers in MWh	0	0	8,892	8,892	8,892	8,892
Total heat supplied to consumers in MWh	162,408	162,408	171,300	180,192	189,084	197,976
Average price of heat supplied to consumers in BAM/MWh	130	130	130	130	130	130
Total revenues from sale of heat BAM	**21,113,040**	**21,113,040**	**22,269,000**	**23,424,960**	**24,580,920**	**25,736,880**

The projection of revenues growth of the Company is based on MWh supplied to the customers and the average price of heat supplied to consumers (calculated in BAM/MWh). However, the actual billing of the customers during the planning period will still be partially based on billing per m2 of heated space or based on collective consumption in buildings (divided by the m2 of heated space per customer).

5.3.5 Project Financing

The total amount of required funds for the implementation of all PIP measures is BAM 53,882,950.

Of this amount, BAM 31,913,750 would be invested in 2017 for procurement of new equipment and modernization of existing equipment.

The remaining amount of BAM 21,969,200 would be invested in the following 20 years (BAM 1,098,460 each year) for metering equipment on apartment level.

A loan in the amount of BAM 30,000,000 would be used finance the envisaged investments in 2017. The estimated repayment period of loan is 10 years with an interest rate of 5% which includes the loan processing fee. This interest rate was presumed based on the average interest rate for public sector companies in BiH and it does not reflect the credit risk associated with the current financial position of the Company. The grace period should not be less than one year taking into account the estimated cash flow projections (Table 87: Cash Flow Projection).

The terms of the foreseen loan are presented in the following table.

Table 86. *Envisaged loan conditions*

Description	Amount
Loan repayment duration (number of years)	10
Grace period (number of years)	1
Fixed interest rate (%)	5
Principal loan amount (BAM)	30,000,000
Annuity repayment amount (BAM)	3,885,137.25
Principal repayment amount per year (BAM)	3,000,000
Interest payment amount per year (BAM)	885,137.25

5.3.6 Cash Flow Projection

The following table presents the estimated cash flow for the Company in the period 2017-2029.

Table 87: *Cash Flow Projection*

Description	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Heat energy supplied to consumers in MWh	162,408	171,300	180,192	189,084	197,976	197,976	197,976	197,976	197,976	197,976	197,976	197,976	197,976
Average price of heat supplied to consumers in BAM/MWh	130	130	130	130	130	130	130	130	130	130	130	130	130
Total revenues from sales of heat (BAM)	**21,835,153**	**22,269,000**	**23,424,960**	**24,580,920**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**
Long term loan (BAM)	**30,000,000**												
TOTAL POSITIVE CASH FLOW (BAM)	**51,835,153**	**22,269,000**	**23,424,960**	**24,580,920**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**	**25,736,880**
Total cost of heavy fuel oil BAM	11,826,978	8,208,705	8,870,453	9,532,201	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950	10,193,950
Total cost of Electricity BAM	1,256,000	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720	1,020,720
Cost of biomass BAM	1,811,780	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885	4,352,885
Fixed costs	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687	6,557,687
Amortization	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991	1,690,991
Total OPEX (BAM)	**19,761,453**	**18,449,006**	**19,110,754**	**19,772,502**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**	**20,434,251**
Installation of the new biomass boiler in the Central Heating plant BAM	20,000,000	0	0	0	0	0	0	0	0	0	0	0	0
Metering on apartment level		1,098,460	1,098,460	1,098,460	1,098,460	1,098,460	1,098,460	1,098,460	1,098,460	1,098,460	1,098,460	1,098,460	1,098,460
Consumer connection shafts	6,813,363												
Priority replacements of secondary network	600,000												
Substation modernization	1,506,331												
Automatic regulation	1,084,056												
Reconstruction of primary network pipeline	1,200,000												
Repair and automation of existing burners	450,000												
Reconstruction of the main circulation pumps system	260,000												
Total CAPEX (BAM)	**31,913,750**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**	**1,098,460**
Loan financing BAM		885,137	3,885,137	3,885,137	3,885,137	3,885,137	3,885,137	3,885,137	3,885,137	3,885,137	3,885,137	3,885,137	0
TOTAL NEGATIVE CASH FLOW (BAM)	**51,675,203**	**20,432,603**	**24,094,351**	**24,756,100**	**25,417,848**	**25,417,848**	**25,417,848**	**25,417,848**	**25,417,848**	**25,417,848**	**25,417,848**	**25,417,848**	**21,532,711**
Net Cash Flow (BAM)	**159,950**	**1,836,397**	**-669,391**	**-175,180**	**319,032**	**319,032**	**319,032**	**319,032**	**319,032**	**319,032**	**319,032**	**319,032**	**4,204,169**
Cumulative Cash Flow (BAM)	**159,950**	**1,996,347**	**1,326,955**	**1,151,776**	**1,470,808**	**1,789,840**	**2,108,872**	**2,427,903**	**2,746,935**	**3,065,967**	**3,384,999**	**3,704,031**	**7,908,200**

The cash flow projections for the considered period are presented in nominal values (without taking into account inflation etc.).

The cash flow projection for the Company was estimated based on the previously elaborated expected revenues, investment costs and operating costs. The table above presents the cash flow projection for the Company for a period of 13 years – starting from 2017 (as the year in which the majority of investments are made), and includes the loan repayment period and the year 2029 (the year following loan repayment). After 2029, the cash flow projection remains the same for the following years, differing only in amount of cumulative cash which would increase for the amount of net cash flow of BAM 4,204,169 each year.

In the period 2017-2020, revenues from the sale of heat energy are expected to have an increasing trend as a result of expected increases in the amount of heat sold due to projected reconnection of the disconnected users, while after 2020 the amount of expected revenues remains at a constant level since the further network expansion and additional new customers are not projected.

Operating costs are also expected to increase until 2020 as a result of increased production of heat energy, while after 2020 they remain at a constant level since increase in production of heat energy is not projected.

The above mentioned trends of expected revenues, operating costs and investment costs are reflected on the net cash flow and cumulative cash flow. In 2017, positive net cash flow and cumulative cash flow are achieved amounting to BAM 159,950. In 2018, as a result of increase in sold heat energy and increased efficiency of the heating system, positive net cash flow is achieved, amounting to BAM 2,721,534, as well as cumulative cash flow amounting to BAM 2,881,484. In 2019, as a result of loan repayment outflows the negative net cash flow is achieved and this trend is kept until 2021. However, the cumulative cash flow remains positive but decreases due to the amount of negative net cash flow during this period. This means that the Company has sufficient funds at its disposal for regular operation during the entire investment period.

Starting from 2021, the positive net cash flow is achieved amounting to BAM 319,032 and the same amount of net cash flow is kept until 2028 resulting in the increase of cumulative cash flow each year by the aforementioned amount. After 2028, the net cash flow amounts to BAM 4,204,169 each year as a result of the full loan repayment resulting in increase of cumulative cash flow each year by the aforementioned amount. Taking into account the current credit commitments of the Company, the increase in disposable funds will enable the Company to plan reprogram of the existing loans. At the same time, it will enable the Company to further invest in the expansion of DH system network.

5.4 Rapid Environmental Assessment of PIP Measures

The impacts associated with the Project and the PIP measures have been identified and evaluated in terms of their significance (major/moderate/minor) and duration (short-term/long-term).

During the implementation of the proposed PIP measures, a number of both long-term and short-term positive and negative impacts are anticipated that are usually associated with infrastructure projects, affecting directly and indirectly the environment and the surrounding area.

The proposed works will be implemented in urbanized areas of the City of Banja Luka, with minimum interventions in the natural environment or in already existing facilities owned by the Company.

5.4.1 Installation of New Biomass Boilers

The installation of new biomass boilers includes two main activities: installation of a new biomass boiler in the central heating plant and installation of a new biomass boiler in the heating plant Kočićev Vijenac.

5.4.1.1 Installation of New Biomass Boilers in the Central Heating Plant

This measure involves the installation of two new biomass boilers with a capacity of 12 MW each (total of 24MW) instead of two boilers (capacity of 7 MW) that are currently out of function in the central heating plant.

The installation of the new biomass boilers is likely to lead to the following impacts:

Table 88: *Impacts Related to Installation of New Biomass Boilers in the Central Heating Plant*

Negative impacts			**Significance of impacts**	**Duration of impacts**
	Impacts related to increased levels of noise	Activities linked to the installation of biomass boilers such as cutting, tamping, welding, boiler lifting, etc., may lead to increased workplace noise levels.	Minor	Short-term
	Impacts related to generation of waste	During replacement activities generation of waste mechanical and electronic parts of existing boilers will occur. The recyclable components should be separated and sold to the waste market while other components should be disposed in accordance with the Law on Waste Management (Official Gazette of RS, No. 111/13, 106/15).		
Positive impacts				
	Increase in boiler efficiency		Major	Long-term
	Reduction in pollutant emissions due to reduced consumption of HFO			

The installation of the new biomass boilers is likely to have reduction of pollutant emissions as shown in table below.

Table 89: *Installation of New Biomass Boilers in the Central Heating Plant - Reduction of Pollutant Emissions*

Reduction of pollutant emissions			
CO_2	**SO_2**	**NO_x**	**Solid particles**
[t/a]	[t/a]	[t/a]	[t/a]
10,714.95	209.84	22.69	1.10

5.4.2 Repair of Central Heating Plant Boilers

5.4.2.1 Repair and Automation of Existing Burners

This measure includes the reconstruction of the boiler infrastructure, respectively the repair and automation of existing burners, with the transition from the two-stage to the modulating burner (variable speed control), as well as the introduction of frequency regulation for recirculation of boiler pumps. All the necessary works will be implemented within the central heating plant with no disruptions to the natural environment.

The small-scale reconstruction works associated with this measure are likely to lead to the following impacts:

Table 90: Impacts Related to Repair and Automation of Existing Burners

Negative impacts			**Significance of impacts**	**Duration of impacts**
	Impacts related to generation of waste	During reconstruction activities production of mechanical and electronic parts from existing burners will occur. The recyclable components should be separated and sold to the waste market while other components should be disposed in accordance with the Law on Waste Management (Official Gazette of RS, No. 111/13, 106/15).	Minor	Short-term
Positive impacts				
	Improved fuel combustion efficiency and reduction in fuel consumption by 6 – 7 % (better management of energy resources)		Major	Long-term
	Reduction of air emissions at central heating plant			

The positive impacts on the environment due to installation of efficient burners on the boilers will include increase of EE and reduced consumption of fuel. Installation of efficient burners on the boilers would reduce fuel consumption by 4-7 % (out of app. 122.125 MWh), which means savings of app. 4.885 to 8.548 MWh heat) per year. The following table provides estimates on potential reduction of pollutant emissions.

Table 91: *Repair and Automation of Existing Burner - Reduction of Pollutant Emissions*

Fuel	**Reduction of**	**Reduction of**	**Reduction of pollutant emissions**

	energy demand	fuel consumption	CO_2	SO_2	NO_x	Solid particles
	[MWh]	[t]	[t/a]	[t/a]	[t/a]	[t/a]
HFO	4,885.00 – 8,548.00	517.81 – 906.09	1,586.42 – 2,776.00	31.07 – 54.37	8.11 – 14.19	0.35 – 0.62

5.4.2.2 Reconstruction of the Main Circulation Pumps System

This measure involves the complete replacement of one of the existing main circulation pumps with a new pump approximately the same characteristics, with less power (approx. 10-20%) and variable frequency regulation.

The reconstruction/replacement works associated with this measure are likely to lead to the following impacts:

Table 92: Impacts Related to Reconstruction of the Main Circulation Pumps System

Negative impacts		**Significance of impacts**	**Duration of impacts**
Impacts related to generation of waste	During replacement activities production of waste pumps, pipes, valves and other mechanical and electronic parts will occur. The recyclable components should be separated and sold to the waste market while other components should be disposed in accordance with the Law on Waste Management (Official Gazette of RS, No. 111/13, 106/15).	Minor	Short-term
Positive impacts			
Reduction in electricity consumption, leading to more energy-efficient operation of the central heating plant.		Major	Long-term

5.4.3 Impacts Associated with Secondary Network Improvements

5.4.3.1 Consumer Connection Shafts

The proposed measures include the construction of new connecting shafts in front of the buildings, and installation of equipment for measurement and control (cumulative meters, balancing valves, thermometers, pressure gauges, ball valves, drain valves).

The implementation of these measures is likely to lead to the following impacts:

Table 93: *Impacts Related to Consumer Connection Shafts*

Negative impacts		**Significance of impacts**	**Duration of impacts**
Impacts related to increased levels of noise	Noise emission is likely to appear during site preparation activities. Possible sources of noise are: excavation of ground and preparation for installation of shafts and the use of tools and working equipment during installation of balancing valves and meters. Noise generated during these activities may also result in disturbances to both the population living in the buildings and the workers on sites. Workers on site exposed to high levels of noise should wear appropriate PPE.	Minor	Short-term
Impacts related to generation of waste	Construction waste (inert earth material, rock and soil) will be generated during construction activities.		
Increase of dust and small particles	During the shaft construction works some dust and small particles may occur. Therefore, workers should wear appropriate PPE.		
Positive impacts			
Reduction in energy consumption		Major	Long-term
Reduction of air emissions at heat generation source			

The proposed measures have no potential to affect the biological and ecological resources nor the potential to cause changes on current land use since the area where the necessary works will be carried out is completely urbanized.

By constructing new connecting shafts in front of buildings and installing measurement and control equipment (cumulative meters, balancing valves, thermometers, pressure gauges, ball valves, drain valves according to the principal scheme), it is possible to reduce energy consumption between 1,624 – 3,248 MWh_{heat}. This reduction in energy consumption will directly cause reduction of air emissions. Since 77% of energy is supplied from the central boiler house, this percentage will apply to savings during calculation of emission reduction from HFO. Potential emission reduction as a result of implementing this measure is presented in the table below.

Table 94: *Consumer Connection Shafts - Reduction of Pollutant Emissions*

Fuel	Reduction of energy demand	Reduction of fuel consumption	Reduction of pollutant emissions			
			CO_2	SO_2	NO_x	Solid particles
	[MWh]	[t]	[t/a]	[t/a]	[t/a]	[t/a]
HFO	1,250.48 – 3,751.44	132.55 – 397.65	406.10 – 1,218.30	7.95 – 23.86	2.08 – 6.23	0.09 – 0.27
Biomass	373.52 – 1,120.56	209.45 – 392.38	-	-	0.36 – 1.09	0.01 – 0.05

5.4.3.2 Replacement of Existing Pipes

The proposed measure includes the replacement of existing deteriorated steel pipes of the secondary pipeline network in the total length of 3,000.00 m and necessary reconstruction works, excavation of earth material and old steel pipes and placing of new pre-insulated pipes (consisting of PEH casing in outer layer, insulation PUR foam in middle layer and steel pipes as the most inner part of the pipe).

The associated large-scale reconstruction works of the secondary heating pipeline and related activities are likely to lead to the following impacts:

Table 95: *Impacts Related to Replacement of Existing Pipes*

Negative impacts			Significance of impacts	Duration of impacts
	Impacts on air quality	Air quality may be temporarily and locally impacted by dust and emission of exhaust gases from mechanization. Dust will appear as a result of site preparation activities (excavation of earth material), reconstruction activities (excavation of old heating pipes and placing the new pre-insulated heating pipes), and movement of vehicles transporting the equipment on unpaved surfaces on the construction site. Combustion of fossil fuels will lead to emission of exhaust gases from mechanization (excavators and transportation trunks).	Moderate	Short-term
	Impacts related to increased levels of noise	Noise emission caused by excavation of ground and use of tools and working equipment is likely to appear during site preparation activities. Noise generated during reconstruction activities may also result in disturbances to both the population living in proximity and the workers on sites. Workers exposed to high levels of noise should wear appropriate PPE.		
	Impacts related to generation of waste	Construction waste (inert earth material, rock and soil) and deteriorated metal parts will be generated during construction activities. It is anticipated that approximately 39.5 tonnes[175] of steel waste will be generated during the implementation of this measure. The old steel pipes are covered with mineral wool, polymer modified bitumen and metal sheets (galvanized with Zn). 1.5 tonnes of mineral wool, 1 tonne of polymer modified bitumen and around 3 tonnes of metal sheets (galvanized with Zn) will be produced.		
	Impacts on soil	The necessary earth works and excavation processes will lead to removal of top soil in the area where the reconstruction of the pipeline will be conducted. The engaged construction machinery (vehicles and equipment for construction activities) may also cause		

[175] One meter of pipeline weighs app. 5.5 kg and pipe girders weigh app. 20% of the pipeline weight.

Negative impacts		**Significance of impacts**	**Duration of impacts**
	compaction of soil in surrounding areas, harm the soil's productivity and impair drainage.		
Impacts on visual values	Visual impacts are expected due to organization of construction sites, delivering and temporary storing of building materials and presence of working machinery on construction sites. Expected visual changes will be perceptible for residents in surrounding area.		
Positive impacts			
Reduction in water and energy consumption in the hot water preparation process (preventing of hot water leakage and re-heating of new cold water)		Major	Long-term
Decrease in heat losses for the secondary network			

Regarding adverse impacts on biological and ecological resources as well as surface and ground water quality, the proposed measures have no potential to cause these impacts since the area of necessary works is completely urbanized. The proposed measures have no potential to cause changes on present land use.

By replacing a part of existing pipes in the secondary network, it will be possible to achieve energy savings of app. 392 MWh_{heat}. This reduction in energy consumption will directly cause reduction of harmful substances into the atmosphere.

The following table provides estimates on potential reduction of Pollutant Emissions.

Table 96: *Replacement of Existing Pipes - Reduction of Pollutant Emissions*

Fuel	**Reduction of energy demand**	**Reduction of fuel consumption**	**Reduction of pollutant emissions**			
			CO_2	**SO_2**	**NO_x**	**Solid particles**
	[MWh]	[t]	[t/a]	[t/a]	[t/a]	[t/a]
HFO	301.84	32.00	98.02	1.92	0.50	0.02
Biomass	90.16	50.56	-	-	0.09	0.00

5.4.4 Substation Modernisation

This measure includes the installation of frequency regulated pumps and automatic regulation.

The installation of frequency regulated pumps implies the replacement of existing circulation pumps and the installation of circulation pumps with variable speed control pumps. The new pumps are designed with lower power. The average consumption of electricity in the distribution network currently amounts to 7,838.66 MWh, and the savings would amount to 40% or 3,135.06 MWh, which is 21% of the total consumption of electricity.

The automatic regulation measure includes the replacement of existing devices for automatic regulation of supply temperature depending on the outdoor temperature (where they are already in place), and the installation of new devices in the substations where they are not in place.

The implementation of this measure is likely to lead to the following impacts:

Table 97: *Impacts Related to Substation Modernisation*

Negative impacts		**Significance of impacts**	**Duration of impacts**
Impacts related to generation of waste	During replacement activities production of waste pumps, pipes, valves and other mechanical and electronic parts will occur. The recyclable components should be separated and sold to the waste market while other components should be disposed in accordance with the Law on Waste Management (Official Gazette of RS, No. 111/13, 106/15).	Minor	Short-term
Positive impacts			
Reduction in energy consumption in the substation (40% savings in electricity consumption)		Major	Long-term
Reduction in fuel consumption 3 - 5% (better management of energy resources)			

Replacement of the existing devices for automatic regulation of supply temperature depending on the outside temperature (where they are built) or installation of new ones in the substations (where they are not built) would lead to energy savings between 4,872 and 8,120 MWh_{heat}. This reduction in energy consumption will directly cause reduction of harmful substances into the atmosphere.

The following table provides estimates on potential reduction of pollutant emissions.

Table 98: *Automatic Regulation - Reduction of Pollutant Emissions*

Fuel	Reduction of energy demand	Reduction of fuel consumption	Reduction of pollutant emissions			
			CO_2	SO_2	NO_x	Solid particles
	[MWh]	[t]	[t/a]	[t/a]	[t/a]	[t/a]
HFO	3,751.44 – 6,252.40	397.65 – 662.75	1,128.30 – 2,030.49	23.86 – 39.77	6.23 – 10.38	0.27 – 0.45
Biomass	1,120.56 – 1,867.60	628.36 – 1,047.27	-	-	1.09 – 1.82	0.04 – 0.08

5.4.5 Primary Network Improvements

5.4.5.1 Reconstruction of Primary Network Pipeline

Reconstruction of the primary network pipeline would include the replacement of the existing deteriorated steel pipes of the primary pipeline network in the length of 2,450 m and the necessary reconstruction works, excavation of earth material and old steel pipes, and placing of new pre-insulated pipes.

It is expected that the impacts which may occur during the implementation of this measure will be similar to those described in section 5.4.3. Since this measure would be implemented in a smaller extent compared to the reconstruction of secondary pipeline network (smaller length of pipeline replacement and required works), the significance of related impacts is assessed as minor to moderate.

Positive impacts (benefits) that will arise after the completion of reconstruction works related to the primary network pipeline are of the same nature as for the reconstruction of the secondary network (see section 5.4.3.).

Reconstruction of the primary network pipeline which includes installation of sectioning valves and rehabilitation of the most critical parts of the primary distribution network system would reduce water consumption, which would directly reduce losses in heating energy, causing significant savings in heating energy. By replacing the part of existing pipes in secondary network, it is possible to achieve energy savings of app. 168 MWh_{heat}. This reduction in energy consumption would directly cause reduction of harmful substances into the atmosphere.

The following table provides estimates on the potential reduction of pollutant emissions.

Table 99: *Impacts Related to Reconstruction of Primary Network Pipeline*

Fuel	Reduction of energy demand	Reduction of fuel consumption	Reduction of pollutant emissions			
			CO_2	SO_2	NO_x	Solid particles
	[MWh]	[t]	[t/a]	[t/a]	[t/a]	[t/a]
HFO	129.36	13.71	42.01	0.82	0.21	0.01
Biomass	38.64	21.67	-	-	0.04	0.00

5.4.5.2 Hydraulic Network Balancing

Installation of balancing valves requires construction of shaft and installation of valves. It is expected that the negative impacts which may occur during the implementation of this measure will be similar to those described in section on Consumer Connection Shafts. Positive impacts are not expected.

5.4.6 Impacts Associated with End User Measures

End user measures include metering at apartment level. This measure implies the replacement of existing manual valves, installation of ultrasonic meters (for one-pipe system buildings), dismantling of existing radiator valves and installation of new thermostatic valves and sub-valves, installation of allocators, routers and GSM/GPRS modem (for two-pipe system buildings).

The mentioned measures will have a minor impact on the environment and the population, and are expected to be temporary in terms of duration.

The implementation of the aforementioned measures is likely to lead to the following impacts:

Table 100: *Impacts Related to End User Measures*

Negative impacts		**Significance of impacts**	**Duration of impacts**
Impacts related to increased levels of noise and vibrations	Tools that will be used during the dismantling of old parts and installation of new parts for the heating regulation will produce minor short-term increase of noise. Noise may be caused by forced dismantling of old parts, through possible cutting that will produce vibrations. During cutting, a force is generated between the tool and work piece, which acts at an angle to the surface. The magnitude of this cutting force depends largely on the tool-work engagement and depth of cut. Vibration may be caused by cutting, if passive damping elements are not being used.	Minor	Short-term
Impacts related to generation of waste	Dismantling and replacement of existing radiator valves will generate waste valves. Waste valves will also be generated at valves' end-of-life. The waste valves may be sold as secondary raw material on the waste market. In case that programmable thermostatic radiator valves are used, replacement of thermostats will generate waste electrical and electronic components that may be sold as secondary raw material on the waste market.		
Positive impacts			
Reduction in fuel consumption (improved management of energy resources)		Major	Long-term
Reduction of air emissions at central heating plant			
Increased energy efficiency (through adjustment of heat production)			

Reduction of emission of harmful substances into the atmosphere is directly proportional to energy savings, or reduction of energy demand. By introducing metering at apartment level, it is possible to decrease energy consumption by 10 – 20 %. Since there are some apartments that are underheated and some are overheated (which results in buildings receiving more energy than they actually need), installation of thermostatic valves will decrease consumption in the amount between 1,624 – 4,872 MWh_{heat}. The following table provides estimates on potential reduction of pollutant emissions.

Table 101: *End User Measures - Reduction of Pollutant Emissions*

Fuel	**Reduction of energy demand**	**Reduction of fuel consumption**	**Reduction of pollutant emissions**			
			CO_2	**SO_2**	**NO_x**	**Solid particles**
	[MWh]	[t]	[t/a]	[t/a]	[t/a]	[t/a]
HFO	1.250,48 – 3.751,44	132.55 – 397.65	406.10 – 1,218.30	7.95 – 23.86	2.08 – 6.23	0.09 – 0.27
Biomass	373.52 – 1,120.56	209.45 – 628.36	-	-	0.36 – 1.09	0.01 – 0.05

5.4.7 Reduction of Pollutant Emissions due to Implementation of All Proposed PIP Measures

Implementation of all proposed PIP measures, including the installation of biomass boilers and all improvements on the distribution network and end user side, will cause significant reduction of emission of harmful substances into the atmosphere. The table below provides estimates on the potential reduction of pollutant emissions following the implementation of all suggested PIPs.

Table 102: *Implementation of all PIP Measures - Reduction of Pollutant Emissions*

CO_2[t/a]	**SO_2[t/a]**	**NO_x[t/a]**	**Solid particles[t/a]**

Current emissions	Expected emissions after PIP	Reduction	Current emissions	Expected emissions after PIP	Reduction	Current emissions	Expected emissions after PIP	Reduction	Current emissions	Expected emissions after PIP	Reduction
50,748,68	36,637.30	18,111.38	993.86	639.18	354.69	286.04	228.67	60.37	12.33	9.72	2.61

5.4.8 Conclusion

The implementation of the proposed measures under PIP will inevitably lead to short-term impacts that are related to construction works and generally associated with infrastructure projects of any type. The significance of negative impacts during the replacement and reconstruction works has been assessed as minor.

On the other side, the implementation of the mentioned measures will result in long-term positive impacts on air quality, more efficient consumption of natural resources (fuel and water consumption) and overall increase in energy efficiency of existing district heating system. In terms of significance, positive impacts have been assessed as major environmental benefits.

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5.5 Policy/Regulatory Gap Analysis

The policy/regulatory gap analysis is presented for the relevant measures proposed within the Priority Investment Program and the recommendations provided.

5.5.1 Installation of New Biomass Boilers

Prior to the installation of two biomass boilers with a total installation capacity of 24MW (2x12MW) in the Central Heating plant and the new biomass boiler with a total installed capacity of 4 MW in the Heating Plant Kočićev Vijenac, the Company needs to obtain the necessary permits required by local legislation, including the Environmental Permit, Location Conditions, Construction Permit and Use Permit.

The environmental permitting procedure in RS is regulated by the *Law on Environmental Protection*[176]*,* the *Regulation on Plants and Facilities that May be Constructed and Operated Only with a Valid Environmental Permit*[177]*,* the *Regulation on Projects Subject to Obligatory Environmental Impact Assessment (EIA) and Criteria for Deciding on the Obligation of Implementation and Scope of the Environmental Impact Assessment*[178]*.* According to the aforementioned regulations, the installation of two biomass boilers with a total installation capacity of 24MW is subject to an Environmental Permit to be issued by the Ministry of Spatial Planning, Civil Engineering and Ecology of RS, and in this case the aforementioned Ministry decides if an EIA Study is necessary to be attached to the request for Environmental Permit. Installation of the new biomass boiler with a total installed capacity of 4 MW in the Heating Plant Kočićev Vijenac is subject to an Environmental Permit to be issued by the authority responsible for environmental protection of the City of Banja Luka and without an EIA procedure.

According to the *Law on Spatial Planning and Construction*[179]*,* facilities for the production of thermal energy - DH and other facilities regulated by specific laws are subject to Location Conditions, Construction Permit and Use Permit issued by the Ministry of Spatial Planning, Civil Engineering and Ecology of RS. This means that for the installation of new biomass boilers in the Central Heating Plant and the new biomass boiler in the Heating Plant Kočićev Vijenac, the aforementioned Permits have to be issued by the Ministry of Spatial Planning, Civil Engineering and Ecology of RS.

5.5.2 Secondary Network Improvements

Consumer connection shafts (shafts, balancing valves, meters, and other equipment)

In case it is not technically feasible and financially acceptable compared to the long-term estimation of energy savings to introduce metering at apartment level, it is necessary to enable the consumer with the possibility to pay heat energy calculated on the basis of actual consumer delivery. The construction of new connecting shafts in front of buildings and installation of measurement and control equipment in such shafts will enable the calculation of heat energy delivered to each building.

The *Decision on General Conditions for Heat Delivery*[180] regulates the possibility of having common meters used for measuring of supplied heat energy to two or more consumers. According to Article 70 of the Decision, consumers who have common meters pay the supply of heat energy according to consumption shown on the common meter, proportionally according to the floor of each apartment for residential consumers, and according to the supply power for business consumers.

In this case, the tariff system determined by the *Decision on General Conditions for Heat Delivery* would need to be changed accordingly in order to enable price setting for consumers whose heat energy consumption is measured through connection shafts. This means that the aforementioned Decision would need to be amended in terms of its provisions on the tariff system which determines the group of heat customers, tariff elements, tariff rates and billing of thermal energy delivered to customers, criteria and benchmarks for the pricing of heat energy, and the criteria for determining tariff rates. All the elements contained in the part regarding the tariff system would need to be modified, and the possibility for pricing of heat energy calculated

[176] Official Gazette of RS No. 71/12 and 79/15
[177] Official Gazette of RS, No. 124/12
[178] Ibid.
[179] Official Gazette of RS, No. 40/13, 106/15 and 3/16
[180] Official Gazette of the City of Banja Luka, No. 26/13

on the floor area would need to be eliminated. It would be necessary to introduce the possibility of pricing the heat delivered to consumers by common meters located in connection shafts according to consumption shown on the common meter, proportionally according to the floor of each apartment for residential consumers, and according to the supply power for business consumers.

5.5.3 End User Measures

Metering at apartment level (individual meters, allocators and thermostatic valves)

The requirement to introduce individual metering of heat consumption in RS is regulated by several laws.

The *Law on Spatial Planning and Construction*[181] which governs, inter alia, the energy performance of buildings, requires the installation of metering devices for each individual condominium (flat) owner in all new buildings, as well as in existing buildings during major renovation[182], if it is technically feasible and financially acceptable, but at least one metering device for measuring the consumption of an entire building has to be installed.

The *Law on Consumer Protection of BiH*[183] states that prices of supplied energy must be based on individual actual consumption calculated on the basis of consumers' meters.

The *Law on Consumer Protection of RS*[184] requires that energy supplied to customers should be metered, and not allocated on the basis of occupied floor area. According to its Article 2, the unit price of utility services is the final price per kilowatt hour of district heating, including all taxes and duties. Article 49 stipulates that consumption of heat must be calculated on the basis of actual consumer delivery, as shown by the consumer metering device. If consumption is not calculated on the basis of individual metering, the service provider is required to enable to the consumer, at the request of the consumer, the installation of an appropriate measuring device, based on the project of technical feasibility and in accordance with the general conditions for service delivery and supply.

Furthermore, the *Law on Energy Efficiency of RS*[185] requires energy distributors to offer their customers the possibility to purchase and install individual energy consumption meters at competitive prices, if installation of individual meters is technically feasible and financially profitable compared to the long-term estimation of energy savings, in the following cases: when the energy is delivered to the end customers without measurement in place, during the renovations of the building, during the reconstruction of a connection to power system. Individual metering is required in new buildings.

The *Decision on General Conditions for Heat Delivery*[186] provides for the obligatory installation of individual meters on home installations and common meters on home substations for new buildings which will be connected to the DH system. Consumers (or investors) have to cover the costs of installation of meters.

In case of introduction of individual meters, allocators and thermostatic valves in all heated buildings, the tariff system would need to be changed so as to allow billing to be based solely on individual metering (actual consumption). It would, therefore, be necessary to amend the existing *Decision on General Conditions for Heat Delivery*[187], i.e. its provisions on the tariff system which determines the group of heat customers, tariff elements, tariff rates and billing of thermal energy delivered to customers, criteria and benchmarks for the pricing of heat energy, and the criteria for determining tariff rates. All the elements contained in the part regarding the tariff system would need to be changed and the possibility for pricing of heat energy calculated based on floor area would need to be eliminated.

[181] Official Gazette of RS, No. 40/13, 106/15 and 3/16

[182] Major renovation means renovation of a building where the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated, or where more than 25 % of the surface of the building envelope undergoes renovation.

[183] Official Gazette of BiH, No. 25/06

[184] Official Gazette of RS, No. 6/12

[185] Official Gazette of RS, No. 59/13

[186] Official Gazette of the City of Banja Luka, No. 26/13

[187] Official Gazette of the City of Banja Luka, No. 26/13

5.5.4 Connection and Disconnection to the DH System

The existing *Decision on General Conditions for Heat Delivery*[188] sets the procedure for voluntary connection of newly constructed buildings or existing buildings to the DH network, and does not require the mandatory connection of such buildings to the network.

According to the aforementioned Decision, consumers are not allowed to connect or disconnect their building installations to/from the DH system without the consent of the Company. However, the Decision does not regulate in detail the procedure of disconnection by individual consumers and does not contain the conditions for allowing such disconnection or the requirement of disconnected consumers to pay the fixed costs of heating.

Prior to the implementation of the expansion of the DH network as elaborated in Chapter Possibilities for Network Expansion, in order to ensure the connection of buildings to the expanded network and define the criteria for disconnection of individual consumers, the existing *Decision on General Conditions for Heat Delivery* would need to be amended to include provisions on obligatory connection of all buildings to the DH network in the event that the technical installations for connections are provided by the Company and the criteria for disconnection.

5.5.5 Pricing and Payment of Fixed Costs

According to the *Decision on General Conditions for Heat Delivery*[189], the total cost of heating for customers is the sum of the monthly cost of supply power for heating (fixed part) and the monthly cost for the amount of delivered thermal energy for heating (variable part). The existing decision on tariffs adopted in 2011[190] does not take into account the fixed cost, but only the variable costs.

It would be necessary to adopt a new decision on tariffs containing heat energy prices which take into account also the monthly cost of supply power for heating (fixed costs). This new decision would determine the value of fixed costs for each of the category of consumers determined by the *Decision on General Conditions for Heat Delivery.* In addition, such a new decision on tariffs would determine the value of fixed costs to be applied to disconnected residential and business consumers in buildings that are connected to the DH system.

5.5.6 Energy Efficiency in Buildings

The results of the analysis elaborated in Chapter Energy Efficiency Measures show that it is necessary to improve EE in buildings in the City of Banja Luka. In addition to measures that may be undertaken without any costs, other energy efficiency measures which include improving the efficiency of the existing system or reducing the energy required for heating through simple improvements to buildings' envelopes need to be undertaken. Some of these measures include thermal insulation of the ceiling, insulation of radiator recesses, sealing of loose windows and doors and installation of thermostatic valves, as well as complex energy efficiency measures such as thermal insulation of facades, replacement of windows and insulation of ceilings of unheated basement under the heated area, which have higher costs.

According to the *Law on Spatial Planning and Construction*[191]*,* during the planning, design and construction of new buildings, as well as during major renovation of existing buildings, a set of long-term measures, as well as the minimum requirements regarding the reduction of energy consumption and switch to the use of energy from renewable sources must be applied.

There are no legal acts that define any obligation for introduction of EE measures for existing buildings; therefore, amendments to existing legislation would be necessary in order to improve the implementation of EE measures in buildings, i.e. introduce obligatory EE measures for existing buildings. In addition to such measures, it would be necessary to introduce incentives for these measures to assist all homeowners in financing the EE measures in buildings.

[188] Ibid.
[189] Ibid.
[190] http://www.bltoplana.com/images/stories/dokumenti/cijena%20toplotne%20energije.pdf
[191] Ibid.

According to the *Law on Environmental Protection Fund and Financing of RS*[192], the Environmental Protection and Energy Efficiency Fund RS may finance EE improvements pursuant to strategic documents in RS (measures for improving EE in residential buildings are included into the Energy Efficiency Action Plan of RS as well as in the SEAP of the City of Banja Luka). According to the *Law on Energy Efficiency of RS*[193], measures contained in LEAPs or in SEAPs may be financed by the mentioned Fund, budget of the local self-government units and other sources. Currently there are no programs for financing or co-financing the implementation of energy efficiency measures in residential buildings.

Taking into account the provisions of the aforementioned laws, a program for the allocation of financial resources for the implementation of EE in residential buildings would need to be initiated by the Environmental Protection and Energy Efficiency Fund. Flat owners would be the beneficiaries of such programs and have the possibility to apply for financial resources of the Fund through their Homeowners Associations (which are legal entities as prescribed by the *Law on Building Maintenance*[194]). Decision on applying for financial resources may be taken by the assemblies of homeowners associations whereas the presidents of managing boards of such associations are authorized to sign contracts with the Fund.

5.5.6.1 Example of Financing Energy Efficiency in Residential Buildings in Croatia

In Croatia, the Environmental Protection and Energy Efficiency Fund finances and co-finances the rational use of energy and EE activities prescribed by the Croatian *Law on Environmental Protection and Energy Efficiency Fund*[195], the National Action Plan and other plans. The Croatian Government, in cooperation with the Ministry of Construction and Physical Planning, adopted in July 2014 a program of energy renovation of residential buildings from 2014 to 2020 which is implemented by the mentioned Fund. This program includes all buildings with a gross floor area of over 400 m², more than 50% for habitation purposes and a minimum of three residential units (flats), and which are managed by building managers.

The Fund offers flat owners the possibility of co-financing energy audits and certification, preparation of project documentation for reconstruction and measures to increase EE and energy renovation of buildings. Financial resources are also allocated for the installation of individual meters for measuring thermal energy consumption. In this case it is the building manager that applies for financial resources for the implementation of this type of projects. Before applying for financial resources, the building manager and owners' representative for energy renovation of buildings have to obtain a written consent of other co-owners. According to the Croatian *Law on Energy Efficiency*[196], energy renovation of buildings may be carried out according to national programs for energy renovation of residential buildings. The beneficiaries of these types of programs are co-owners of these buildings (flat owners). Decisions for signing the contract for energy renovation of residential buildings can be taken by flat owners on the basis of a simple majority of their votes.

5.5.7 Combined Heat and Power (CHP)

In case of installation of a CHP system as explained in Chapter Analysis of Combined Heat and Power (CHP) Options , the Company would become an electricity producer. For construction of a CHP system, the Company would need to obtain an environmental permit, location conditions, construction permit and use permit.

In addition, according to the *Regulation on Permit Issuance*[197] which regulates the issuance of permits necessary for electricity production, the Company would need to obtain the permit for the construction of an electricity generation facility with an installed capacity over 1 MW. This permit is issued by the Regulatory Commission for Energy of RS (RERS) according to the procedure set out in the aforementioned Regulation.

The Company would also need to obtain the permit for production of electricity. This permit is also issued by RERS according to the same procedure for the issuance of permit for construction of the electricity generation facilities. According to Article 6 of the *Regulation on Permit Issuance,* the permit for the production of electricity is issued for a period not longer than 30 years from the date of beginning of production.

[192] Official Gazette of RS, No. 117/11 and 63/14
[193] Official Gazette of RS, No. 59/13
[194] Official Gazette of RS, No. 101/11
[195] Official Gazette of Republic of Croatia, No. 107/03 and 144/12
[196] Official Gazette of Republic of Croatia, No. 127/14
[197] Official Gazette of RS, No. 39/10 and 65/13

The *Law on Renewable Energy Sources and Efficient Co-generation*[198] regulates the obtainment of the certificate for production facilities. This certificate has to be obtained after the issuance of a Use Permit. According to Article 8 of this Law, the certificate can be issued to the producer of electricity produced from RES or efficient co-generation in an economically appropriate manner, by protecting the environment and in which measuring of all energy values is carried out. Obtaining the certificate for the production facility is a necessary condition for exercising the right to incentives for generation of electricity from RES and in efficient co-generation or issuance of a guarantee of origin of electricity. This permit is issued by RERS according to the procedure prescribed by the *Regulation on Issuance of Certificates for the Production Facility which Produces Electricity from Renewable Sources or in Efficient Co-generation*[199]. For production facilities which produce electricity in efficient co-generation, this certificate is valid for one year.

The *Law on Renewable Energy Sources and Efficient Co-generation* also regulates the types of incentives for generation of electricity from RES or in efficient co-generation. The types of incentives for generation of electricity from RES or in efficient co-generation are as follows:

- Benefits for connection to the network,
- Advantages in access to the network (dispatching),
- Right to the obligatory purchase of electricity,
- Right to the guaranteed purchase price (feed-in tariff),
- Right to the premium for consumption of electricity for its own needs, or sale to the electricity market.

The right to incentives can be exercised by the electricity producer if it produces electricity in efficient co-generation by using new facilities with an installed capacity of up to $10MW_{el}$, if the amount of installed capacities does not exceed the amounts for incentives as determined by the Action Plan[200] and if the producer holds the certificate for the production facility.

According to Article 24 of the mentioned Law, electricity producers which meet the aforementioned criteria and requirements are granted the right to guaranteed purchase of electricity in whole or in part at the guaranteed purchase price (feed-in tariff) or the right to the premium if they use electricity for their own needs or sell it on the RS market. Electricity producers are granted the right to purchase at the guaranteed purchase price or right to the premium for a period of up to 15 years.

The amount of guaranteed feed-in tariffs and premiums for electricity generated from RES or in efficient co-generation facilities are determined by the *Decision on the Level of Guaranteed Purchase Prices and Premiums for Electricity Generated from Renewable Energy Sources and in Efficient Co-generation*. According to Article 26 of the *Law on Renewable Energy Sources and Efficient Co-generation,* when signing the contract on purchase at guaranteed purchase prices, the prices established by the Decision in force at the time of conclusion of the contract are applied and remain unchanged during the validity period of the contract, except in the case of major changes in the exchange rate of the convertible mark (BAM) in relation to the euro exchange rate in BiH.

5.5.8 Private Sector Participation (PSP) in DH System

5.5.8.1 PPP and Concessions

According to the *Law on Public Private Partnership of RS*[201]*,* PPP is a form of cooperation between the public and the private sector, achieved by pooling of resources, capital and expert knowledge, for the purpose of fulfilment of public needs. Agreements in the field of cooperation between the public and the private sector may take two basic forms: contractual form of PPP or institutional form of PPP, and these agreements contain clear risks and the risk distribution between the public and private partner. Among these risks there is the demand risk related to instability of the demand compared to the expected demand at the time of contract signature, regardless of the involvement of the private partner, and it is a common risk borne by private parties in a market economy.

[198] Official Gazette of RS, No. 39/13, 108/13 and 79/15
[199] Official Gazette of RS, No. 112/13
[200] Official Gazette of RS, No. 45/14
[201] Official Gazette of RS, no. 59/09 and 63/11

According to Article 10 of the *Law on Public Private Partnership of RS*[202]*,* the contractual form of PPP also includes concessions and private financial initiatives. According to the *Law on Concessions of RS*[203]*,* utilities, except for water supply, and construction, rehabilitation, maintenance and/or modernization of utilities may be the subject of concessions. According to this Law, concessions for construction or reconstruction of buildings, facilities or plants may be granted according to the Build-Operate-Transfer (BOT) model, which includes the construction or reconstruction and financing of the entire building, facility or plants, its use and passing the ownership to the conceding party (grantor) within the agreed timeframe or according to other models. According to Article 10 of the *Law on Concessions of RS,* types of BOT and other types of concessions and detailed provisions regarding the granting of concessions have to be regulated by the *Document on Policy on Granting of Concessions*. The preparation of this Document is under the responsibility of the Commission on Concessions and is adopted by the National Assembly of RS. Currently, the only existing document is the *Document on Policy on Granting of Concessions*[204] adopted according to the former *Law on Concession of RS*[205] from 2002 (amended in 2006 and 2009). This Document is thus not in line with the new *Law on Concessions of RS* and does not contain provisions on BOT, and district heating is regulated as part of energy facilities. According to this Document, the revitalization of existing DH systems in RS, as well as the construction of new ones is possible through concessions. It is necessary also to use new technologies such as RES or natural gas, in order to avoid the use of heavy oil.

According to Article 68 of the *Law on Concessions of RS,* the Commission on Concessions is responsible for preparing the new *Document on Policy on Granting of Concessions* containing detailed provisions on BOT and on granting concessions for utilities. The possibility of granting concessions to ESCOs (or other type of legal entities) for distribution of heat energy produced by DH systems would need to be regulated in order to provide heat energy supply with energy services. This would enable ESCOs to be granted with concessions for part of the DH network to be constructed, revitalised or modernised and managed by ESCOs.

5.5.8.2 ESCOs

The establishment of ESCOs or other legal entities providing energy services on the basis of energy performance contracts is foreseen by the *Law on Energy Efficiency*[206] as one of the measures of EE improvements. ESCOs may perform energy audits, design, construction, reconstruction, energy retrofit, maintenance, consulting or management and control of energy use.

ESCOs could play an important role in providing energy services but it would be necessary to adopt a detailed regulatory framework with the aim of regulating the ESCOs operations and the payments for the provision of energy services in accordance with the energy service contract. In addition, establishment of PPP with ESCOs would need to be regulated in order to provide the heat energy supply with energy services.

5.5.8.3 Example of Partnership with ESCO

Seattle Steam (now Enwave Seattle) is a privately-owned utility that provides district heating to approximately 200 buildings in Seattle's Central Business District and First Hill neighbourhoods. The company produces thermal energy from five boilers located in two plants in downtown Seattle[207]. In the fall of 2009, the company made the commitment to begin generating thermal energy primarily from a sustainable, non-fossil fuel source: biomass. Seattle Steam partnered with an energy service company (ESCO) to offer an energy saving programme directly to its own customers, helping them reduce energy consumption by 29%. The programme assesses a building’s energy saving potential and provides access to grants and low-interest loans, which customers can pay back through their monthly utility bills. From a business development perspective, this lowers customers’ utility bills (typically after a payback of five to seven years), allowing Seattle Steam to retain customers. Furthermore, the efficiency improvements free up existing heat generation capacity to service new

[202] Ibid.
[203] Official Gazette of RS, No. 59/13
[204] Official Gazette of RS, No. 31/06
[205] Official Gazette of RS, No. 25/02, 91/06 and 92/09
[206] Ibid.
[207] http://www.enwaveseattle.com/

customers, allowing the company to build its customer base without additional capital costs associated with increasing generation capacity[208].

[208] IFC and Public-Private Infrastructure Advisory Facility (PPIAF), Unlocking the Potential for Private Sector Participation in District Heating, 2014