MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

UNDP
Empowered lives.
Resilient nations.

SUMMARY

STUDY OF THE RENEWABLE ENERGY SOURCES WITH FOCUS ON BIOMASS, GEOTHERMAL ENERGY AND SOLAR ENERGY IN BOSNIA AND HERZEGOVINA

Sarajevo, 2019.

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

Table of Contents

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The Study of renewable energy sources with focus on biomass, geothermal energy and solar energy in Bosnia and Herzegovina has been developed within the project "Improving the air quality in Bosnia and Herzegovina through renewable energy sources and improvements in district heating", funded by the Ministry of Environmental, Land and Sea Protection of the Republic of Italy, and implemented by the United Nations Development Programme (UNDP). The objective of the said Study is the air quality improvement through the use of renewable energy sources (RES) for the heating, especially in the district heating systems.

Within the Study, the condition of the district heating systems in BiH has been analysed including the analysis of the available data, collection of the data through the questionnaire and by visits to the specific district heating companies. Furthermore, the potentials of the wood biomass, solar and geothermal energy were analysed at BiH level as well as the level of the local communities which have the district heating or plans to build it. The technologies for the use of RES have been presented including their description and presentation of the case studies from the EU countries where the technologies have been applied. On the basis of the mentioned analyses, recommendations have been provided in the form of draft designs for the district heating systems in the respective local communities[1]. For each draft design, the power has been calculated in the boiler room necessary for the heating, consumption of certain fuels, investment, levelled cost of heat production, reduction of the emission of pollutants of air and carbon dioxide in the urban area where the district heating is located.

2 DISTRICT HEATING SYSTEMS IN BOSNIA AND HERZEGOVINA

Currently, there are 32 district heating systems (DHS) active in the territory of BiH, and there are three companies under bankruptcy. Among the mentioned DHSs, 22 are located in the territory of FBiH, and 13 are located in the RS. According to the data collected through the questionnaire, the conclusion has been made that the average age of the boilers installed in the DHS is 26 years, while the average age of the distribution grid of the analysed DHSs is 21 year. The total installed power for 29 DHSs that have provided data is 1,823.78 MW. The total annual production of the heat energy at the level of the all identified DHSs in 2017 was 1,608,208 MWh, which is about 8% of the total heat demand in the building sector in BiH. The biggest part in the annual production of the heat energy is the heat produced by the thermo-power plants and industrial installations where the primary fuel is coal with the share of 39%, followed by the natural gas with the share of 27%. The total heated area of all analysed DHSs, according to the available data, is 10,048,516 m^2.

[1] Draft designs have been provided for 20 district heating systems, for district heating systems using heat from the industry draft designs have not been provided since, given the current level of development of the technologies, it is not possible to achieve leveled costs of heat in relation to the current ones.

In most of the cities of BiH with the population of 25,000 and over, DHSs are not available. Some of these DHSs have been partly renovated after the war (after 1995), and only some of them have been completely renovated (Sarajevo, Prijedor, Banja Luka, Gradiška,Tuzla, etc.). In most of other systems, only the most necessary and provisional repair has been conducted; therefore it is clear that major heat losses occur in these systems. In recent years, by private sector investments, several DHSs powered by biomass have been constructed (Gračanica, Bosanska Gradiška, Livno, Nemila, Prijedor, Banja Luka and Srebrenik).

The specificity of the DHSs in BiH, that are located in the vicinity of the thermal power plants and industrial facilities, is that they are supplied with the heat energy from those facilities. Because of such connection between the district heating systems and industrial facilities, DHSs that rely on such facilities are designed in a way to use steam for getting hot and/or warm water for the purpose of heating. DHSs exist also in smaller towns with small systems supplying public institutions and small settlements. On the other hand, there are several different examples of the newly-constructed DHSs in BiH, like those powered by biomass. In the areas with big forest potential, there are district heating systems which traditionally use biomass (e.g. Sokolac and Pale). Some of those systems stopped working in the post-war period (e.g. Vlasenica, Kladanj and Milići).

In FBiH, most of DHSs use fossil fuels (coal and natural gas). Some of the companies dealing with the supply of the heat energy do not have their own facilities (plants), and the supply of the heat energy is made from the local facilities for the production of the heat – thermal power plant powered by coal (Tuzla, Lukavac, Kakanj, Ugljevik) and steel factory where the primary fuel is coal and process gas (Zenica). Some of these DHSs are sustainable mainly because of the low price of the heat energy provided from the CHP facilities. For example, in Kakanj, Tuzla and Lukavac, the price of the heat energy at the entrance of the system is only 23.50 KM/MWh. The reason for such low prices of the heat energy is that the public energy supply company *Elektroprivreda Bosne i Hercegovine* (JP EP BiH – owner of the facility) provides the heat energy at low price to the local companies which perform the distribution in order to compensate for the environmental effect of the thermal power plants.

DHSs in RS mostly rely on their own boiler rooms which use the biomass, coal and natural gas as a fuel. The business activities and possibility of investment in the renovation and development in this case depend on the percentage of collection of money for the services, which is varies. Both in RS and in FBiH, the supplied heat is used only for the heating of the space, not for the preparation of the consumable hot water. The general problem of almost all DHSs constructed in the 1990s is their inadequate size. The facilities were designed for much higher number of users in relation to the number of users they currently supply. In addition, the method of calculation of the heat demand was such that the system could heat buildings adequately at extremely low external temperatures. Since all systems provide only heat for the heating of space (not for consumable hot water), their annual level of use is around 20%.

Over 80% of the housing stock supplied with the heat energy from the DHSs pays lump sum costs per m^2 of the heated space. The activity of the supply of the heat energy is performed by principle of the production and supply of heat (MWh) and tariff system KM/m^2 per month. Among the analysed DHSs, only two companies (in Gračanica and Livno) charge the actual consumption of the heat energy.

Around 20% of the building sector in BiH connected to the district heating system pays for energy really consumed where the individual suppliers of the heat energy have their tariff positions. The precondition for the motivation of the final users to use energy rationally is to enable the payment of real consumption, which is defined by the EU directives.

According to the situation and policy documents in BiH, the trend is the transition to the use of wood biomass. The reason for that is that the facilities powered by coal are a major source of the local air pollution. Preparations are underway in many municipalities for the investment in the so called *green field* district heating systems, primarily because of the problems related to the air quality faced by the municipalities. The fact that DHSs are non-existent causes the intensive air pollution in winter months from the individual furnaces, especially those powered by coal and fire wood. In addition, there are problems like storage of wood at public areas (including green areas), huge amounts of ash in the containers (usually causing burning), low level of housing comfort and high consumption of the fire wood (which causes the depletion of the wood resources and development of the black market). On the other hand, the complex organisational structure in the energy structure leads to the complexity of the legal framework, which is primarily adopted at the level of entities and Brčko District. In the sector of RES, district heating and air quality, the secondary legislation is also adopted at the level of entities, cantons and Brčko District, and decisions are made at the level of cities and municipalities. The municipality government is responsible for the district heating, except in Sarajevo Canton, where the matter is the responsibility of the cantonal government. It means that the municipality councils or assemblies are responsible for the adoption of the decision on district hating and that they can regulate any important aspect of the district heating. Regarding the regulation framework for RES in BiH, it has been enacted at the entity level. Only the biomass standards have been adopted at the level of BiH.

3 POTENTIALS OF THE RENEWABLE ENERGY SOURCES

BiH is a country which has significant potentials of RES. As for the district heating systems, the most significant RES is the wood biomass the use of which in the district heating systems has been growing rapidly in recent years. In the period from 2008 to 2017, seven district heating systems powered by wood chips were constructed, in addition to the two systems constructed in the 1980s. Such district heating systems mainly use wood chips from the wood residues in the wood processing facilities and fire wood of low quality. The potential of the forest wood residues is used insufficiently, and since such potential exists, there is a basis for the continuation of the trend of growth of the district heating systems powered by wood chips. The technical potential of the biomass (forest wood residue, fire wood and sawmill wood residue) in the cities which have DHSs is high equalling to 407,066 MWh/year in the territory of Banja Luka, 250,437 MWh/year in Prijedor, 204,283 MWh/year in Livno, 104,875 MWh in Srebrenik, etc. On the other hand, there is a significant potential of biomass in places which do not have DHSs like Teslić in the amount of 356,653 MWh/year, where the preparation of the investment in the so called green field district heating is underway.

Given the increase of the price of coal, more stringent requirements for its use and unused potentials of biomass, a further growth of the number of district heating systems powered by biomass can be expected. In addition to the mentioned forms of biomass, BiH has significant potentials for the

production of biogas. However, the biogas facilities have not been analysed as a potential for the district heating systems since those are relatively small facilities (in size of about 100 kW per facility).

Another significant RES for the district heating systems in BiH is the geothermal energy. Given the fact that the identified sources are mainly low-enthalpy sources, it is not realistic to expect their use in the CHP facilities. Only a small part of such potentials is currently used for the heating of the tourist facilities, spas and business buildings mainly by use of heat pumps. There are examples of direct use, however their share is very small. The capacity of the existing systems is between 100 kW and 2 MW. The challenge for the use of the geothermal potential of higher temperature levels (50°C and above - direct use) is the distance of the heat demand from the source.

Despite its high potential, the solar energy is little used for the production of heat, and its use in the district heating systems is non-existent. Its use in the district heating systems makes sense if the district heating system supplies heat for the heating of the consumable hot water or if the system has the seasonal accumulation in the form of the relatively big tanks. The seasonal accumulation significantly increases the price of the entire system, so in the short-term and medium-term, the use of the solar energy cannot be expected for the district heating in BiH. The potential for the use of the solar energy is relatively small. The new district heating systems constructed according to the principles of the fourth generation of the district heating systems (relatively low temperatures of water in the system) will be used for the supplying of heat and for the preparation of the consumable water and possibly for some low-temperature industrial processes. The development of the cooling technology will on the long-term make the use of solar energy for district cooling more competitive in combination with the concentrating solar plants (cogeneration process).

In addition to the mentioned RES forms which can be directly used for the production of heat in the district heating systems, the potential of wind and small hydro-power plants should also be taken into account as their energy in the periods of low demand for electricity can be used for the heating of water in the district heating systems by use of the simple *power to heat*[2] technologies.

Table 1 below shows the potential of the analysed renewable energy sources in BiH.

Table 1: Summary of potential of renewable energy sources in BiH

Type of assessed potential	FBiH	RS	BiH
Theoretical potential of biomass [PJ/a]	26.76	27.30	54.06
Theoretical potential of solar energy [PJ/a]	-	-	253,800
Technical potential of biomass [PJ/a]	10.97	11.19	22.16
Technical potential of geothermal energy [PJ/a]	0.65	0.54	1.18

The total technical potential of the biomass and geothermal energy in BiH equals 23.34 PJ per year. According to the data of the International Energy Agency (IEA) BiH had the total consumption of energy for the heating in 2015 in the amount of 71 PJ. In the same year, the share of district heating systems in the total consumption of heat energy for the heating was 8 % (IEA, 2015). In order to assess the impact of the level of use of the assessed technical potentials of biomass and geothermal energy on the share of heat from district heating systems in the total consumption of energy, 3 scenarios were considered

[2] Power to heat tehnologijom se električna energija iz mreže, u periodima kad je ponuda veća od potražnje, pretvara u toplotu (elektrootporno grijanje i toplotne pumpe).

and compared with the baseline (share of heat from district heating systems in 2015; 5.6 PJ). The considered scenarios are shown in the Table 2.

Table 2: Scenarios of use of technical potential of biomass and geothermal energy in district heating systems in BiH

Scenario	Used potential of biomass and geothermal energy [PJ/a]	Share of district heating system in the total consumption of energy for the heating [%]
Scenario 20% of use of the technical potential of biomass and geothermal energy (S1)	4.67	14
Scenario 50 % of use of the technical potential of biomass and geothermal energy (S2)	11.67	24
Scenario 100 % of use of the technical potential of biomass and geothermal energy (S3)	23.34	41

In case of scenario with 20% use of the available technical potential of the biomass and geothermal energy in the district heating system, the share of heat from the district heating systems would be increased to 14%. In case of scenario with 50% use of the available technical potential of the biomass and geothermal energy for the needs of the district heating systems, the share of heat from the district heating systems would be increased to 24%, which means it would be tripled compared to baseline.

In case of the most ambitious target, which is the use of the total of the available technical potential of the biomass and geothermal energy for the needs of the district heating systems, the share of heat from the district heating systems would be increased to 41 %. In the calculation of the share of heat from the district heating systems in the total consumption of heat energy for the heating in the analysed scenarios, the current status of production of the energy from the district heating systems was aggregated with the assessed potential of the geothermal energy and biomass for the district heating systems and was divided by the total consumption of energy for the heating (71 PJ), since it is not planned to shut down the existing capacities of the district heating systems (with the planned replacement of fuel). The EU target is that the share of the district heating systems in the heat demands to become 30% by 2030. Therefore, with the use of the technical potential of the wood biomass and geothermal energy BiH may exceed the EU target.

The Study also provides the overview of the technologies for the RES use that are the most efficient in a sense of technological and economic criteria including the technical description of the concepts and data on equipment, necessary space, estimated needs for RES, estimated investment and operative costs of heating and distribution grid and costs of the generated energy and income from the generation of the heat energy and electrical energy.

4 DRAFT PROPOSALS OF CERTAIN DISTRICT HEATING SYSTEMS IN BOSNIA AND HERZEGOVINA

Based on the conducted analysis, the recommendations have been provided for the draft solutions of use of the renewable energy sources (biomass, geothermal and solar energy) in the district heating systems. A total of 27 district heating systems in BiH have been analysed. To provide the recommendations for the district heating systems, the locally available potentials of the renewable energy sources have been taken into consideration. For each analysed community, the potentials of the solar energy, biomass and geothermal energy have been estimated.

The potentials of biomass for each community is estimated as a technical potential of the wood biomass obtained on the basis of the area of the certain types of forests in the territory of the specific municipality/city (in case of Sarajevo, Sarajevo canton has been analysed) and allowed annual cut for certain types of forests. The potential of the solar energy is estimated on the basis of the solar radiation and estimated area suitable for the installation of the solar collectors in the territory of the analysed urban area. The roofs of the buildings which are or will be connected to the district heating system and face south, south-west and south-east are considered a suitable surface for the solar collectors. The total surface of roofs in an area is estimated on the basis of the heated area and average number of floors in the building. The potential of the geothermal energy is provided on the basis of the potentials in the so far examined locations in BiH.

A recommendation for each analysed district heating system includes the capacities for the generation of the heat energy (and electrical energy where appropriate), estimate of the consumption of certain fuels, amount of investment for the boiler room (without construction and/or reconstruction of the grid and interior installation of the user), calculated levelled costs of heat at the exit of the boiler room, and impact of the operation of the recommended district heating system on the balance of emission of the pollutants and carbon-dioxide.

The assessment of the impact on the balance of emission of pollutants takes into consideration the direct emissions, and in case of carbon-dioxide the indirect emissions were also taken into consideration. In case of CHP plants powered by renewable energy sources, calculated was the reduction of the emission of carbon-dioxide because of the generation of the electrical energy without emission of carbon-dioxide. The indirect emission and reduction of emission of carbon-dioxide due to generation of electricity from CHP were calculated by use of the emission factor of the grid in the amount of 0.726 t/MWh taken over from the III National report on climate changes in BiH. The emission of the pollutants was calculated by use of the emission coefficient from the EMEP database.

Figure 1 shows the calculated levelled costs of heat at the exit from the boiler plant for all draft solutions of using renewable energy sources in the district heating systems. Tuzla, Kakanj, Lukavac and Ugljevik have significant RES potentials, but also their LCOH on the boiler house outlets is low and they cannot get a lower one from RES.

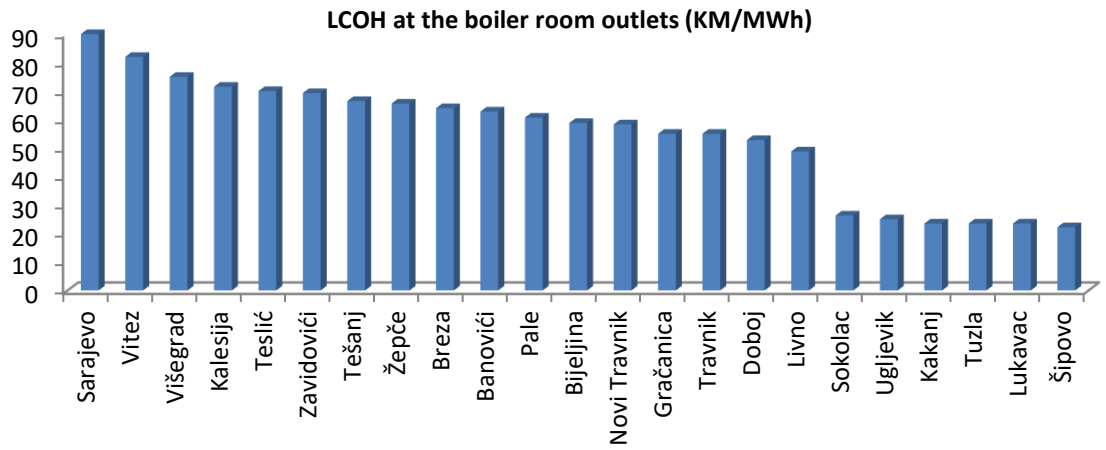

Figure 1: LCOH at the boiler room outlets

The lowest LCOH value is in case of the Šipovo district heating which includes the biomass cogeneration with the supply of heat for the preparation of the sanitary water. The LCOH value is the lowest one because of the relatively long period of work in the cogeneration regime. The highest LCOH value is in case of the design for Sarajevo, primarily because of the high share of heat from natural gas. Majority of district heating systems have LCOH from 50 to 70 KM/MWh. These are medium scale district heating systems (10-20 MW) which as a main source of heat have boilers powered by wood chips and in some cases they get up to 10% of heat from the solar collectors.

The chart in Figure 2 shows the estimate of the reduction of emission of air pollutants that would be caused by the implementation of all recommended draft designs.

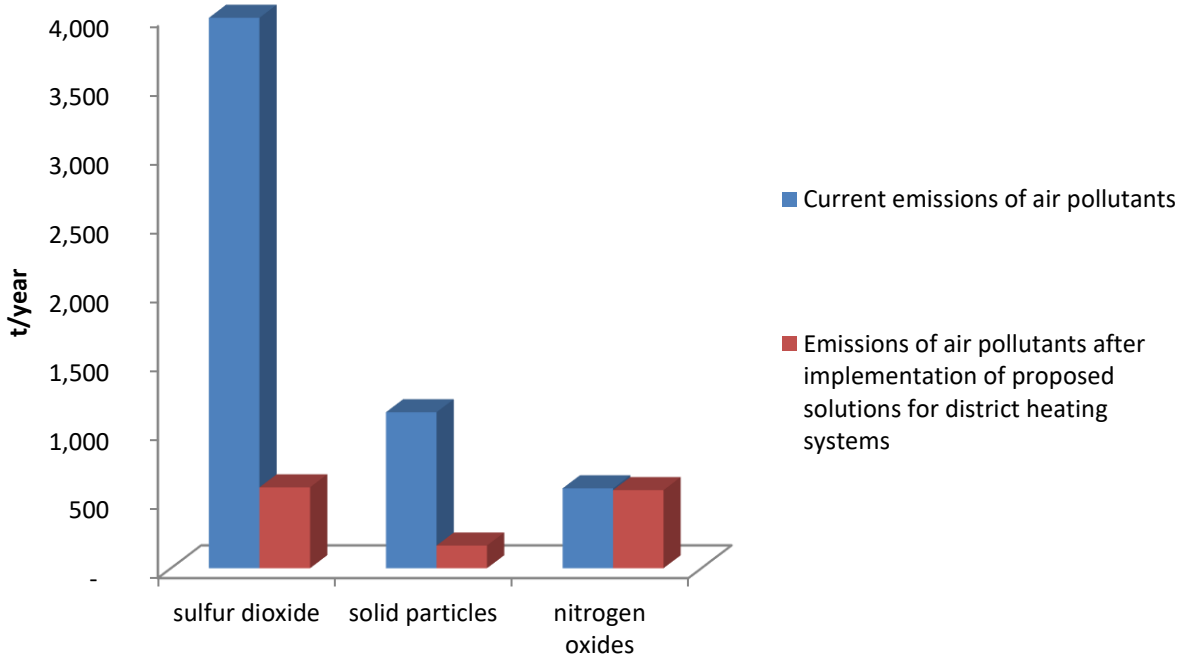

Figure 2: Assessment of impact on the balance of emission of pollutants in the analysed areas

The biggest reduction would be achieved in the emission of sulphur-dioxide because the draft designs are based on biomass (with small emission of sulphur-dioxide) and solar and geothermal energy which do not have any emissions. Also, significant is the reduction of the emission of solid particles the concentration of which is very high in some areas. The reduction of emission of nitrogen oxides is relatively low because biomass powered boiler rooms have slightly higher emission of nitrogen oxides compared to individual furnaces.

The comparison of the installed power and the corresponding generation of heat from the district heating systems before and after the implementation of the draft designs are shown in the charts in the Figure 3.

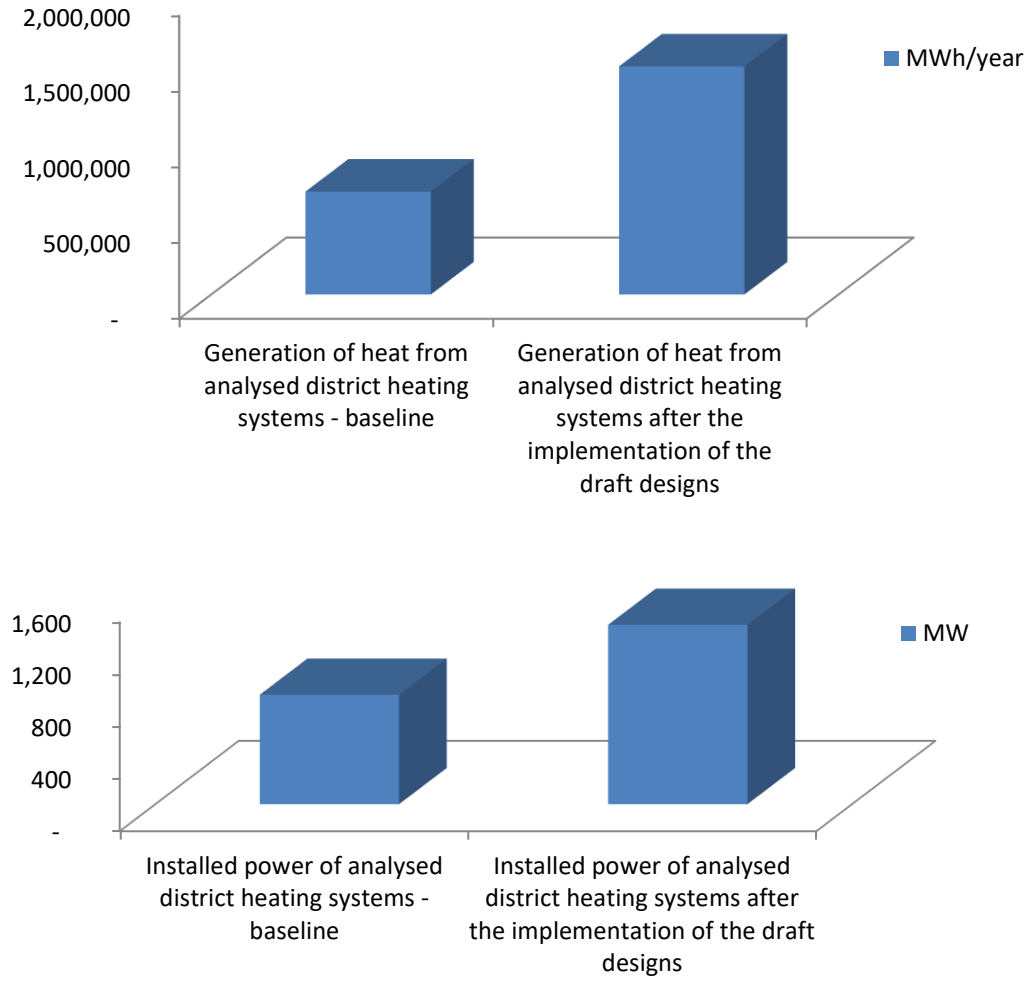

Figure 3: Comparison of the installed power and generation of heat from the district heating systems in 2017 and after the implementation of the draft designs for the district heating systems

Figure 4 shows the total potential of biomass, geothermal and solar energy for each analysed area. Based on the locally available potential of the renewable energy sources, the assessment of possibilities of the use of the part of such potential was made for the existing and envisaged district heating systems in BiH and is also shown in the chart of the Figure 4.

The highest level of use would be achieved with biomass. The total biomass potential in the analysed areas is about 2 TWh per year. By the implementation of the recommended designs, about 0.37 TWh would be used per year or about 18.5%. The average level of use of the potential for the analysed municipalities/cities is about 30%. The maximum level of use of the potential is in Bijeljina equalling to about 70%. The level of use of the solar energy is relatively low because it is not competitive in the systems which do not supply the heat beyond the season of heating. The level of use of the geothermal energy is limited by the location of the source which is often quite distant from the urban areas, therefore their use is not cost-effective.

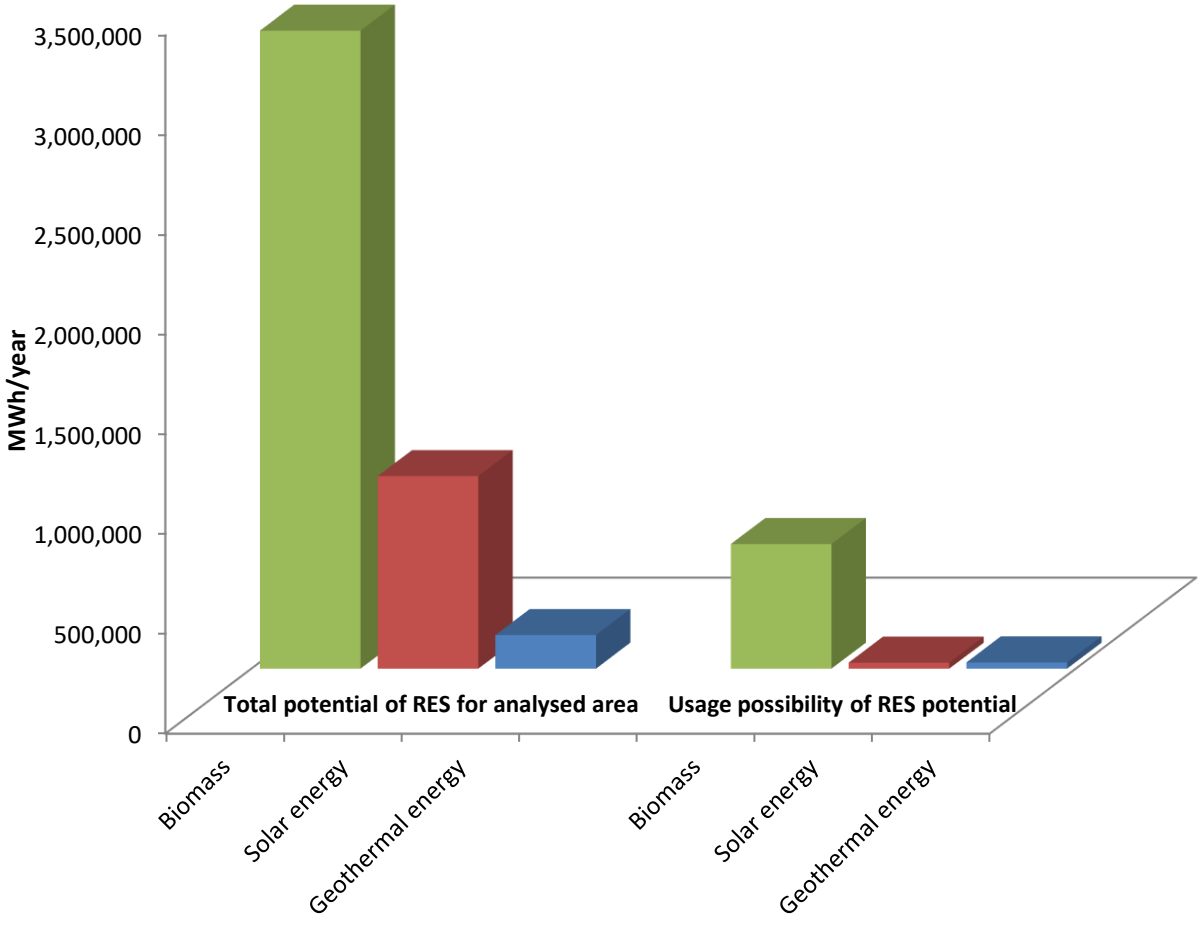

Figure 4: Level of use of the potentials of the renewable energy sources in the district heating systems in BiH with the implementation of the draft designs

The necessary investment for the recommended designs provided in the Study amount to 284,750,000 KM. The breakdown of the investment per envisaged fuel is provided in Table 3.

Table 3: Total investment for recommended designs of the district heating systems

	Investment (1,000 KM)
Biomass	182,930
Geothermal energy	12,800
Solar energy	24,500
Natural gas	58,000
Fuel oil	6,520
Total	**284,750**

The biggest part of the investment relates to the biomass boilers, around 67%. The total investment of around 285 million KM seems enormous. However, given the fact that it takes about 10 years to implement the recommended draft systems, the derived data is that the investment of around 28 million KM per year is needed, which is roughly like an investment in two average district heating systems in BiH.

By the implementation of the recommended district heating systems, the living standard of citizens in those communities would be significantly improved; air quality and efficiency of using natural resources would also be improved. Similarly, this would significantly contribute to the achievement of the climate targets of BiH defined in INDC (Intended Nationally Determined Contribution).