Energy Development Plan

Cross border development

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Europäisches Zentrum für Erneuerbare Energie Güssing GmbH

BIJELJINA & BOGATIĆ

cross border development

EUROPÄISCHES ZENTRUM
FÜR ERNEUERBARE ENERGIE
GÜSSING GMBH

IMPRESSUM:

PRINCIPAL:

Municipality Bogatić

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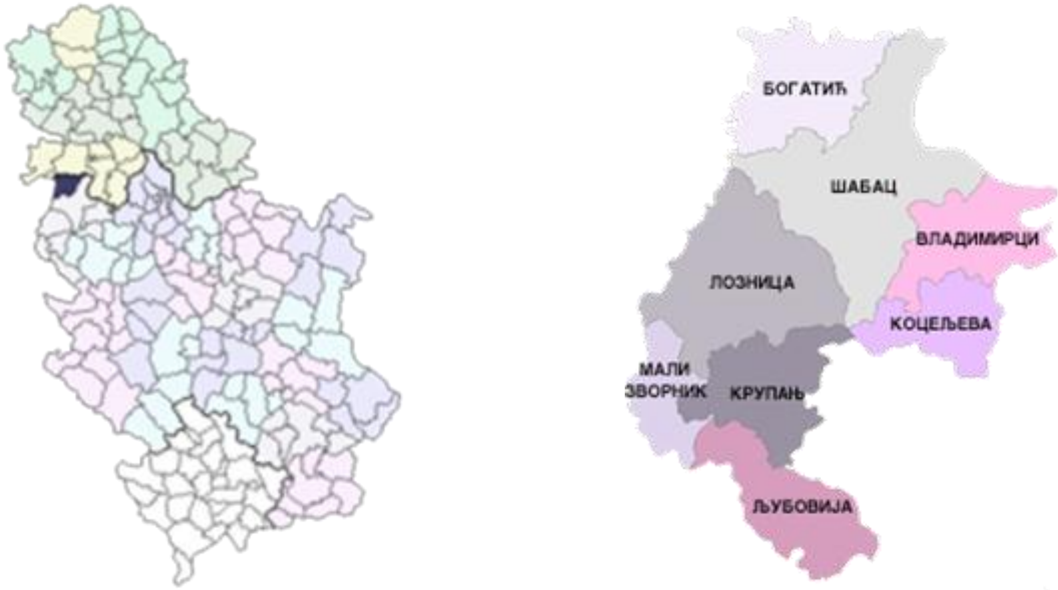
1 Description of the project area Bogatić

1.1 General data on the geographical situation / climate of Bogatić

Municipality Bogatić is located within the region of Western Serbia, in Mačva and covers an area of 384 km^2. It is a plane area, on the banks of the Drina River, which represents the western border of Serbia, to Bosnia and Herzegovina (Bijeljina municipality within Republika Srpska) in length of 38 km. It borders to the city of Sremska Mitrovica in norh-length of 53 km and to southeast to the city of Sabac in a length of 66 km.



Graphic 1: Geographical location of municipalities in Serbia (left), location of Bogatić municipality within Mačva region (right) (Source: Spatial plan of the Municipality of Bogatić)

The area of Bogatić includes the central and north-western part of Mačva. Erosive action of the Drina River streams, just before confluence into the river Sava, a parcel of land in the alluvial plain of the Drina is transferred to the left bank, into municipality of Bijeljina, therefore it cannot be seen as a municipality boundary. The municipality consists of 14 settlements.

The central settlement is Bogatić. According to the 2011 census 28,883 residents are living in 9,037 households. In the settlement of Bogatić lives a population of 6,555, while other 13 rural communities have a total population of 22,328. Residents are mainly engaged in agriculture.

Within central Serbia main axes of development the position of Bogatić is peripheral. The villages are linked by road network of 218 km, of which 163 km with modern pavement. Thanks to the extremely fertile soil, the most developed is agricultural production. In general, out of 38,432 ha of the total land 30,594 ha is covered by agricultural land.

Near the municipality, are the roads of international and national significance: Corridor 10, that runs through Sremska Mitrovica municipality (roads M-19 and M-21), railway Ruma - Sabac - Loznica - Zvornik, which follows south - eastern border and partially through Bogatić area, and a rivers port in Sabac and Sremska Mitrovica. Through the territory of the Bogatić municipality, several regional roads are passing, that are connecting the area of the municipality with the neighbouring districts, and through them with the road and rail networks as well with a network of Serbian waterways.

1.1.1 Geomorphological characteristics of the area like altitude characteristics

The municipality of Bogatić includes a part of Mačva accumulative plain, whose relief has typical plains, with insignificant height disparities. The lowest point is located along the river Bitve in Glusci (76 meters above mean sea level) and the highest point of elevation is 94 m.a.m.s.l., and is located to the south, in Badovinci, which causes in height difference is 18 m. Field gradients do not exceed 0.5%.

1.1.2 Gradients and terrain exposure

Low slope gradients (up to 5%) are typical for Mačva region that provides favourable conditions for the development of all sorts of agriculture, as well for application of mechanization and irrigation. Mačva is plain and is unaffected by exposure.

1.1.3 Relief

Mačva belongs to the bottom of southern part of the Pannonian basin. To the west is limited by the lower course of the river Drina, to the north and east by curves Sava river and to the south by the Mačva section.

1.1.4 Air temperature

The annual average of temperature for the period 1961 to 2011 was 11.3°C. Highest monthly average is in July 21.7°C and the lowest in January 0.3°C, so that the amplitude between the highest and lowest monthly average temperature is 21.4°C. Heating period, HD (Eng. heating days) lasts 185 days, while the mean average temperature of the heating period 5,2°C.

1.1.5 Humidity

The annual average of relative humidity is 79.5%. Annual fluctuation is 12.6%. Relative humidity increases from April to December. The highest average humidity is in December (86.6%) and January (85.6%). High relative humidity in these months is a consequence of the precipitation falls in the form of rain and snow, as well as low temperatures. The lowest values of relative humidity in April (74.0%) and May (74.7%).

1.1.6 Cloudiness

The annual average cloudiness is 5.3 which means that in the period 1961 - 2008, averagely more than ½ the sky was covered by clouds. Clearest month is August (average cloudiness

3.4) and cloudiest is December (average cloudiness 7.2). The difference between the average of the clearest and cloudiest month was 3.8.

1.1.7 Insolation

The annual average of insolation in Sremska Mitrovica is 2095 hours, 4 hours (or 5.7 hours per day). Duration of insolation changes during the year, being the highest in summer and the lowest in winter months. Insolation depends of the day length, or season, elevation of the Sun, and the cloudiness. The longest average of insolation in the observed period is July (292.2 hours or 9.4 hours per day), and the shortest in December (48.9 hours or 1.6 hours per day).

1.1.8 Precipitation

The level ground of Mačva, due to higher wind speed and faster crossing clouds, excreted less rainfall than in the hilly Pocerina. According to the agro climatic zoning requirements with reference to conditions for agriculture, there is not enough wet area in Mačva. The annual average rainfall was 681.3 mm in Sabac, in the period of 1961 till 2007. In terms of monthly average values in Sabac, maximum precipitation occurs in June, with monthly average value of 78.2 mm, then in July, 64.2 mm and 62.1 mm in May. Minimum precipitation occurs in February (41.9 mm) and January (46.4 mm).

Snow occurs between October and April averagely 2.4 days in March and 0.3 days in April, but most often during winter. In general there is an average number of 29.3 days with snowfall.

1.1.9 The movement of air masses (wind)

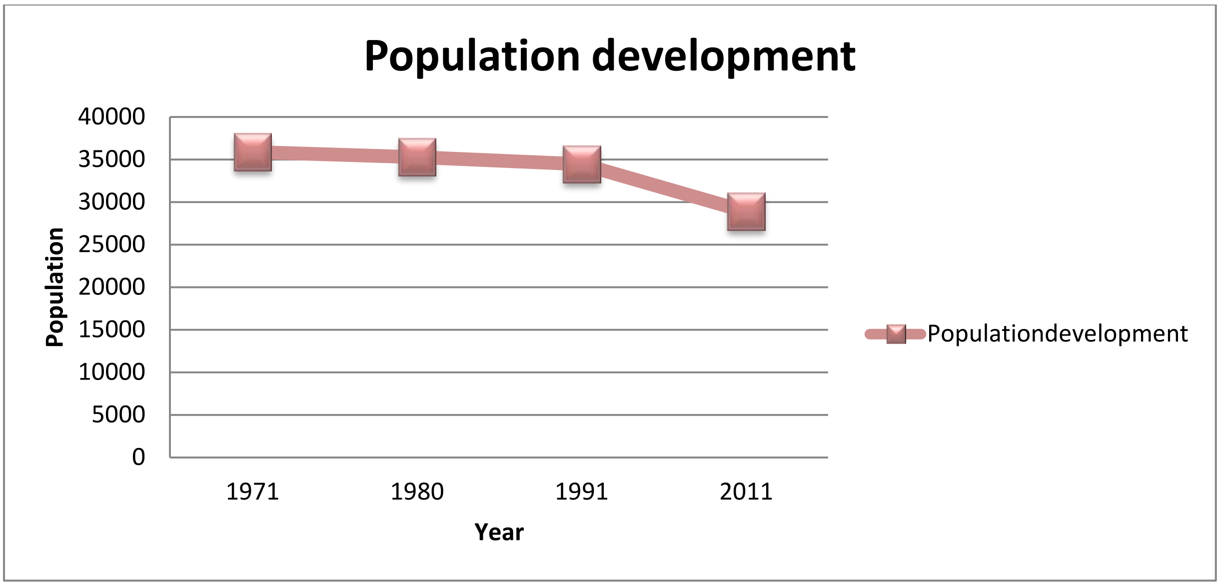
Station Bogatić observations were made in the period of three years 1991, 1992, and 1993. Based on latest available data of Bogatić (3 years), the most common winds are from the Northwest (169.6 ‰), Western (133.3 ‰) and South (125.1 ‰) and the Southeast (120.5 ‰) direction. The lowest frequency is marked the south wind (11.9 ‰) and north wind (29.6 ‰) in Sabac, alike in Bogatić. Respectively, in Bogatić presence of winds from these directions is slightly higher. According to data of the station Sabac, there is an average wind speed of 1.3 m/sec. The highest average wind speed is in March, 1.6 m/sec.

Although in the studied area are represented predominantly low intensity winds, occasionally appear strong and stormy wind. Average number of days with high winds over 6 knots in Sabac is 6.6, and with a wind storm, measuring over 8 knots is 1.8 days.

1.2 Demographic development and structure

1.2.1 Population

According to census 2011, there are 28,883 inhabitants in Bogatić area. Compared to the census 2002, the population decreased by 4,107 (32,990 inhabitants according to the census of 2002). The trend of declining population of Bogatić goes back to 1961 when 37,141 inhabitants were listed, which are 351 residents less than according to census 1953 (37,492 inhabitants). Analysis of the data showed that the trend of population declines in Serbia, and in the municipality of Bogatić. The main feature of the projected population is the growing movement of Serbia in 2002 - 2032. In fact the population of Serbia in the year 2032, will be less than in 2011.



Graphic 2: Population development in Bogatić (Source: Census data)

1.2.2 Households

Since 1991 the number of households in Bogatić has been increasing. The census of 2001 revealed a total number of households have slightly increased from 9,739 (census 1991) to 9,794 (census 2001). Furthermore, according to 2011 census, as first time the number of households is decreasing within the municipality of Bogatić.

Table 1: Number of households in Bogatić (Source: Census data)

	Municipality	Number of households 1991	Number of households 2001	Number of households 2011
1	Badovinci	1,494	1,510	1,433
2	Banovo Polje	473	444	401
3	Belotic	500	504	471
4	Bogatić	2,180	2,289	2,060
5	Glogovac	289	301	259
6	Glusci	687	713	622
7	Dublje	980	932	852
8	Klenje	977	957	890
9	Metkovic	356	347	313
10	Ocage	126	124	111
11	Salas Crnobarski	426	418	353
12	Sovljak	188	193	173

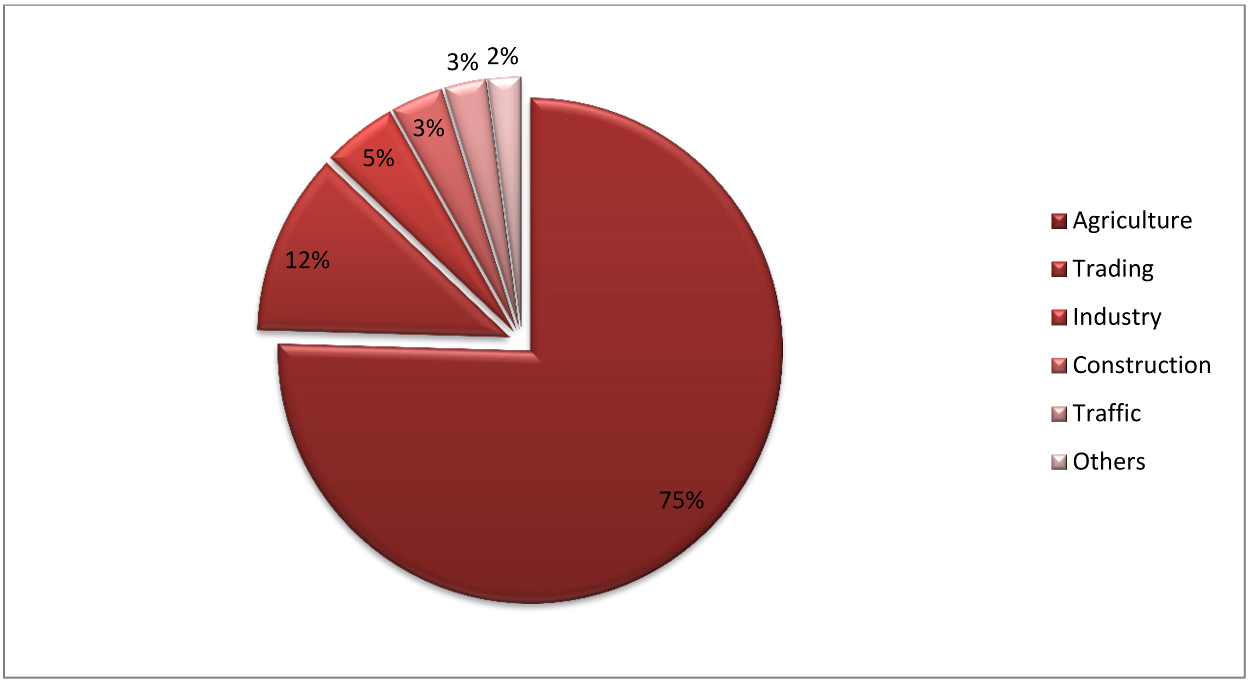
13	Uzvece	332	379	301
14	Crna Bara	731	683	630
	TOTAL	**9,739**	**9,794**	**8,869**

According to 2011 census, average number of household members is 3.25 in the municipality of Bogatić, which is over the average number of Serbia by 2.88. An average density of population in Serbia is 93 habitants per square kilometre, which is above the average of the municipality with 75 habitants (census 2011).

1.2.3 Economic development and structure

Agriculture is the main sector, forming national income with a share of 75% within Bogatić. The other parts are represented by the trading sector (12%), industry (5%) and smaller amounts by the construction sector (3%), traffic (3%) and other sectors.

The following illustration shows the areas of economy that participate in forming national income:



Graphic 3: Economy structure in Bogatić (Source: Statistical Office of the Republic of Serbia)

The following table shows the structure of national income by activities in percentage:

Table 2: structure of the national income Serbia and Bogatić (source: Statistical Office of the Republic of Serbia – municipalities within Serbia, year 2002, 2006)

	Republic of Serbia		Bogatić municipality	
	2001	**2005**	**2001**	**2005**
Agriculture, forestry and water management	27.9	17.0	78.6	75.9
Industry and mining	31.4	34.0	2.8	4.7
Construction	5.4	7.3	1.3	3.4

Trading	15.9	24.7	12.9	11.7
Traffic	6.9	10.4	1.1	2.7
Other activities	10.2	6.6	3.3	1.6
Total	***100 %*** **7.360 mil. euro**	***100 %*** **10.745 mil. euro**	***100 %*** **33 mil. euro**	***100 %*** **31 mil. euro**

Since 2006, Statistical Office of the Republic of Serbia hasn't analysed data on national income, but on national product and only for regions where the top-down method end.
The total number of employed people within the Bogatić municipality is 3,922. Moreover, the unemployment is also too high by 3,360.
Number of employees is split in:

- *private firms employ 2,286 workers*
- *public service employs 1,636 workers.*

The average net salary is 242 euros in Bogatić for year 2012 (326 euros Serbia average). The characteristic poorly developed industrial production caused in a high rate of population engagement in agricultural production by 50 % (12% in Serbia).

For transport the household consumed 3,966 dinars per month or 35 euros. An average monthly expenditure per household for heating and electricity is or 59 euros (according to the Statistical Office of the Republic of Serbia data for year 2012.)
In Bogatić municipality residents have expended 6,279 million euros on heating and electricity, and additional 3,724 million on transport.

1.2.4 Transport infrastructure

The municipality of Bogatić is taking peripheral position in the central Serbia, in relation to the main axis of development of Serbia. These peripheral devices is significantly reduced by building a bridge over the Drina ("Pavlovic Bridge "), so that the area now has the role of transport links between Serbia and the Republic of Srpska of Bosnia and Herzegovina. Traffic potential of Bogatić represents regional roads that pass through the area of the municipality and allow its integration into regional, national and international traffic flows. Proximity of roads of international significance and good links with the roads: Corridor 10, which runs through Srem part of Sremska Mitrovica municipality , and state corridor Novi Sad - Ruma - Sabac and Sabac - Loznica, in Sabac municipality new bridge over the Sava river, railway Ruma - Sabac - Loznica -Zvornik , that runs in a length of 2.5 km through Bogatić municipality, the railway route Sabac - Zvornik, the railway station in Dublje and ports on Sava river, in Sabac and Sremska Mitrovica. Municipal roads are in a total length of 140.1 km, of which 90.5 km are asphalt roads, and 49.6 km gravel roads. This road network in terms of total size and direction is providing a satisfactory transport links with other areas of the Municipality and suitable communication within its borders.

1.3 Regulatory framework and forecasts

1.3.1 Feed-in tariffs in Serbia

- Biogas and biomass Power plants can obtain beneficiary price, guaranteed by law for a period of 12 years if power is produced from biomass or biogas.
- Fossil fuels can be used for power production within CHP power plants of capacity up to 10 MW, depending on proved high efficiency.
- Solar power plants (with capacity limits)
- Geothermal power plants
- Hydro power plants (up to 30MW)
- Waste fired power plants
- Landfill and sewage gas power plant
- The inflation factor is allowed (EU zone) to be used for power price correction

Decree on the conditions and procedure for obtaining the status of privileged power produced:

- *<u>biomass power plants</u> are power plants using biodegradable materials derived from agriculture, forestry and households, including: plants and parts of plants, plant residues from agriculture (straw, corn stalks, branches, stones, shells), manure from farms, plant residues in forestry (residues from deforestation), biodegradable residues in food and wood processing industries not containing hazardous substances and separated biodegradable fraction of municipal waste*
- *<u>biogas power plants</u> are power plants with one or more generators using the gas created in their own facilities (reactors), through anaerobic processes from biomass, excluding biomass of animal origin;*
- *<u>animal origin biogas power plants</u> are power plants using the gas created in the facilities for treatment of animal by-products (category 2 and 3 materials – animal carcasses, body, parts of animal bodies, integral parts of animal bodies, products of animal origin and food of animal origin which are not intended for human consumption), in accordance with the regulations prescribing the treatment of animal origin by-products, as well as other veterinary regulations;*

<u>The incentive purchase prices under paragraph 1 of this Article are as follows:</u>

Power plant type of privileged power producer	Installed Capacity P (MW)	Incentive Purchase Price (c€/kWh)
Biomass power plants	Up to 1	13.26
	1 - 10	13.82 – 0.56*P
	Above10	8.22
Biogas power plants	Up to 0.2	15.66
	0.2 - 1	16.498 – 4.188*P
	Above 1	12.31
Biogas of animal origin		12.31

1.3.2 Subvention in private sector

In Serbia, currently there are no subventions for households. The Ministry of Energy is working on defining the model for this kind of subvention.
The budgetary found for energy efficiency increase is formed at the beginning of the year. It is expected that funds for households will be available from May through subvention credits.

2 Energy demand in Bogatić

The demand for final energy in form of the use of energy carriers was calculated referring to all submitted data from the municipality of Bogatić together with data of the International Energy Agency (in case of missing data; this regards mainly the demand of households).

Because of the lack of major industry, the energy demand was calculated only for the municipality and for households. The study focusses mainly on electricity and heat, transport fuel energy demand is calculated in case of the total energy demand, but not at that detailed level.

The total energy demand is generally composed from the following elements:

- Heat for buildings (all used energy carriers including electric heating)
- Process heat in industry
- Heat for warm water supply in buildings
- Electricity for building lighting and building services engineering (pumps etc.)
- Electricity for production applications
- Electricity for street lighting
- Electricity for pumps in sewage disposal and tap water supply
- Liquid fuels for transport and landscape work

2.1 Energy demand in private sector

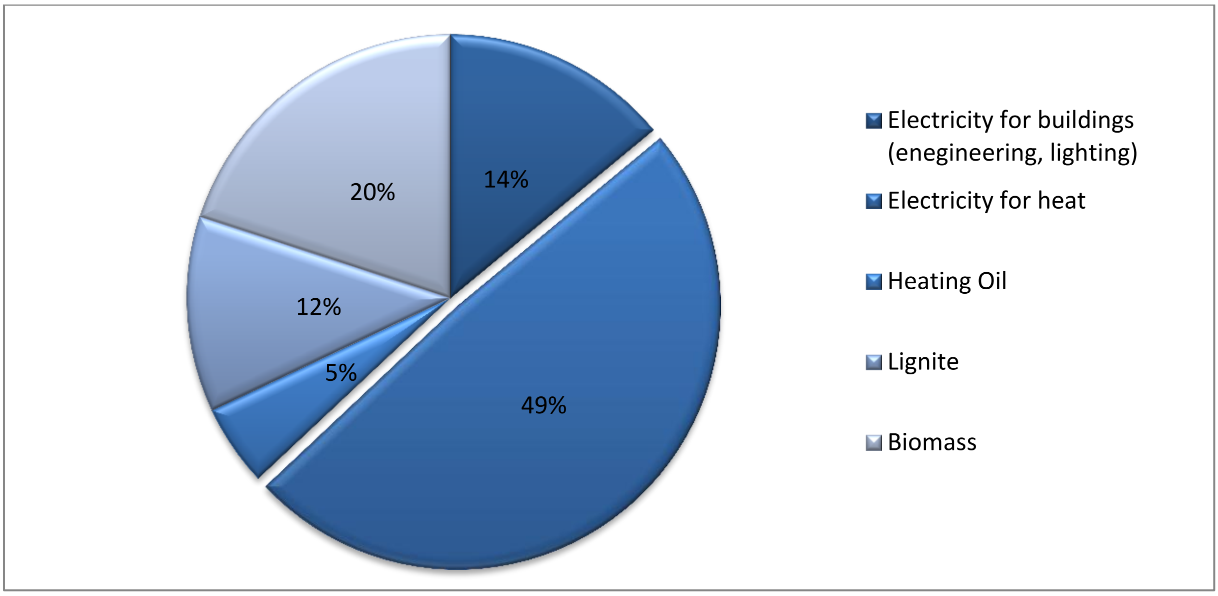
The final energy demand of the residential was calculated for the submitted number of 9,037 households in Bogatić. It is shown in the following Table 3.

Table 3: Residential energy demand in Bogatić (Source: Calculation EEE, 2013)

Residential energy demand	Final energy in MWh/a	*Share*
Electricity for building engineering, lighting etc.	52,776	*14%*
Electricity for heat	187,836	*49%*
Heating oil	18,373	*5%*
Lignite	47,377	*12%*
Biomass	75,544	*20%*
Total	**381,906**	*100%*

The final energy demand of the residential sector is 381,907 MWh/a. The total share of electricity in the residential sector is 63%, followed by biomass with a share of 20% and lignite with 12%. The share of heating oil is only 5%, also illustrated in the next graphic.

These data have been calculated using information received in bilateral working meetings and, mainly an adaption of the national energy balance of Serbia, published by the International Energy Agency on www.iea.org. Since these data showed, that they are also corresponding to the information from the working meetings, the shares of energy carriers as well as the average amounts in energy demand were applied for the calculation.



Graphic 4: Total share of energy types in private sector demand in Bogatić (Source: Calculation EEE, 2013)

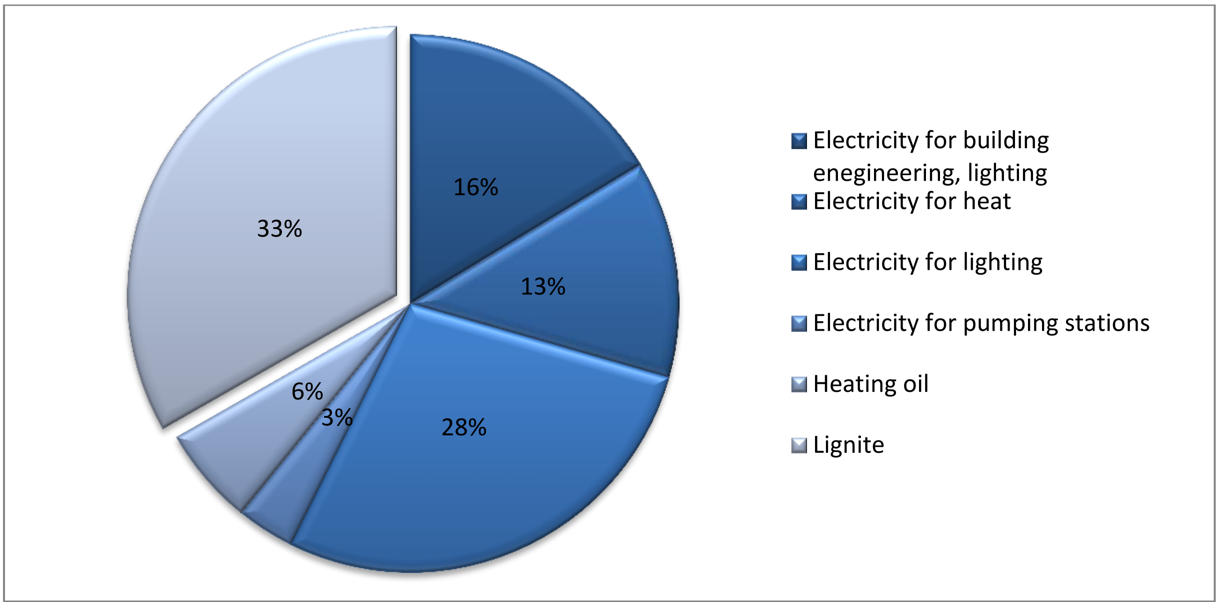
2.2 Energy demand for public service in the municipality

The municipal energy demand for Bogatić is shown in Table 4:

Table 4: Municipal energy demand in Bogatić (Source: Calculation EEE, 2013)

Energy demand for municipal public service	Final energy in MWh/a	*Share*
Electricity for buildings (engineering and lighting)	1,297	16%
Electricity for heat	1,038	13%
Electricity for street lighting	2,214	28%
Electricity for pumping stations	276	3%
Heating oil	470	6%
Lignite	2,638	33%
Total	**7,933**	**100%**

The final energy demand for municipal public service is **7,933 MWh/a**. The total share of electricity is 61%, lignite has a share of 33% and the share of heating oil is only 6%, also illustrated in the next graphic.



Graphic 5: Total share of energy types in municipality in Bogatić (Source: Calculation EEE, 2013)

2.3 Energy demand in industry sector

The industry sector in Bogatić is according to submitted data and to information received in the working meetings, very low developed. Due to the lack of information on structure in energy carrier demand as well as key figures for a statistical estimation, it was not possible to produce an overview of the energy demand in the industrial sector.

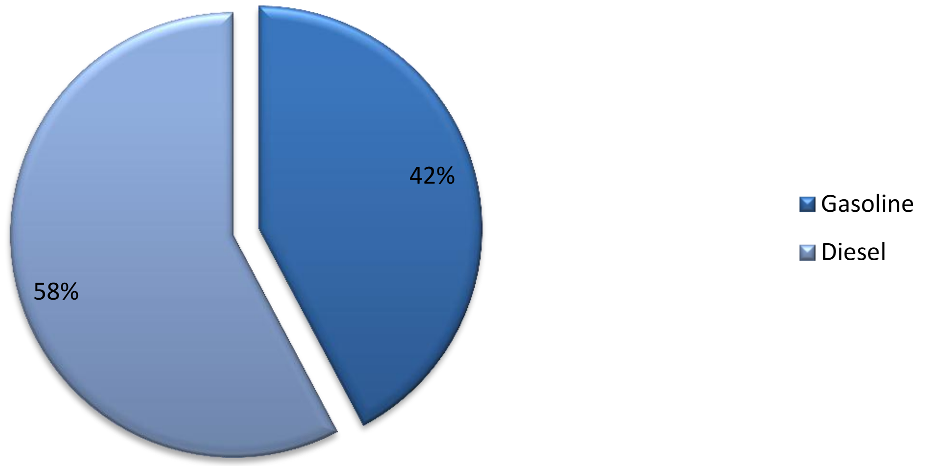
2.4 Energy demand in transport sector

The final energy demand for transport, according to the number and types of vehicles, as submitted is shown in Table 5:

Table 5: Energy demand in transport sector in Bogatić (Source: Calculation EEE, 2013)

Transport fuel	**MWh/a**	*Share*
Gasoline	27,092	*42%*
Diesel	37,034	*58%*
Total	**64,126**	*100%*

The final energy demand of transport sector is **64,126 MWh/a**. There two main carriers of the energy demand; gasoline with a share of 42% and diesel with a share of 58%, also illustrated in the next graphic.



Graphic 6: Total share of energy types in transport sector (Source: Calculation EEE, 2014)

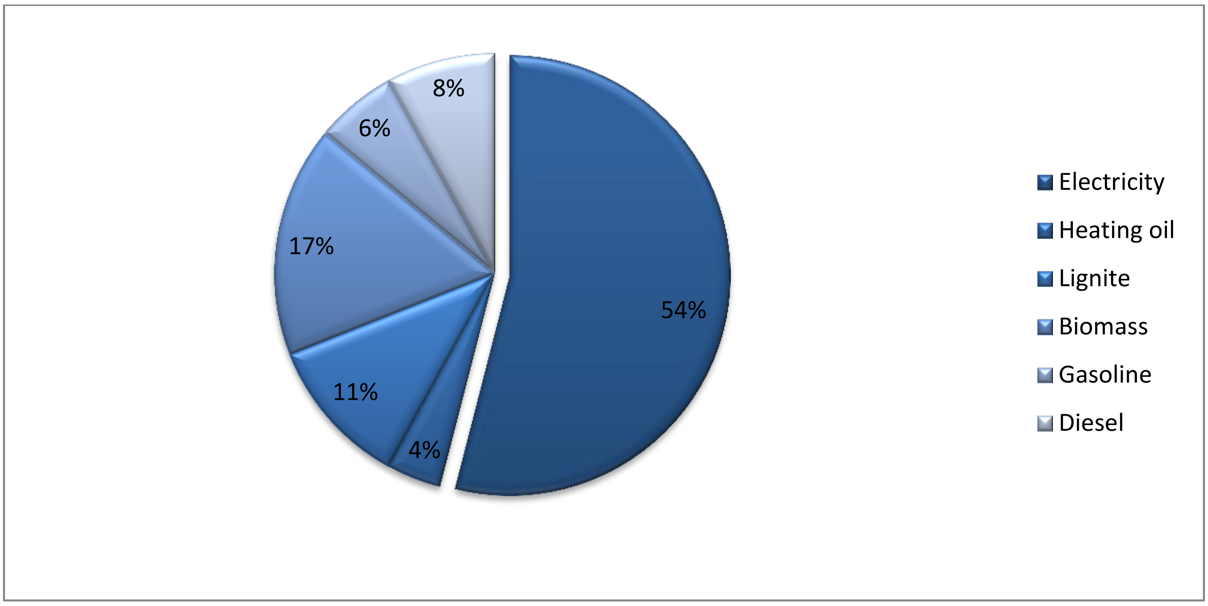
2.5 Calculable total energy demand

The calculable total energy demand consists of the sectorial energy demands above. The energy demand for agriculture is included within the previous table, as well as services, but due to the lack of key information, industry is not included.

Table 6: Total energy demand by energy carriers in Bogatić (Source; Calculation EEE, 2014)

Energy carrier	**Final energy in MWh**	*Share*
Electricity	245,438	*54%*
Heating oil	18,844	*4%*
Lignite	50,015	*11%*
Biomass	75,544	*17%*
Gasoline	27,092	*6%*
Diesel	37,034	*8%*
Total	**453,967**	*100%*

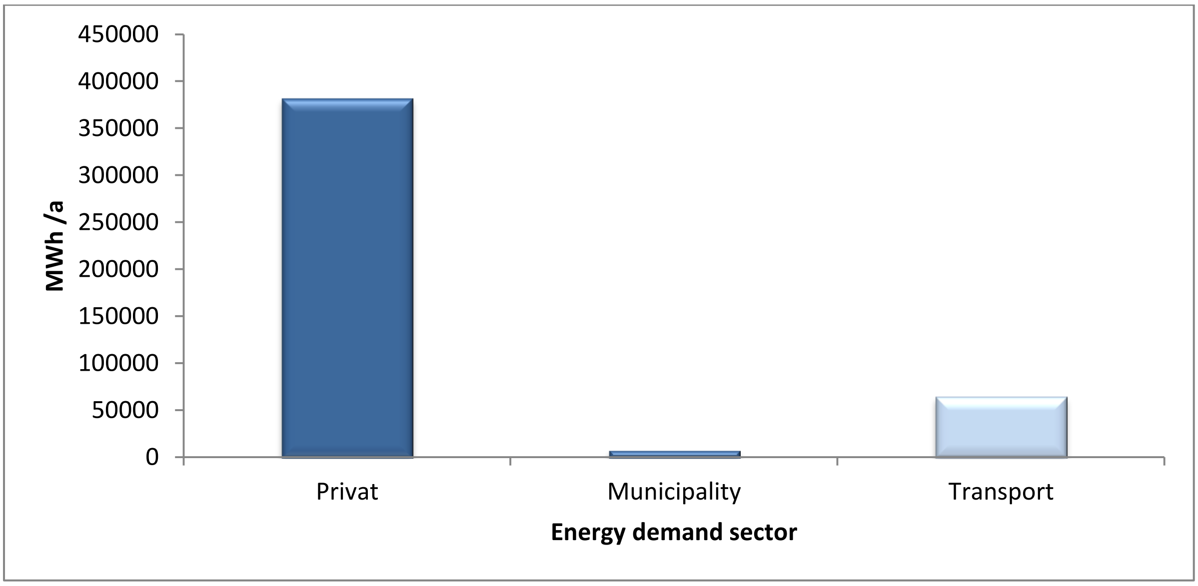
The total energy demand of Bogatić is **453,967 MWh/a.** The share of electricity is 54%, oil products have a share of 18%, the share of biomass is 17% and the share of coal products is 11%, also illustrated in the following graphic.



Graphic 7: Total share of energy types of total energy demand in Bogatić (Source: Calculation EEE, 2013)

Compared to the final energy consumption on national level, electricity has a remarkably high share: 54% compared to 25% (national). Also the share of biomass is higher: 17% compared to 11%. The consumption of oil products is below national average level: 18% compared to 33%.

The following graphic illustrate the energy demand of the individual sectors on the total energy demand. The highest of the energy demand on the total energy demand has the private sector by up to 84%.



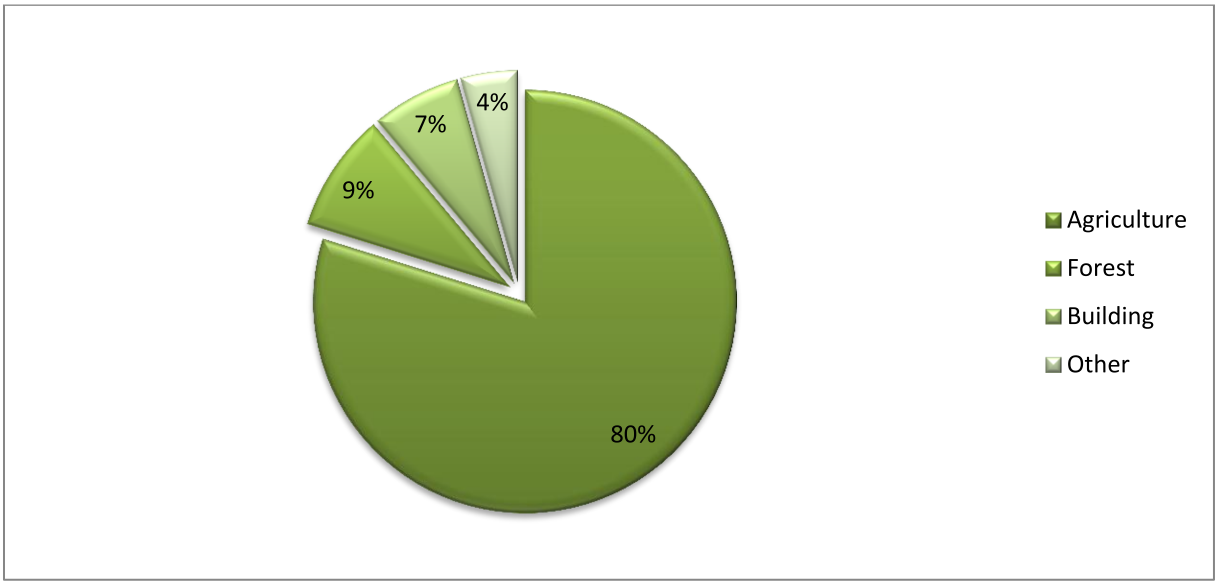
Graphic 8: Share of the demand sectors on the total energy demand (Source: Calculation EEE, 2013)

3 Resources of Bogatić

The renewable resources potential is calculated on the basis of the received information regarding:

- Forestry
- Agriculture
- Geothermy
- Solar radiation
- Hydropower

Municipality Bogatić covers an area of 38,432 ha, which is split in agricultural and forest, building land and land for other utilizations.



Graphic 9: Covering of the land of Bogatić (Source: Statistical Office of the Republic of Serbia)

Height variance within Bogatić municipality is only about 18m, therefore the terrain is almost perfectly plane. Up to 100 % of the area has a slope of up to 0.5 degrees which is favorable for any activity or construction, or intensive agriculture and a variety of construction projects. Municipality of Bogatić has covers around 30,594 hectares of agricultural land. It is 105.9 acres (64 acres Serbia average) per capita, which is above the European average, and 65 % higher than the average of the Republic of Serbia.

3.1 Potentials from the forestry sector

With *3,524 hectares* of forest land, Bogatić municipality is a part Serbia for which can be said to have a minor forest. Annual increment in the forests, according to the submitted data, is 4 m^3/ha. About 92 % of the forests are privately owned. Forest wood is in 90% used as a fire wood.

Referring to these data, the annual increment is 14,000 m^3 of which 12,900 m^3 is used as firewood with a total energy content of **41,500 MWh/a**, based on the heating value of 3,2 MWh/m^3. This amount is covering 55% of the total biomass demand.

Referring to the data received from the municipality later in 2013, the annual increment of forestall biomass is currently 2.64 m³/ha*a. This is a rather low amount and results in an annual total increment of about 9,200 m³ on the regarded territory.

Due to the Serbian forestry statistics a share of 36% of the harvests in the Mačva region is used as technical wood. The major share of 64% is used for energy purposes (heat supply). Regarding this distribution the potential from forestry is 5,800 m³/a. The energy content of this biomass is 18,700 MWh/a. Furthermore, the covering rate of this potential is about 25% of the current biomass energy demand and it can also be assumed that this amount is already in use.

Because of the differing basic data regarding the annual increment, the annual potential of forestall biomass was calculated in form of an upper and a lower limit. The real potential will be found between these limit values.

*Usable forestall biomass resources are between **18,700** and **41,500 MWh/a**.*
*Resulting heat load: **14** to **32 MW***
This amount of energy is already in use and there are no further free potentials.

3.2 Potentials from the agricultural sector

Agriculture is the most dominant economic activity that accounts for the ¾ of the total national income of the municipality and 49.9 % of the population is agricultural (12% in Serbia). The structure of agricultural land is characterized by a significant share of arable land (91.6%), representing a significant potential for the development of agriculture and animal husbandry (pigs and cattle) and farming (production of corn, wheat and fodder crops). With the introduction of irrigation, recently (since in 1991) creates favorable conditions for the development of large-scale growing vegetables.

Only 2.4% of the agricultural land are pastures. Land intended for arable land is mostly used for growing crops (16.3 to 20 thousand hectares, data 2007) In other words, the global area of crops comprises 68.3 % of agricultural land (59% of Serbia). At the same time, under fodder crops is 16.7% of agricultural land (Serbia 14%), about 8.3 % of vegetable crops (Serbian 8.5%). According to those figures, there is no doubt that the land within the Bogatić municipality is used more intense than in the rest of Serbia. That presents big potential for development of all forms of agricultural production.

Along with an exceptionally high - quality land, affluent geothermal springs allow the expansion and diversification of land use.

Ownership structure is characterized by the highest representation of households with smaller farms between 1 ha and 3 ha of used land. For the 6,901 farm - households that reside in 14 settlements, with the same number of cadastral municipalities, the average size per farm is 2.91 ha of land.

Most of the sown area are cereals (wheat and corn, data 2012), 20,580 ha (67.3 % of the farm) and the least industrial crops (1,604 ha or 5.2%). Orchards covers 1,558 ha or 5.1%. The average wheat yield is of 4 tons/acre and corn of 5.3 tons/acre.

Livestock production

Livestock production in recent years is in a small decline but still far above the average production in Serbia. In 2012, there are 144,223 registered pigs for fattening, 3,625 dairy cows and 15,877 beef cattle in the municipality. Despite the poor economic conditions in this branch of agriculture, farmers from the municipality of Bogatić traditionally remained faithful to animal husbandry. As indicated by the fact that the municipality has more than one animal per hectare of arable land (1.49 animal in 1985 and 1.48 animal in 2007).

Energy from agricultural resources can be provided by the use of residues from the common production process or by the specific production of biomass for energy purposes. Resources from agriculture can be used either for *combustion* or for *anaerobic digestion*. In some cases, agricultural residues can be used in both ways, as for example crop straw.

3.2.1 Agricultural residues

The potential of agricultural biomass from crop residues on the territory of Bogatić is listed in Table 7. The values are MWh of primary energy, but in case of real use, need to be reduced by the efficiency factor of a chosen conversion technology. Additionally, the energy content is calculated in two ways of energy production for:

1. *a scenario based on combustion*
2. *a scenario based on conversion to biogas.*

Table 7: Potentials of the agricultural residues in Bogatić (Source: Calculation EEE, 2013)

Type	t/a	Combustion scenario MWh	Biogas scenario MWh
Wheat	17,864	85,747	44,660
Barley	1,176	5,645	2,940
Rapeseed	-	-	-
Sunflower	652	3,129	1,630
Maizes	97,838	469,622	244,595
Total	**117,530**	**564,144**	**293,825**

The lower heat value for straw, referring to dry matter, is 4.8 MWh/t in the combustion scenario. For the biogas scenario, the heating value of the resulting biogas is 2.5 MWh, produced from 1 ton of straw.

Although the primary energy content in the biogas scenario is lower, due to higher efficiency of power generation from the biogas process, the power potential is very close to the one from the combustion scenario.

*Combustion scenario **564,144 MWh (**Power potential: **13 MWel** and **34 MWth)***
*Biogas scenario **293,825 MWh** (Power potential: **12 MWel** and **14 MWth**)*

3.2.2 Residues combustion scenario

The use of *grain straw* in small scale furnaces is problematic because of the low melting point of its ash (800-900°C) and its high content of chlorine. Both factors are causing damage to the furnaces. The conversion of grain straw to useful energy needs special technologies which are only on a larger power scale also economically viable.

Only *maize straw* has an ash melting point which is higher (1,200°C) and can therefore be used also in small scale furnaces. Nevertheless it needs to be processed and conditioned first and brought into a useable form, like pellets or briquettes.

The theoretical covering rate by straw is **170%** of the total heat demand. The highest potential is coming from maize straw, since maize is covering 50% of the cultivated land (other grains are covering only 28% of the arable land). Maize straw can theoretically cover **140%**. This means, that at least the currently used amount of lignite could be replaced by (maize) straw.

*Theoretical covering rate by straw: **170% (564,144 MWh)** of the total heat demand.*

3.2.3 Residues biogas scenario

The use of straw for biogas production needs also some processing at the front end of the process. It has to be cut or grinded into small pieces in order to not create problems inside the fermenters. Furthermore, as experience showed, only a maximum share of 20% of straw can be added to the anaerobic digestion to maintain a safe continuous process.

The energy output in a biogas process is lower than in the combustion way, because the digestion is also creating CO_2, which is of no energetic use. The advantage of the anaerobic digestion is the resulting digestate still containing almost all minerals and nitrogen, which makes it cheap and very effective fertilizer.

The theoretical covering rate of the current energy demand is about **40%** of the electricity demand and **75%** of the heat demand. The share of useable heat drops to 16% if one regards only the heat production through the heating period. For the summer months, different uses need to be found for the co-produced heat.

*The theoretical covering rate of the current energy demand is about **40%** of the electricity demand and **75% (293,825 MWh)** of the heat demand.*

3.2.4 Anaerobic digestion of animal manure

Anaerobic digestion of animal manure carries a potential of **8,100 MWh** of electricity and **9,200 MWh** of heat. This would cover 3% of the current electricity demand, as well as 3% of the heat demand. The theoretical electric power potential from animal manure is **1 MW**, resulting in a power potential of **1.2 MW** for heat generation.

Since the total live stock is distributed over the territory with few noteworthy concentrations, the chance for economic viable power generation from anaerobic digestion of animal manure seems to be rather small. In the best case a co-fermentation of animal manure, straw and specific green biomass could probably lead to a viable power generation from biogas.

*Theoretical electricity generation potential from manure: **8,100 MWh***
*Theoretical heat generation potential from manure: **9,200 MWh***
*Power potential from manure **1 MWel and 1.2 MWth**.*

3.2.5 Specific agricultural biomass production for energy purposes

Biomass for energy generation is one of the possible types of business in farming.

In any calculation of potentials, at least the needed area for food production needs to be excluded. According to experience, farmers are agreeing to use a maximum of 20% of their arable land for energy-biomass production. Thus, depending on the size of the observed territory, the potential of the share of land for energy production can vary between a very low percentage rate and 20%.

The type of energy-biomass to cultivate is depending on the respective type of end use. If the biomass is used in a biogas generation process, the production process will have the same intensity as the one for food or animal alimentation. If the production of combustive material is the goal, extensive forms of cultivation, like short-rotation-coppices (SRC) of willows and poplars can be chosen. SRCs should preferably be sited on areas with low average soil quality and thus low productivity regarding food production. The best quality soils should be reserved for human food production

Of the approximately 28,600 ha of agricultural land, about 7,300 ha are needed for food production, thus remaining 21,300 ha for other purposes. Taking into account also the 20%-scenario described above it seems to be realistic, that an area of 4,000 to 5,000 ha could be used for energy production in the long run.

In case of silo maize for biogas production, the expected energy yield is, according to the widely varying data received, between **20** and **40 MWh/ha**. The same values can be assumed for sorghum. Sorghum is even more resistant to summer droughts than maize. The energy yield of a SRC is expected to be about **40** to **50 MWh/ha**. In order to replace the currently used lignite by biomass from SRC, for example, an area of **1,100 ha** would be needed.

This topic will be discussed closer in the section: Agricultural biomass production.

*In the long run, an area of **4,000 to 5,000 hectares** could be used **for energy production.***

3.3 Solar energy potential in Bogatić

The average annual insolation in Sremska Mitrovica is 2095 hours, 4 hours, or 5.7 hours per day. Duration of insolation changes during the year, being the highest in summer and the lowest in winter months. Insolation depends of the day length, or a season, elevation of the Sun, and the cloudiness. The longest average insolation in the observed period is July (292.2 hours or 9.4 hours per day), and the shortest in December (48.9 hours or 1.6 hours per day).

According to the *European solar data service* „Satel-light“, the annual sum of global irradiation on a horizontal surface in the region of Bogatić is **1,520 kWh/m²**. Assuming an average conversion efficiency of 12%, the annual yield of a solar panel with the size of 1 m² can be specified with a value of 182 kWh. 1 kW peak facility thus has an output of approximately 1.8 MWh/a (Source: The values are calculated on the basis of Pavlovic, T. et al. (2011): Solar energy in Serbia).

The analysis of suitable rooftop areas (using satellite images) showed a very low potential for roof-bound photovoltaic facilities. The total installable power in this case is **250 kW**, which would allow an annual electricity production of **456 MWh**. This amount is only about 10% of the electricity demand for municipal services as street lighting, electric heating in public buildings etc. and less than 1% of the total electricity demand.

The respective rooftops are marked in yellow at the following image.

Graphic 10: The respective rooftops in Bogatić (Source: Google Maps, 2014)

Besides the construction of rooftop facilities there is also the possibility of the construction of ground photovoltaic. In this case a facility with a capacity of 1 MW peak can be installed on an area of 3ha. To cover the current electricity demand of the municipality for public services, for example, a ground facility with the power of 2.5 MW peak is needed.

*Installable power on the rooftops: **250 kW**,*
*Annual electricity production: **456 MWh**.*

3.4 Organic waste and sewage energy potential

Organic waste and sewage can be a source for renewable energy if they are collected thoroughly and treated systematically. Outside urban areas organic waste is normally composted without creating larger problems. In more or less urban areas the disposal of e.g. used cooking oil through the sewage system can degrade the performance of the sewage system by narrowing the effective diameter of the tubes and thus raise the maintenance costs of the whole system. Because of that many municipalities, mainly in middle and north European countries have started to collect waste oil. The collection is obligatory for hotels, restaurants etc. and voluntary for households. According to experience an amount of 3kg/cap*year can be collected. This cooking oil is converted into biodiesel in a few facilities.

Another possibility is to add the waste oil continuously to an anaerobic digestion process to increase the output of biogas.

In the case of Bogatić the annual amount of waste oil is about **86 t**. Converted into biodiesel, the annual energy yield could be **800 MWh**. This is a rather small amount and a conversion facility would not show an economic viability.

A conversion into biogas would lead to an annual yield of about **500 MWh primary** (of which 170 MWh of electricity, equaling an installed power of 20kWel).

Another type of organic waste is *sewage*. If treated in a central purification plant, the occurring sewage gas can be converted into electricity by use of a gas motor or a micro-gas-turbine. The threshold for an economic viable conversion is the central processing of sewage occurring from about 25,000 inhabitants. In case of Bogatić the resulting electric energy from sewage gas is about **450 MWh** of electricity. This equals to an installed power of **56 kWel.**

The amount of sewage is calculated from a standardized per capita value, regarding only population and not industry. Of course it is a theoretical potential, if all households are connected to the sewage grid.

Electric energy from sewage gas: ***450 MWh/a.***
Installed power: ***56 kWel.***

3.5 Other potentials (hydro power, wind power, geothermal energy, etc.)

3.5.1 Wind power

There are no complete data sets for characteristics of wind regime, because the Station Sabac observations carried out intermittently, therefore available data for the period: 1961-1972, 1983-1993, 1996-1999, 2001 - 2002 and 2004 - 2005 were used.
Based on limited data of Bogatić (1991, 1992, 1993 - 3 years of observation), the most common winds are from the Northwest (169.6 ‰), Western (133.3 ‰) and South (125.1 ‰) and the Southeast (120.5 ‰) direction. The lowest frequency is marked the south wind (11.9 ‰) and north wind (29.6 ‰) in Sabac, alike in Bogatić.
Respectively, in Bogatić presence of winds from these directions is slightly higher. According to data of the station Sabac, there is an average wind speed of 1.3 m/sec. The highest average wind speed is in March, 1.6 m/sec.
Although in the studied area are represented predominantly low intensity winds, occasionally appear strong and stormy wind. Average number of days with high winds over 6 knots in Sabac is 6.6, and with a wind storm, measuring over 8 knots was 1.8 days.
Due to not sufficient average wind speeds in the region, there is no economic viable potential for wind power.

There is no wind potential.

3.5.2 Mineral properties and potential

The degree of exploration of mineral resources

In the area of Bogatić are significant reserves of underground water, thermal water, from which it gets geothermal energy, building materials, sand and gravel.

Reserves of sand and gravel are found within all of Mačva (Quaternary alluvial sediments) and the inundation area of the Drina River, on the coast and in the river bed. Gravel has significant economic reserves, but has not been extensively studied and classified, there are no data on reserves. Until the construction of the upstream accumulation on the Drina, due to poor kinetic power of the Drina, in relation to the upper and middle course, the lower the delay, there was a large amount of sand and gravel, especially in the period of high water. The thickness of these layers along the Drina is about 2 - 10m. With construction of upstream water reservoirs on the river Drina river stocks of materials became practically non-renewable. The estimated annual sediment yield is about 400,000 m³, and it is assumed that this amount will be reduced. Therefore, when planning the total annual exploitation of river materials to ensure that any excess over the amount of river transport is the abstraction of its own non-recoverable reserves.

Extraction of sand and gravel are often conducted without control, the arbitrarily chosen locations and undefined conditions. In many cases, removing material from the abandoned branches, created conditions for their reactivation, and this activity should guide the planning and control to define the locations of extraction, volume and operating conditions.

3.5.3 Geothermy

Survey results show that the low-temperature convective system Hydro-geothermal "Mačva" is a part of the regional system, which extends below Mačva, Semberije and Srem about 2000km². Basic research is not complete, but the results are favourable. Below Neogene sediments is a karst limestone reservoir of the Triassic age, from where is possible to achieve a large-scale exploitation of geothermal energy. Research of the geothermal potential of the Mačva region, have shown that this territory has a geothermal potential to produce at least **500 MWh** thermal energy. Water temperatures in the exploration wells ranging from 30°C to 78°C, and the area of Bogatić is identified as very promising, especially area Dublje - Bogatić.

The thermal waters were discovered in the Triassic limestone and the lowest parts of the Neogene sediments within exploration wells in cadastral municipalities, Bogatić, Belotic and Metkovic (D-1 Dublje: 49.2°C, BD-1 Dublje: 50.5°C and new exploration and exploitation wells IEBSZ-1/2002, the water temperature is around 29.0°C, which is used to heat greenhouses; Bogatić BB-1: 75.5°C; Beljiste BB-2: 78.0°C; BBE-1 Belotic: 34.0°C ; BME-1 Metkovic 63.0°C; B2-1 experiment: 30.0 °C and B2-2 experiment: 39.0 °C). The results of previous, basic geological researches exposed thermal waters of good quality and in sufficient quantities. Thermal waters in the Neogene sediments, with temperature ranges between 18 - 29 °C, were found in dozens of wells, so called. "Arteski" wells at several sites in Bogatić, Belotic and Klenj.

Thermal waters in Bogatić were discovered during drilling artesian wells (exploration well BB-1, in 1986, and BB-2, 1989), where they recorded a relatively high temperature of 75-80°C and the yield of 37-60 l/sec.. In Klenj, geothermal resource is discovered in the Neogene sediments at a depth of 170m, the water temperature to 17.8°C and the yield of 0,2 l/sec.. In Metkovic (MEB-1), the geothermal water is detected in the Neogene clayey-sandy sediments, with a temperature of 65 °C and give way of 7 l/sec.. Within the Belotic village (BeB-1), the water temperature is 23°C, yield 0.5 l/sec., and the depth is about 195-200m.

Hydrothermal reservoir feeding system "Mačva" water shall be direct or indirect plunge rainfall and river water inflow thermal water from the deeper layers of the system. Infiltration of precipitation is expressed on the northern edge of the Cer Mountain, where Permian, Triassic and Cretaceous lime stones were discovered, indirectly through the upper most thin blanket of sand and gravel, a direct descent of the water of the Drina river (at Koviljača) smothered in Triassic lime stones in their riverbeds. The flow of thermal water is from the deep layers of Semberia and Srem areas. Conducted isotopic studies indicate that the thermal waters of the southern part of the reservoir are younger than 30 years. They should come directly from infiltrating rainfall and river water, while the water in the northern part of the reservoir derived from thermal waters older than 50 years (within the Mačva system) came from Semberija and Srem areas. In other words, the thermal water in the reservoir of hydrothermal systems "Mačva" , is a mixture of young and old water from different areas. All these data, together with data on the chemical composition indicate an active flow of water through the tank, and his resilient character.

Analysing the value of artesian water temperature in northern Mačva it is obtained that the average value of the geothermal level was 18.9 m/°C. The cause of high temperatures in the Neogene sediments (Triassic limestone) is a consequence of geothermal anomalies within the territory of Serbia, and the very high values terrestrial regional heat flow in the Earth's crust. The composition of water is not attractive enough to be without prudential treatment could be used for drinking (increased presence of fluoride, ammonia, and sulphur oxides, a reduced amount of microelements). Despite the fact that water is not recommended for drinking and bottling, remain huge possibilities for its use and further exploitation, and the most realistic options are to use it primarily for agricultural purposes, then biological and hydrotherapy treatment methods, as well as sports and recreational purposes.

The realization of the use of geothermal water for treatment in the resort Dublje has already begun by construction of leisure and health centre "Mačvansko Vrelo" (Dublje spa), near the drill holes (DB-1) in the north-eastern part of the settlement. The planned construction of the spa complex for the treatment of chronic rheumatism and skin diseases, and construction of a covered swimming pool with three thermal water shells and associated facilities, a plateau with an outdoor swimming pool with three shells in thermal water, dressing rooms and a separate bathroom. Within the complex is a well, **400m** deep, with yield of **15 l/sec**. and a water temperature of **50.5°C**, intended for hot water supply. Constructed objects were not in service. Regarding that the facility with the pool haven't been used for a number of years, it is in relatively good shape, so that with a detailed reconstruction and additional related content, this object could be returned to the function, whether it is the original or a compatible purpose.

Based on the results of the preliminary assessment of geothermal resources in Mačva, there are real preconditions for intensive exploitation and use of thermal waters in agriculture, greenhouse warming and intensive production of vegetables, fruits, flowers, etc. plants; heating of buildings in livestock; drying plant products, in warm water ponds for the production of consumable fish, for sports - recreational, tourism and other purposes. Studies of geothermal resources are not finalised, neither the grade on reserves of geothermal energy, but exploitation and utilization can start on the locations of individual consumers, for intensive production of food, flowers, drying plant products, and other purposes. Objective of future explorations should be defining of regional geothermal three dimensional model. At the same time it is necessary to construct exploration well of 1000m in depth of large diameter, and then perform hydrodynamic tests.

Geothermy is one of the most promising renewable energy sources in the region. The usability of geothermal hot water is depending on the spring delivery and the temperature level of the geothermal wells. The advantage in Bogatić is the fact, that there are already some existing wells with a potential ready to use.

The biggest well is ***BB2*** with a delivery of about ***60 l/sec***. at a temperature of ***78°C***. Information regarding the other wells are showing a wider range of deliveries and temperature levels. Among all wells, regarding the main parameters, BB2 seems to be the most constant one, since BB1, even if higher in temperature has dropped in delivery from initially 37 l/s to currently about 17 l/s.

The power yield of BB2, in case of use in a district heating system, is estimated between 5 and 7 MW, depending on transport losses in the grid and the operation temperature drop. The energy yield during the heating period is between 6,000 and 7,000 MWh, during the rest of the year this heat is not useful.

A possibility to use more of the well´s capacity is electric power generation by an ORC process. An applicable working fluid at the given temperature level is perfluoropentane, which can be used already at a temperature level of around 80°C, which is about 20°C lower than the temperature level required for the Kalina-process (with a minimum temperature of around 100°C). The power yield for BB2 of this process is estimated to be located around **500 kW**, resulting in an energy production of about **3,600 MWh/a**. BB1 would have an output of about 130 kW power and 980 MWh of electricity production.

*Expected power potential form BB2: **500kWel,** (electricity production: 3,600 MWh/a)*
*Expected heat energy from BB2: **6,000 – 7,000 MWh / a.***
*Expected power potential from BB1: **130 kWel** (electricity production 980 MWh)*
*Expected heat energy from BB1: **1,800 MWh***

3.5.4 Hydro power

The most important energy resource in the field of Bogatić is the Drina river hydropower and geothermal energy.
Hydropower potential as the only conventional renewable energy resource is of great importance, especially in the multi-purpose integrated water management solutions and the total energy balance. Certain limitation in the use of hydropower comes from the need to firstly arrange watershed and streams before using these resources, or because of possession of the premises by other users. Total unrealized hydropower potential of the river Drina, which can be used for plants larger than 10 MW is estimated at 3,000 GWh /a. Lower Drina river, at a current level consideration would be solved by four dams - the stairs, "Kozluk", "Drina" and "Drina II" and "III Drina" power of 93.4 MW with average annual production of 342 GWh /a. In recent years, a solution with a higher number of steps is considered (5 - 6) steps.
According to the submitted data by the municipality, the hydropower potential of the Drina is about **93 MWel**, with an annual electricity output of about **340,000 MWh**.

*The hydropower potential of the Drina is about **93 MWel**, with an annual electricity output of about **340,000 MWh**.*

3.6 Comparison of already available resources & current energy demand in Bogatić

83% of the energy demand is covered by fossil sources, 17% by renewable ones in the form of biomass.

The most used energy carrier is electric energy with a share of 54% of the total energy consumption. 78% of the electricity are used for heat applications. If heat applications are excluded, the electricity demand drops to a value of about 54,000 MWh/a. Thus the power demand for electric heating equals at least 22 MW, whereas the power demand for non-heat applications of electricity equals 7 MW.

Only ¼ of the total demand for biomass can be obtained from local sources in the form of forestall biomass, the remaining ¾ are obviously coming from outside of the project region.

Thus, the potential of forestry is already in full use and the energy development has to concentrate on other resources for energy supply.

- One aspect is to focus on the substitution of problematic fossil energy sources, especially lignite, by less noxious ones.
- The other one is to provide electricity by use of local resources, if possible and if economically feasible.

Nevertheless, the territory of Bogatić is very rich in resources and, remarkably, the potentials for energy production are even bigger than the current energy demand.

Substitution of lignite

The resources for the substitution of lignite by environmental compliant energy sources are on one hand the already developed potential of geothermy and on the other hand the vast potential of biomass agricultural from agricultural residues.

The currently developed potential of geothermy can deliver about 6,000 MWh of heat to a district heating system during the heating period. This is only 15% of the thermal capacity of the well, so another application needs to be found for the warm seasons, for example electricity production.

Agricultural residues are occurring in great masses and are currently not used, although they are containing 564,000 MWh/a and thus more heat energy than is needed in the project area. The main problem is that they are having a low energy density if used in loose bulks. For heat supply they need to be processed and compressed to pellets or briquettes.

Electricity production from local resources

As stated above, the already existing geothermal well BB-2 can either be used district heat during the heating period or for electricity production, providing at least 3,600 MWh/a. Including BB1, the theoretical potential for electricity production rises up to 4,500 MWh.

Photovoltaic on rooftops doesn´t carry a high potential, just 456 MWh/a.

The potential of *organic waste* and sewage is also very low.

Organic farm waste has not been specified. Animal manure is considered for biogas production scenario.

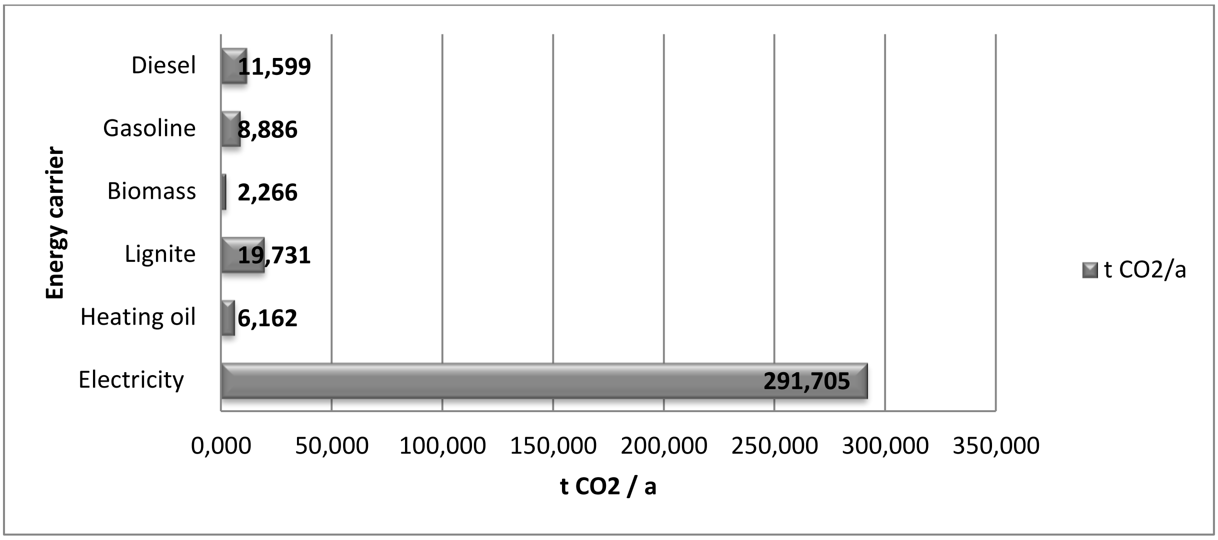
The detected ready-to-use-potentials for electricity production can cover only **2%** of the current annual demand, so a different development path needs to be chosen for rising electricity production to a reasonable level. This could be done by using agricultural biomass in one or more biogas plants or in combined-heat-power units.

The development of these resources needs to be sketched in scenarios of resource potentials and, later on in the respective feasibility studies. The resource potentials are outlined in the following chapter regarding biomass production scenarios.

*The development path should focus on the **reduction of lignite** and the **production of electricity** from local resources*

3.7 CO_2 emissions

The CO_2 Emissions are calculated according to the directions of GEMIS (**G**lobal **E**mission **M**odel for **I**ntegrated **S**ystems). GEMIS was first released in 1989, and is continuously updated and extended since then. It is used by many parties in more than 30 countries for environmental, cost and employment analyses of energy, materials and transport systems. The calculation according to GEMIS do not only consider the CO_2 emissions during the generation or combustion process, but also the emissions which are occurring in the provision chain but also in the disposal route and is thus a full lifecycle emission analysis tool for products and energy carriers.



Graphic 11: CO2 emissions by energy carriers in Bogatić (Source: Calculation EEE, 2014)

Electricity has the highest share in CO_2 emissions by 86%. The emissions of all other energy carriers are located below the 10% level.

3.8 Estimated energy costs

Based on the calculations regarding the energy demand, also the average annual costs for energy supply have been calculated. The results are shown in Table 8.

Table 8: Estimated energy costs by energy carriers in Bogatić (Source: Calculation EEE, 2014)

Energy carrier	Energy costs in €	*Share*
Electricity	13,989,939	*62%*

Heating oil	2,204,725	*10%*
Lignite	414,349	*2%*
Biomass	680,655	*3%*
Gasoline	3,603,183	*16%*
Diesel	1,554,281	*7%*
Total	**22,447,132**	*100%*

3.9 Possible agricultural biomass production scenarios

As stated in the section 3.2.5: *"Specific agricultural biomass production for energy purposes"*, the theoretical as well as the technical potential of agricultural biomass are depending on different scenarios. The scenarios are depending on the chosen development path for energy production and the aspects of sustainability.

According to experiences in Austria and Germany, farmers are ready to use a rate of up to **20%** of their farmland for the production of biomass for energy purposes.

3.9.1 Scenario 1: Biogas - potentials and possibilities

The information regarding the production potential for green maize is showing a range between **22 and 40 t/ha*a**. Based upon this range 20-40 MWh of biogas per hectare can be expected. For the following calculation a value of **31 t/ha***a (average) will be used, which results in an output of primary energy of **30.7 MWh/ha** in the form of biogas, capable to generate **10.1 MWh** of electricity which can be fed into the electric grid and **11.4 MWh** of useable heat, if a gas engine with an **electrical efficiency of 33%** is used. The remaining difference consists of the facility´s own requirements and some losses. The same values can be inserted also for sorghum.

3.9.1.1 Biogas from silages for power generation

For a biogas facility with 1 MW electric power (generated by a gas engine) an area of 790 ha is needed for providing the substrate in form of silages from maize or sorghum.

In a non-sustainable-scenario, the 20% rate of the existing farmland is represented by 5,720 ha. For the sustainable scenario, which takes into consideration also the necessary farmland for food production, the 20% scenario ends up in 4,200 ha of farmland.

- The possible power capacity for the non-sustainable scenario is 7 MWel and 8 MWth. The facilty is capable to produce app. 58,000 MWh/a of electricity and app. 65,000 MWh/a of useable heat.
- The possible power capacity for the sustainable scenario is 5 MWel and 6 MWth. The facility is capable to produce app. 43,000 MWh of electricity and app. 48,000 MWh of useable heat.

Non-sustainable scenario: ***58,000 MWh el*** *and* ***65,000 MWh th***
Sustainable scenario: ***43,000 MWh el*** *and* ***48,000 MWh th***

3.9.1.2 Biogas from silages and maize straw mix for power generation

Using a mix of maize straw from the current production of corn-maize is a possibility to reduce the demand for farmland for producing biogas substrates. In this case the maize straw needs to be processed (cut and shredded) before being fed into the fermenters. According to the experiences in the biogas plant in Strem (Austria), a maximum of 20% of the needed silage can be replaced by maize straw without creating problems inside the fermenters.

For obtaining the same power capacities in biogas production, the demand for farmland in the 7 MWel scenario is reduced by 1,140 ha and in the 5 MWel scenario by 850 ha.

3.9.1.3 Biogas for direct use or biogas upgrading for obtaining natural gas quality

Biogas can also be used directly for heat applications or transported in a biogas-grid to the location, where the co-generated heat from power generation can be used.

Another practiced possibility is the refinery of biogas by upgrading. A biogas upgrader is a facility that is used to concentrate the methane in biogas to natural gas standards. The system removes carbon dioxide, hydrogen sulphide, water and contaminants from the biogas. Raw biogas produced from digestion is roughly 60% methane and 29% CO_2 with trace elements of hydrogen sulphide (H_2S); it is not high quality enough to be used as fuel gas for machinery. The corrosive nature of H_2S alone is enough to destroy the internals of a plant. The solution is the use of biogas upgrading or purification processes whereby contaminants in the raw biogas stream are absorbed or scrubbed, leaving more methane per unit volume of gas. There are four main methods of upgrading: water washing, pressure swing absorption, selexol absorption, and amine gas treating.

The most prevalent method is water washing where high pressure gas flows into a column where the carbon dioxide and other trace elements are scrubbed by cascading water running counter-flow to the gas. This arrangement could deliver 98% methane with manufacturers guaranteeing maximum 2% methane loss in the system. There are several facilities in Europe which are upgrading biogas and feeding it into at the natural gas grid. The economic viability is depending on the feed in tariffs in the respective country.

Upgrading of biogas, based on the data used above would deliver:

- 123,000 MWh of biomethane (1.23 million m^3) per year in the non-sustainable scenario
- 92,000 MWh of biomethane (920,000 m^3) per year in the sustainable scenario

Non-sustainable scenario: ***123,000 MWh***
Sustainable scenario: ***92,000 MWh***

3.9.2 Scenario 2: Short rotation coppices - Potentials and possibilities

A short rotation coppice (SRC) is the practice of cultivating fast-growing trees on farmland with harvesting periods between 3 and 5 years. The coppices consist of willows or poplars, in dry areas also of locusts. The harvest is normally done with a field chopper and the wood chips need to be dried in order to gain a reasonable heating value.

For further calculations the „20%-scenario“ as described before is used.

3.9.2.1 Power generation from SRCs

Wood chips from SRC can be used for fuelling a combined-heat-power process. The electrical efficiency of such a CHP unit is about between **15% and 30%**, depending on size and used technology, most facilities have efficiencies around 20%, so this ratio is also used for the calculation.

Power generation can be done either by external combustion of the biomass and the compression and expansion cycle of a working fluid (steam turbine, ORC, stirling motor etc.) or by thermal gasification of the biomass and the internal combustion of the resulting gas in a gas engine.

- The possible power capacity for the non-sustainable scenario is 7 MWel and 21 MWth. The facility is capable to produce app. 45,800 MWh of electricity and app. 137,300 MWh of useable heat.

- The possible power capacity for the sustainable scenario is 5 MWel and 16 MWth. The facilty is capable to produce app. 34,200 MWh of electricity and app. 102,600 MWh of useable heat.

Non-sustainable scenario: ***45,800 MWh el*** *and* ***137,300 MWh th***
Sustainable scenario: ***34,200 MWh el*** *and* ***102,600 MWh th***

3.9.2.2 Heat generation from SRCs

Wood chips from SRCs are used in buildings for operating central heating’s or for providing district heat by energy central.

Another possibility, already practiced, is the use of processed SRC-wood for the production of pellets (for central heating’s) and briquettes (for single furnaces).

- For the non-sustainable scenario 45,700 t/a of biomass with an energy content of 228,900 MWh could be harvested

- In the sustainable scenario 34,200 t/a of biomass with an energy content of 171,100 MWh could be harvested.

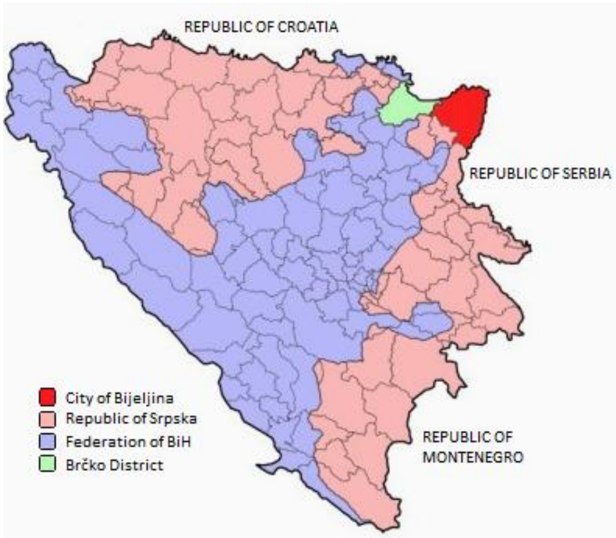
Non-sustainable scenario: ***228,900 MWh***
Sustainable scenario: ***171,100 MWh th***

4 Description of the project area Bijeljina

4.1 General data of the geographical situation / climate of Bijeljina

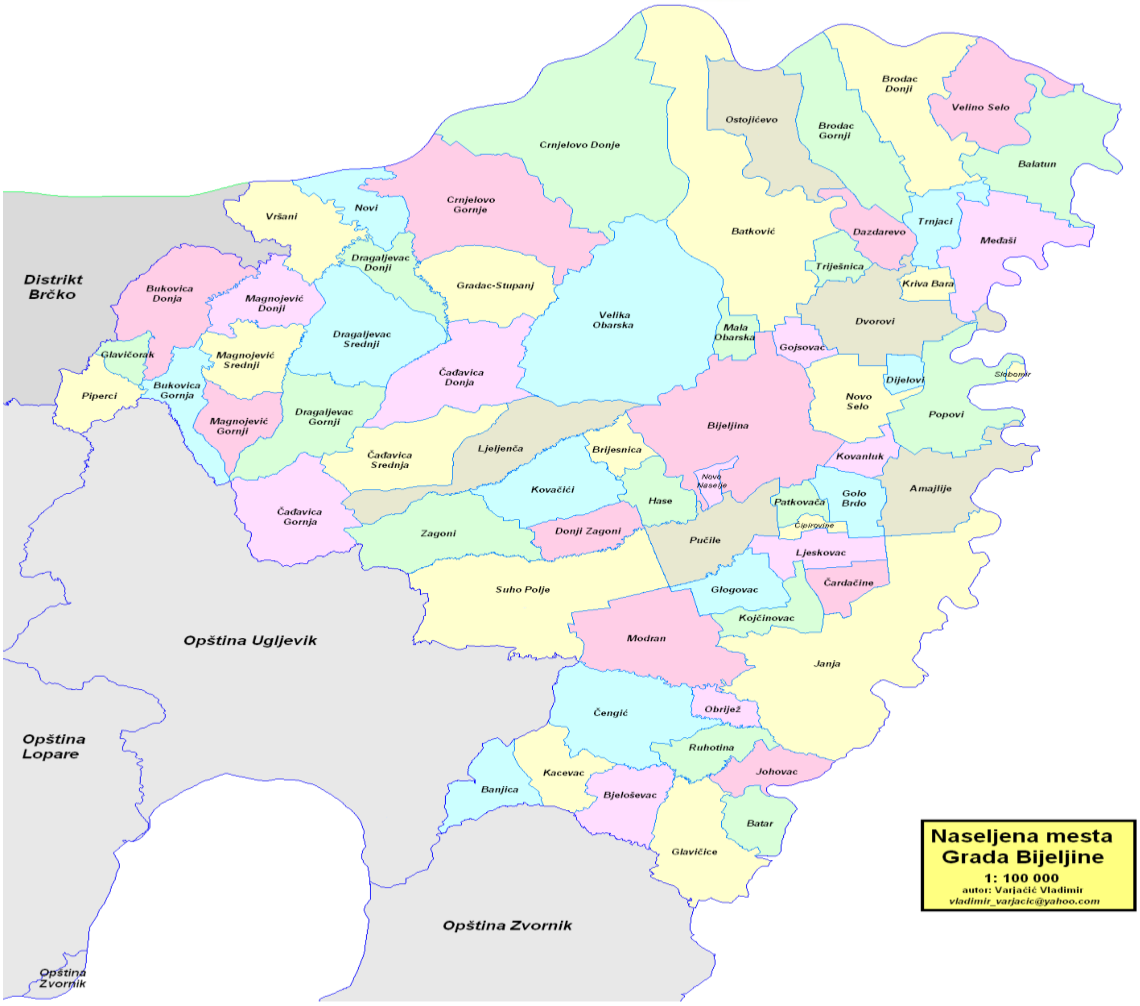
The City of Bijeljina is the most important centre of the region of Semberija, Majevica and part of Posavina. It occupies an area of 734 km^2 and borders the municipalities of Brčko, Lopare, Ugljevik and Zvornik. It is located in the north-eastern part of the Republic of Srpska and Bosnia and Herzegovina, and with its position in Semberija lowland and an average elevation of 90 m, it is their most fertile region.

The east and west boundaries have the following coordinates: Y1 and Y2 = 6608 = 6573 and 4976 = abscissa X1 and X2 = 4937 km, which makes a square with sides Y = 35 km and X = 39 km.



Graphic 12: On the left hand side is the geographical location of the Bijeljina in Republic of Srpska and Bosnia and Herzegovina, on the right hand side is the Mesoregion Bijeljina (Soruce: Ministry of Security of Bosnia and Herzegovina; http://hr.wikipedia.org/wiki/Datoteka:BH_municipality_location_Bijeljina.png; http://sps.gov.ba/index.php?option=com_content&view=article&Itemid=15&lang=ba&id=6)

The City consists of 67 settlements. According to the Population Census 2013, the total population in the city of Bijeljina is 114,663 with 34,651 households. The central settlement is Bijeljina with 45,291 number of enumerated persons and 14,660 households, and other settlements have a total of 69,372 inhabitants and 19,991 households.



Graphic 13: Location ofthe settlements within the area ofthe City of Bijeljina (Source: http://upload.wikimedia.org/wikipedia/sr/4/43/Bijeljina-naselja.PNG)

The borders of the City of Bijeljina were established with the peripheral borders of cadastral municipalities that are located within the City. Western and southern border is in the area of the mountain Majevica (area under Majevica). On the northern border the City of Bijeljina is connected with the Republic of Serbia - over the Sava River with the border crossing Rača - Sremska Rača. Distance to road border crossing Rača from the city centre is 22 km. On the eastern border there is a bridge crossing Pavlovića most (Slobomir) - Badovinci, over the Drina River which is 10 km away from the city centre, and it also connects the City of Bijeljina with Serbia. In the southern part, the border crossing Šepak-Zvornik is 36 km away.

In terms of traffic, the City of Bijeljina is located in the area in which a number of important routes converge. Bijeljina is located about 50 km from the Pan-European Transport Corridor 10, i.e. highway E-70 Belgrade-Zagreb, which is the main roadway to the western and central Europe, and the rest of the Balkan Peninsula.

Within the existing road network, the orientation of the main roads is in the direction Rača - Bijeljina - Ugljevik - Tuzla (M-18) and Brčko - Bijeljina - Zvornik (M-14.1).

The length of modern network of paved roads is 144 km, which provides good connections to other parts of the Republic of Srpska and Bosnia and Herzegovina, and Serbia and Croatia. The closest border crossing to Serbia is 10 km away and 40 km to Croatia.

4.1.1 Air temperature

Summers are warm with an average temperature of 20-22°C (July), and winters are cold with temperatures of -1°C to -20°C (January). Annual fluctuation of temperature is 21°C -24°C, which is a feature of pronounced continental climate. Vegetation period is 150 - 200 days, with an average temperature of 16°C - 18°C. The average annual air temperature for the period of measurement from 1997 to 2012 was 12.2°C.

Mists are characteristic for river valleys, they are very common and occur throughout the year. The average number of foggy days in the interval from 1997 to 2012 was 52.1 days and the average number of frost days was 82.3 .

4.1.2 Humidity

The average relative humidity in the City of Bijeljina increases from April to December (wettest month in average), and then rapidly decreases from December to April. The average relative humidity is 74.43%.

4.1.3 Cloudiness

Cloudiness is greatest in the winter months - December and January, with a continuously decreasing to July. The annual average of cloudiness is 5.9 tenths, using a scale of 0-10 (0 means complete clearness and 10 means total cloudiness). The data refer to the period of measurement from 1997 to 2012.

4.1.4 Insolation

Insolation lasts for 1800 - 1900 hours per year, which is 4.9-5.2 hours a day. The insolation is highest in summer and lowest in winter.

4.1.5 Percipitation

The annual sum of precipitation is 754.2 mm of sediment in the form of rain or snow. The highest average precipitation is in the period May-July (about 33%) and lowest is in the period January-March (about 20%) of the total annual precipitation. Number of snowy days is in the range 16-57, i.e. an average of 37 days, and the average number of rainy days is 130.7.

4.2 Demographic development and structure Bijeljina

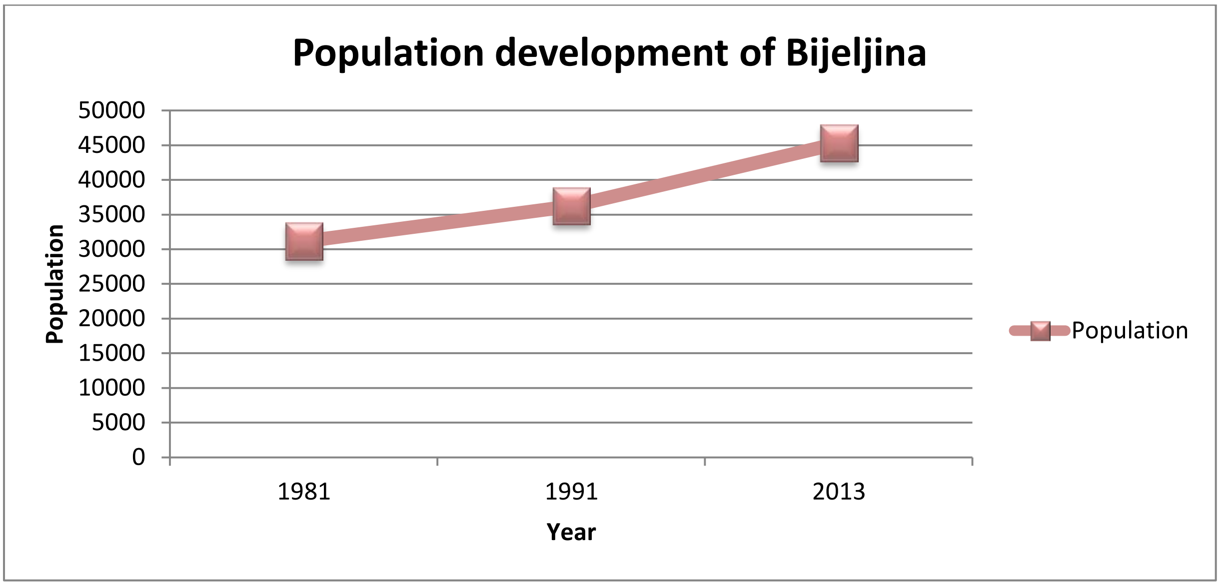
4.2.1 Population and households

According to preliminary result of the official 2013 census of population, the city of Bijeljina has 114,663 inhabitants and 34,651 households (Institute of Statistics of the Republic of Srpska).

This number is 8.6% of the total population of the Republic of Srpska (1,326,991), which makes the city of Bijeljina the second largest city in the Republic of Srpska. The population of the city of Bijeljina is 3.02% of the total population of Bosnia and Herzegovina (3,791,622), and it is the fifth largest city in Bosnia and Herzegovina, after Banja Luka, Novi Grad Sarajevo, Tuzla and Zenica.

The relationship between the number of births and number of deaths shows a negative population growth rate. In 2008 the number of live births / number of deaths was 972/1150 and the population growth rate was -178 (Natural increase), and in 2012 this ratio was 956/1303, which represents growth rate of -347 (Natural increase). Also, the number of marriages has a tendency to decrease.

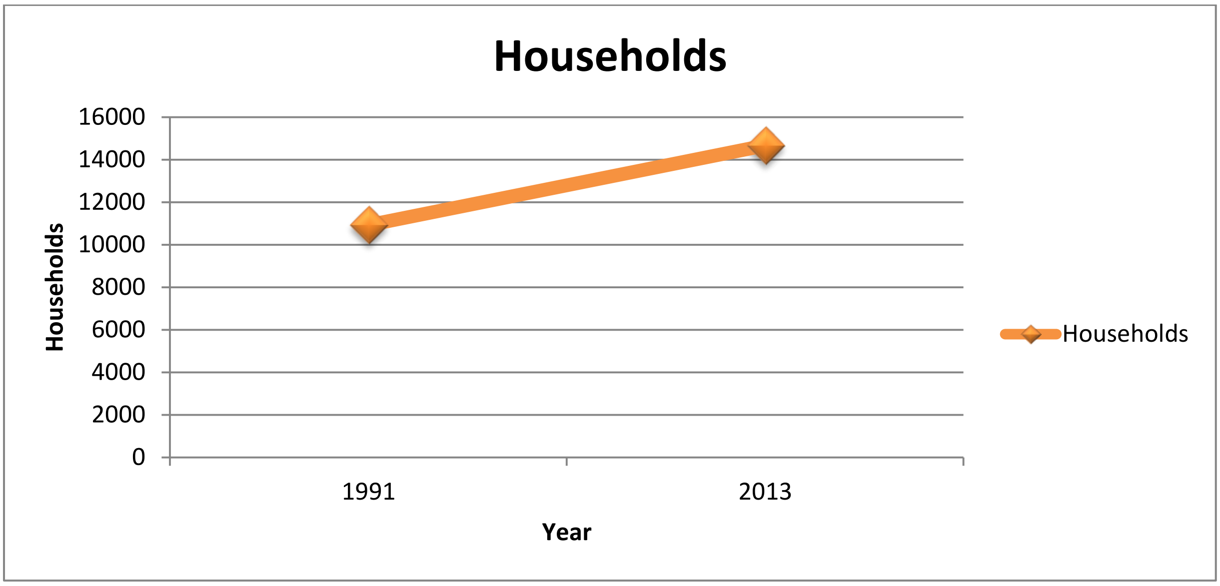
According to estimates, the largest part of population includes citizens between 15 and 64 years of age, and compared to 1991 the proportion of the population older than 65 has increased, which significantly reduced the participation of children and youth. Compared to 1991 there has been an increase in the number of working-age population between 15 and 64 years of age by approximately 35%.



Graphic 14: Population development of Bijeljina (Source: Statistical Office of the Republic of Serbia - Population by nationalities and type of settlements, Census 1981; Statistical Office of the Republic of Serbia, Population by national affiliation and settlements' area, Census 1991, Bosnia and Herzegovina; Institute of Statistics of the Republic of Srpska, 23rd August 2013)

In the period from 2008 until 2012, the internal migrations show that 5,619 persons came to live in the area of the city of Bijeljina, and 2,236 moved away, which shows a positive migration of 3,385 persons for the mentioned period.

Average number of members per household is 3.3. The urban area has 39.5% of the population, and the rest is in rural. Population density is 156 inhabitants per km².



Graphic 15: The structure of households in Bijeljina (Source: Preliminary result of the 2013 Census of Population, Households and Dwellings in BiH, Institute of Statistics of the Republic of Srpska; Institute for Statistic of Bosnia and Herzegovina, 5th November 2013 (Census of Population, Households and Dwellings 1991)

4.2.2 Economy, incomes, national income, expenditure by household

Gross domestic product (GDP) per capita for the city of Bijeljina for 2010 was 6,916.53 BAM. It is higher than the GDP per capita for the Republic of Srpska by 19.3%, and by 8.12% higher than the GDP per capita for Bosnia and Herzegovina. For the period from 2007 to 2011, GDP per capita in Bijeljina is on average 12-15% higher than in the Republic of Srpska and 2-2.5% higher than in Bosnia and Herzegovina. The trend of GDP per capita is shown in the figure below. In the reporting period, GDP per capita in Bijeljina grew by an average of 6.5%. (Strategy for the Development of Local Self-Government in the Republic of Srpska for the period from 2009 to 2015, Institute of Statistics of the Republic of Srpska, the Agency for Statistics of Bosnia and Herzegovina).

<u>Number and Structure of Business Entities</u>

Number of business entities - situation on 31st December

Table 9: Number of business entities – situation on 31st of December2012 (Source: Institute of Statistics of the Republic of Srpska)

	2008	2009	2010	2011	2012
Republic of Srpska	21,835	22,993	24,055	25,173	26,233
Bijeljina	2,198	2,298	2,388	2,495	2,583

Table 10: Number of business entities according to the form of organization (Source: Source: Institute of Statistics of the Republic of Srpska (situation on 31st December 2012))

	Republic of Srpska	The City of Bijeljina
Public companies	181	6
Joint stock companies	2,232	253
Limited liability companies	15,377	1,673
Limited partnerships	3	-
Partnership companies	164	11
Enterprises for the disabled	2	1
Business associations	25	4
General cooperatives	194	21
Specialized cooperatives	228	16
Cooperative unions	5	2
Funds	21	4
Other financial organizations	20	4
Institutions	1,262	99
The legislative and executive authorities	328	2
The judicial and law enforcement agencies	65	5
Associations	5,601	436
Foundations	53	-
Religious organizations / communities	344	3
Foreign NGOs	24	-
Representative offices of foreign entities	46	-
Other forms	58	-
TOTAL:	26,233	2,583

Independent entrepreneurs

The number of registered independent entrepreneurs in 2011 was 3,745 (out of which 34.7% were female entrepreneurs), while according to the Tax Administration of the Republic of Srpska - Regional Centre Bijeljina, independent business activities were performed by 1,842 persons in the city of Bijeljina. The difference in the number of registered and active entrepreneurs is a result of poor practice by which entrepreneurs do not de-register with the competent departments of the city after the cessation of activities. Comparing the number of registered entrepreneurs with the number in 2005 (3,464 entrepreneurs), a mild increase can be observed.

In the framework of entrepreneurial activity, 1,615 trade shops were registered (43.1%), 677 hospitality establishments (18.0%), 923 handicraft shops (24.7%), 322 shops in the field of transport (8.6%) and 208 involved in other activities (5.6%). Also, during the year 2011, 309 entrepreneurial shops were de-registered. As the main reasons for the de-registration, entrepreneurs specified unprofitable operations caused by a lack of jobs, high duties, expensive loans and unfair competition in the form of large enterprises (shopping centres).

Business infrastructure

Business infrastructure in the City of Bijeljina is defined through the existence of three industrial zones with complete infrastructure and with existing facilities.

- *Industrial zone I*

- Surface area is 83.05 hectares, out of which 46 hectares includes existing industrial facilities (companies Elvako, Orao, Sava, Žitopromet);

- Surface area of 32 hectares is designated for the construction of commercial buildings - industrial, small business and craft production, storage and sales and warehouse facilities, and commercial and service activities; also, bus and train stations are planned within this zone.

- *Industrial zone II*

- Surface area of 44 hectares according to the Urban Development Plan of the City of Bijeljina is a separate complex for light industry and small businesses;

- Railway station and a terminal for trucks are planned in the northern part;

- *Industrial zone III*

- According to the Urban Development Plan, this is a surface area of 22 hectares which is defined as a zone for light industry and small businesses, divided into construction plots of 2500-5000 m²;

- In this zone the necessary infrastructure have been built (water, electricity facilities, roads) with access to the second phase of the city bypass.

In contrast to the demographic growth, there has been a sharp decline in the field of economy, which is directly reflected in the low level of employment. The pace of economic recovery is very slow, and realized structural changes are far from expectations. The transport sector was the only to achieve significant growth in the previous period, thanks to the position of Bijeljina, the specifics of the environment and conditions in which people live and work today.

The privatization process is not finished yet, not even in companies where it started much earlier. Most companies that work is characterized by a very low level of capacity utilization, which often ranges between 20-50%, while the situation in trade is the best, since the privatization in this field is completed. Lack of capital, in circumstances where there is no local accumulation and there has been no influx of foreign capital, restructuring of industry is not possible (financial, organizational and production), especially of the former drivers of industrial and economic development. The growth of the service sector is primarily based on the development of the transport sector, which is not the case with other service activities.

The town of Bijeljina has the potential for development of food, metal processing industry, textile, and, footwear and wood processing industry. Given the tradition of the presence of these industries, there is no shortage of qualified and experienced workforce. This, with existing industry infrastructure and natural resources, makes operations and organization of the production process much easier.

The total revenue, though with a certain tendency of growth, is below expectations as a result of a pronounced decline in economic activities, particularly industrial.

Salaries and employees

The average net salary in the city of Bijeljina in 2012 was € 408 and € 676 gross, and in the Republic of Srpska € 419 net and € 692 gross, while the average net salary in Bosnia and Herzegovina was € 422.

At the end of 2012 the total number of employees was 19,837, out of which 11,212 men and 8,625 women. Number of employees in the city of Bijeljina makes 9.86% of the total number of employed in the Republic of Srpska (201,297) and 2.9% of total number of employed persons in Bosnia and Herzegovina (685,117). The most workers (4,196) are employed in the field of wholesale and retail trade and repair of motor vehicles, followed by processing industry with 2,880 workers. 1,621 were employed in the area of public administration and defense and compulsory social security, and 251 in agriculture, forestry and fishing.

According to data from the Employment Agency of Republic of Srpska, the number of persons seeking employment at the end of 2012 was 14,272, which represents 2.6% of the total number of persons seeking employment in Bosnia and Herzegovina. (Institute of Statistics of the Republic of Srpska, Statistical Yearbook of the Republic of Srpska 2013; Agency for Statistics of Bosnia and Herzegovina)

Average monthly expenditure per household

Average monthly expenditure per household in 2011 was ***€ 708.*** Costs for electricity, gas, water and other fuels were € 65, and € 77 for the transportation.

4.3 Regulatory framework and forecasts

4.3.1 Subvention for private sector

Unfortunately there are no subsides for the private households that want to connect to the district heating system. However there are subvention of costs for purchasing and installation of systems for renewable energy sources.

<u>The co-financing costs of purchasing and installing a system for the use of RES</u>

The legal basis for co-financing costs of purchasing and installing renewable energy systems are:

- *The Law on the Fund and environmental financing Republic of Srpska,*
- *Official gazette .RS 117/11 and*
- *The Rulebook on the criteria for the allocation of funding for programs and projects in the field of environmental protection, 2008.*

The mentioned Rulebook envisages the possibility that the beneficiaries of the Fund for environmental protection, among others, may be a private person. The Management Board of the Fund in this work program for the current year priorities for the allocation of funds, and in accordance with the priorities issues a public call for funds. Due to the fact that the Fund is established recently in 2011, and lack of funding for such projects, it is expected that the funding for the installation and use of renewable energy for individuals begin awarding grants in 2014.

4.3.2 Prices of energy and energy sources

4.3.2.1 Regulatory framework for Electricity

The Law on Electricity prescribes that the Regulatory Commission for Energy of Republic of Srpska prepares, produces and passes the methodology and criteria for pricing, tariff system for selling the electricity and the use of the distribution network, incentives for production of electricity, the price structure and the total price of electricity at the power plants and prices for electricity distribution.

The categories of consumption and customer groups are determined by the tariff system, together with tariff elements for determining the amount of electricity supplied and the value of service, and manner of application of positions to calculate the cost of supplied electricity.

The basics of the tariff system are:

- *tariff elements for the calculation of the value of supplied energy and customer service by electricity companies*
- *categories of consumption (depending on the voltage at the point of delivery of electricity, power of devices, purpose of consumption, ways of measuring, etc.)*
- *daily and seasonal periods of the application of different price tariff elements for each consumption category and customer group.*

Tariff elements are:

- *capacity charge*
- *active electricity*
- *excess reactive electricity*
- *fixed charge per measuring point of the customer.*

Prices of electricity

The average price of electricity in the RS in the period 2011-2013 was following:

Table 11: Prices of electricity in Republica Srpska (Source: Institute of Statistics of the Republic of Srpska, 2013)

Source of energy	Unit of measure	Year		
		2011	2012	Jan-Jun 2013
Electricity, high tariff	kWh	0.077 €	0.077 €	0.077 €
Electricity, low tariff	kWh	0.036 €	0.036 €	0.036 €

4.3.3 Regulatory framework for oil and oil products

The Law on Oil and Oil Products it prescribes that the oil derivatives prices are formed in accordance with the market conditions. The Government of the Republic of Srpska may, in cases of difficulties or serious disruption in supply, at the proposal of the Ministry of Industry, Energy and Mining, prescribe the manner of establishing the maximum rates of certain oil products.

Customs is added to the base price of the imported oil products, and all oil products placed on the market are subject to special taxes (excise), road tax and value added tax, in accordance with the regulations of BiH (Law on Excise Duties in Bosnia and Herzegovina).

Prices of oil and oil products

The average price of oil products in the RS in the period 2010-2013

Table 12: Prices of oil and oil products in the Republic of Srpska (Source: Institute of Statistics of the Republic of Srpska, 2013)

€/l	2010			2011			2012			2013		
Month	Petrol 98	Petrol 95	Euro diesel	Petrol 98	Petrol 95	Euro diesel	Petrol 98	Petrol 95	Euro diesel	Petrol 98	Petrol 95	Euro diesel
January	0.96	0.94	0.93	1.07	1.05	1.06	1.18	1.15	1.22	1.21	1.16	1.23
February	0.96	0.94	0.93	1.09	1.07	1.08	1.23	1.19	1.24	1.25	1.20	1.23
March	0.99	0.96	0.94	1.13	1.11	1.13	1.30	1.24	1.28	1.25	1.20	1.22
April	1.00	0.99	0.96	1.15	1.13	1.17	1.34	1.29	1.28	1.23	1.19	1.21
May	1.02	1.01	0.99	1.19	1.17	1.18	1.30	1.25	1.25	1.21	1.17	1.20
June	1.03	1.01	1.00	1.16	1.14	1.15	1.24	1.19	1.20	1.22	1.18	1.20

July	1.03	1.01	1.00	1.17	1.14	1.16	1.23	1.18	1.19	1.22	1.18	1.19
August	1.03	1.01	1.00	1.19	1.17	1.18	1.28	1.24	1.26	1.23	1.18	1.20
September	1.02	1.00	0.99	1.18	1.17	1.18	1.33	1.30	1.29	1.26	1.21	1.23
October	1.01	0.99	0.99	1.16	1.14	1.18	1.28	1.24	1.26	1.24	1.19	1.22
November	1.03	1.01	1.01	1.17	1.14	1.20	1.22	1.18	1.24			
December	1.04	1.03	1.03	1.15	1.13	1.21	1.20	1.16	1.23			

4.3.4 Regulatory framework for thermal energy / district heating

Heating sector in the Republic of Srpska is covered by the following acts:

- *The Law on Energy (Official Gazette, no. 49/09)*
- *The Law on Public Utilities Activities (Official Gazette of the RS, no. 124/11)*
- *The Law on Maintenance of Apartment Buildings (Official Gazette of the RS, no. 16/02 and 65/03)*
- *The Law on Public Companies (Official Gazette of the RS, no. 75/04 and 78/11)*
- *The Law on Obligations (Official Gazette of the RS, no. 17/93 and 74/04)*
- *Decisions on heating plants and networks at local community levels*
- *General conditions of operating at the level of each company*

The Law on Energy is the base low of the energy sector of the Republic of Srpska of which, among other things, defines thermal energy production and related following energy activities:

- *Distribution and management of distribution systems for thermal energy*
- *Supplying thermal energy, and*
- *Trade in thermal energy*

Distribution and supply of thermal energy are energy activities that are of general interest and are carried out in the system of obligatory public service, in accordance with the Law and permit for such activities issued by the Regulatory Commission of the RS. Activity may be performed by a legal entity or entrepreneur who is organized in accordance with the law and who has a permit to perform it in the RS. A permit is not required for the production of thermal energy for own needs up to 0.3 MW of power. The conditions of production and distribution of thermal energy, security of energy facilities and the status of producers and eligible producers of thermal energy that needs to be regulated by a special regulation. Until the adoption of special regulations, this activity is regulated by the Law on Public Utilities Activities.

Prices of heating

The prices of district heating in Bijeljina in the period 2006 -2013 were following:

Table 13: Prices of district heating in Bijeljina (Source: Heating Sistem provides service Public Company "Gradska toplana")

Category of customer	2006/07 €/m^2	2007/08 €/m^2	2008/09 €/m^2	2009/10 €/m^2	2010/11 €/m^2	2011/12 €/m^2	2012/13 €/m^2
residential	1.03	1.23	1.23	1.23	1.41	1.41	1.41
business	2.26	2.75	2.75	2.75	3.02	3.02	3.02

Vehicles

Number of registered vehicles according to the place of registration at PSC Bijeljina, type of vehicle and fuel and ownership:

Table 14: Number of registered vehicles in Bijeljina (Source: Agency for identification documents, registers and data exchange (IDDEEA), 2013)

No.	TYPE OF VEHICLE	TYPE OF FUEL		TOTAL ON 2nd December 2013
		PETROL	DIESEL	
1.	Moped, motorcycle, quadricycle, light quadricycle	852	1	853
2.	Passenger car	12,199	13,702	25,901
3.	Bus	0	2	2
4.	Freight vehicles	41	1,113	1,154
5.	Trailer vehicle	0	0	539 (without engine)
6.	Work machinery	2	35	37
7.	Tractors	0	1,492	1,492
Totally owned by natural persons				**29,978**
No.	**TYPE OF VEHICLE**	**TYPE OF FUEL**		**TOTAL ON 2nd December 2013**
		PETROL	DIESEL	
1.	Moped, motorcycle, quadricycle, light quadricycle	5	0	5
2.	Passenger car	497	753	1,250
3.	Bus	0	57	57
4.	Freight vehicles	79	1,561	1,640
5.	Trailer vehicle	0	1	413 (412 without engine)
6.	Work machinery	0	34	34
7.	Tractors	0	32	32
Totally owned by legal entities				**3,431**

4.3.5 Regulatory framework for coal

The prices of coal are formed on the free market principles and are subject to special regulations.

Prices for coal

Average retail price of brown coal (€/ton) in the household sector according to data of the Institute of Statistics of the Republic of Srpska:

Table 15: Avarage retail prices of brown coal (Source: Institute of Statistics of the Republic of Srpska,2013)

€/ton	Year			
Month	**2010**	**2011**	**2012**	**2013**
January	92.31	107.69	112.82	107.69
February	92.31	107.69	112.82	107.69
March	92.31	107.69	112.82	107.69
April	92.31	107.69	112.82	107.69
May	92.31	107.69	112.82	107.69
June	92.31	107.69	107.69	107.69
July	92.31	107.69	107.69	107.69
August	92.31	107.69	107.69	107.69
September	92.31	107.69	107.69	107.69
October	92.31	107.69	107.69	107.69
November	92.31	107.69	107.69	
December	92.31	107.69	107.69	

4.3.6 Regulatory framework for firewood

Public Company for forestry "Šume Republike Srpske" establishes the price of firewood in the RS. The prices are established on the basis of their own calculations and the situation in the sector.

Regulations are related to the business of PC "Šume Republike Srpske", and the company makes decisions on the prices of timber assortments in the RS, and the price of firewood. The prices of firewood are influenced, among other things, by the existence of private forests and situation in the forestry sector.

Prices of firewood

Average retail prices of firewood according to data of the Institute of Statistics of the Republic of Srpska:

Table 16: Avarage retail prices of firewood (Source: Institute of Statistics of the Republic of Srpska,2013)

€/m^3	Year			
Month	**2010**	**2011**	**2012**	**2013**
January	34.93	34.86	34.25	35.37
February	34.93	34.86	34.77	35.37
March	34.93	34.86	34.25	34.44
April	34.93	34.53	34.25	33.39
May	34.93	34.01	34.25	33.39
June	34.93	34.01	33.72	32.87
July	34.93	33.39	33.72	32.87
August	34.93	33.91	34.25	33.39
September	34.93	34.25	34.25	33.39
October	34.93	34.25	34.25	34.05

November	34.93	34.25	35.37	
December	34.93	33.91	35.37	

5 Energy demand in Bijeljina

The demand for final energy in form of use of energy carriers was calculated referring to all submitted data from the urban municipality of Bijeljina in comparison with data of the *International Energy Agency* (IEA).

Because of the lack of reliable information on industry, the energy demand was calculated only for the municipality and for households. The energy demand of business and industry was estimated from IEA data. The study focusses mainly on electricity and heat, transport fuel energy demand, which is calculated in case of the total energy demand, but not at that detailed level.

The complete energy demand is generally composed from the following elements:

- Heat for buildings (all used energy carriers including electric heating systems)
- Process heat in Industry
- Heat for warm water supply in buildings
- Electricity for building lighting and building services engeneering (pumps etc.)
- Electricity for production applications
- Electricity for street lighting
- Electricity for pumps in sewage disposal and tap water supply
- Liquid fuels for transport and landscape work

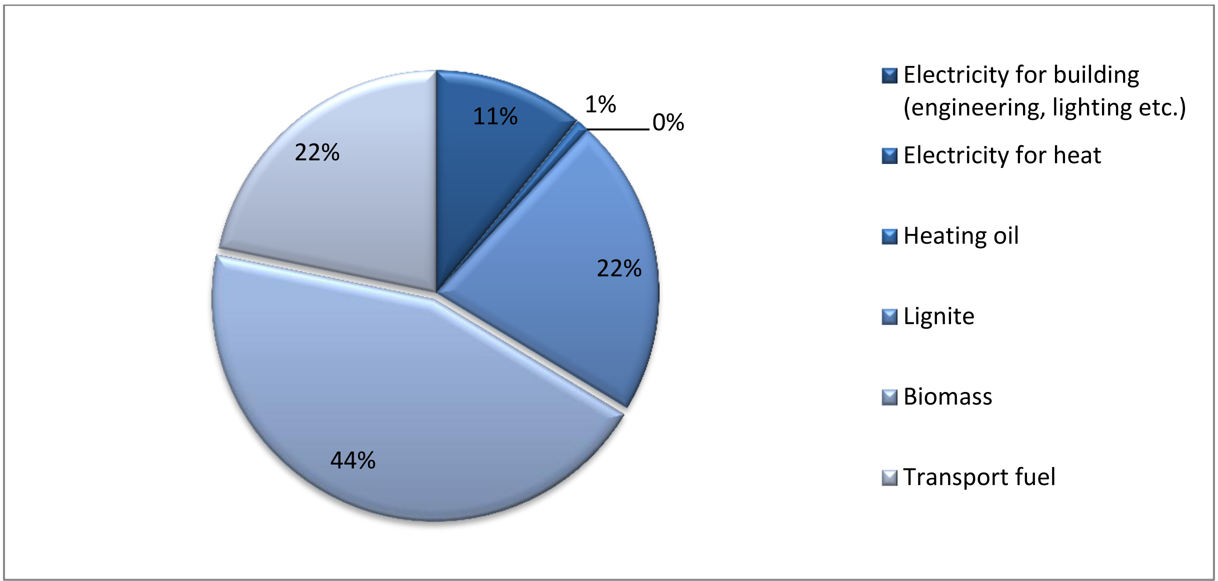
5.1 Energy demand in private sector

The final energy demand of the 28,730 households is shown in Table 17:

Table 17: Residential energy demand in Bijeljina (Source: Calculation EEE, 2014)

Residential energy demand	Final energy in MWh / a	*Share*
Electricity for building (engineering, lighting)	162,593	*11%*
Elictricity for heat	8,916	*1%*
Heating oil	5,315	*0%*
Lignite	329,882	*22%*
Biomass	680,253	*45%*
Transport fuel	327,163	*22%*
Total	**1,514,122**	*100%*

The most used energy carrier in the residential sector is biomass with a share of 45%, followed by lignite and transport fuel, each with 22%. The share of electricity is almost 12%, also illustrated in the next graphic.



Graphic 16: Total share of energy types in private sector demand in Bijeljina (Source: Calculation EEE, 2014)

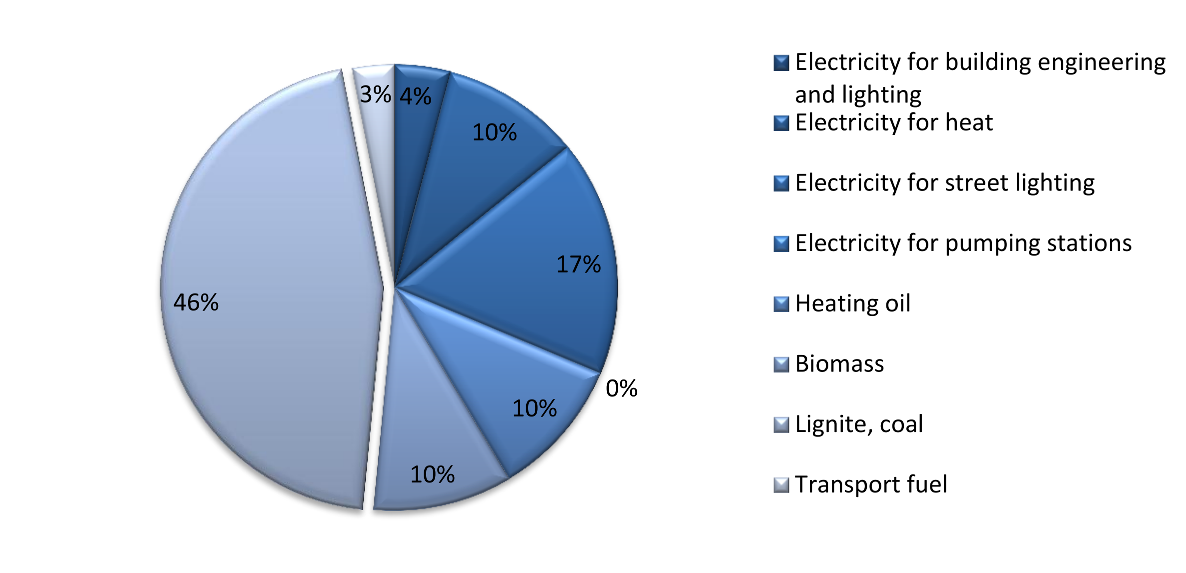
5.2 Energy demand in municipality

The municipal energy demand for Bijeljina is shown in Table 18:

Table 18: Municipal and public energy demand in Bijeljina (Source: Calculation EEE, 2014)

Municipal energy demand	**Final energy in MWh / a**	*Share*
Electricity for building engineering and lighting	900	*4%*
Electricity for heat	2,296	*10%*
Electricity for street lighting	4,111	*17%*
Electricity for pumping stations	-	-
Heating oil	2,387	*10%*
Biomass	2,442	*10%*
Lignite, coal	10,622	*45%*
Transport fuel	744	*3%*
Total	**23,502**	*100%*

Main used energy sources are lignite with a share of 45% and electricity with a share of 31%, also illustrated in the following graphic.



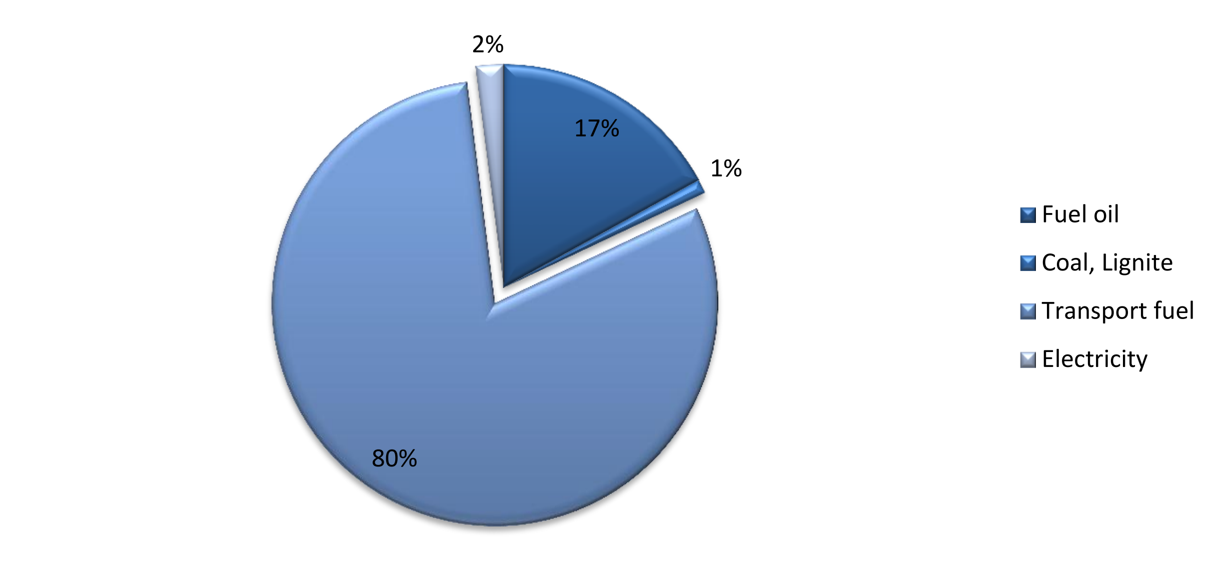
Graphic 17: Total share of energy types of municipality in Bijeljina (Source: Calculation EEE, 2014)

5.3 Energy demand in business and industry

For the business and industry sector some data from 8 major companies could be collected. The energy demand in these companies is described in the Table 19:

Table 19: Business and industry demand by energy carriers (Source: Calculation EEE, 2014)

Energy carrier	Final energy in MWh/a	*Share*
Fuel oil	1,284	*17%*
Coal, Lignite	110	*1%*
Transport fuel	6,114	*80%*
Electricity	167	*2%*
Total	**7,675**	*100%*



Graphic 18: Share of energy carriers in business and industry sector in Bijeljina (Source: Calculation EEE, 2014)

5.4 Energy demand in transport sector

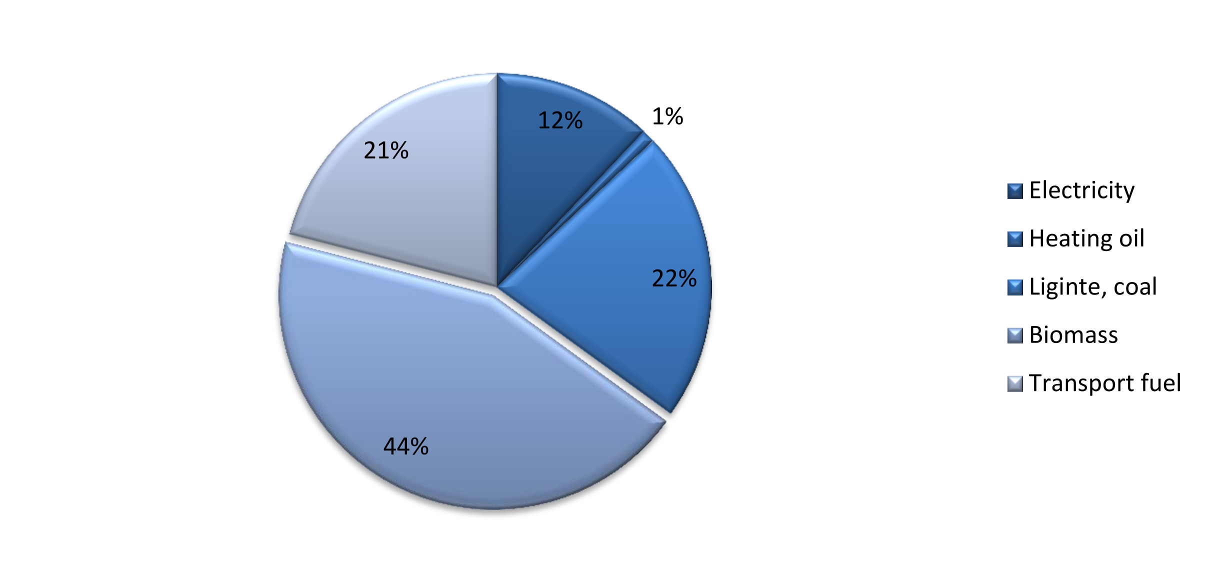
The final energy demand for transport is already treated in the residential and municipal energy demand. Specific data for business and industry could not be obtained.

5.5 Calculable total energy demand

The calculable total energy demand consists of the sectorial energy demands above. Because of lack of data, the energy demand for agriculture as well as for services and industry is not included.

Table 20: Total energy demand by energy carriers (Source: Calculation EEE, 2014)

Energy carrier	**Final energy in MWh**	*Share*
Electricity	178,983	*12%*
Heating oil	8,986	*1%*
Liginte, coal	340,614	*22%*
Biomass	682,695	*44%*
Transport fuel	334,021	*22%*
Total	**1,545,299**	*100%*



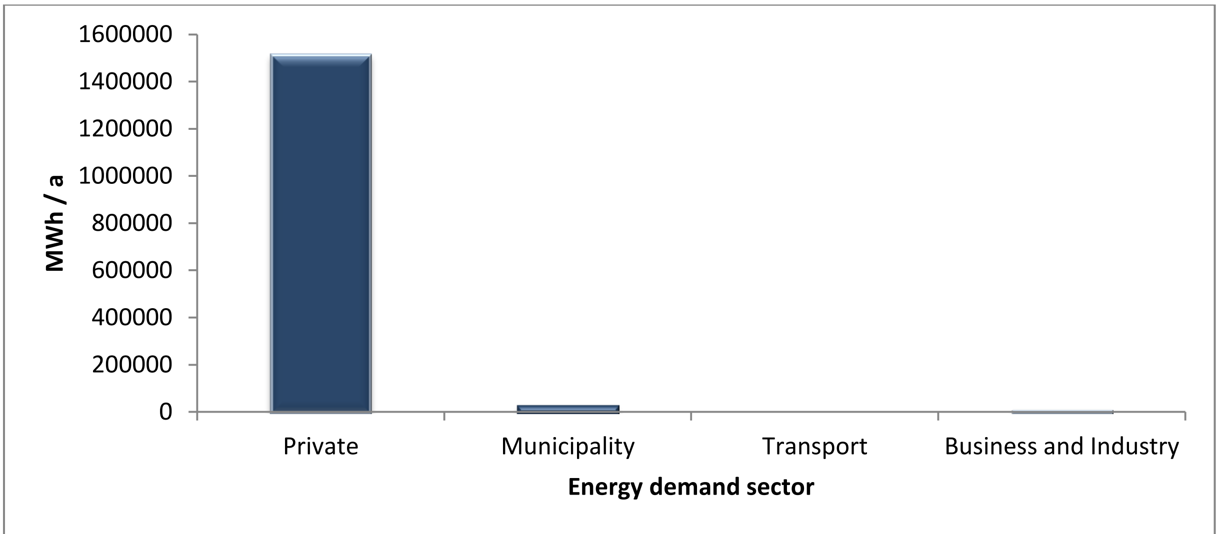
Graphic 19: Total share of energy types of total energy demand in Bijeljina (Source: Calculation EEE, 2014)

The share of electricity is 12%, oil products have a share of 23%. Most used energy carrier for heat is biomass with a share of 44%, followed by lignite with a share of 22%.

Compared to the final energy consumption on national level, biomass has a remarkably high share: 44% compared to 5% (national). Also the share of lignite and coal is higher: 22% compared to 12%. The consumption of oil products is below national average level: 21% compared to 46%.

The following graphic illustrate the share of the energy demand of the individual sectors on the total energy demand. The highest respectively the main demand on the total energy demand has the private sector by a share up to 98%.

Table 21: Share of the demand sectors on the total energy demand (Source: Calculation EEE, 2014)



6 Resources of Bijeljina

The renewable resources potential is calculated on the basis of the received information regarding:

- Forestry
- Agriculture
- Geothermy
- Solar radiation
- Hydropower

6.1 Potential from the forestry sector

The area of forests on the territory of Bijeljina is 10,708 ha.

The annual increment of forestall biomass is currently 4,8 $m^3/ha*a$. This is a rather low amount and results in an annual total increment of about 50,000 m^3 on the regarded territory. This is at the same time the highest amount of wood which could be harvested per year under the aspect of sustainable forestry. In reality, these values are more or less lower.

Due to the information of the Food and Agriculture Organisation of the United Nations, a share of 73% of the harvests in the Republika Srpska is used as technical wood. The minor share of 27% is used for energy purposes (heat supply). These shares are not expected to be applicable also for the territory of Bijeljina, because there is a huge demand for fuel wood to cover the heat supply. The share for fuel wood is set to 67% scenario that means that at least two thirds of the current harvest potential is used for heat supply.

Regarding this distribution the potential from forestry is **34,400 m^3/a**. The energy content of this biomass is **110,000 MWh/a**. Even a 100% scenario for fuel wood could cover only a part of the demand. This scenario would provide **57,000 m^3/a** with an energy content of **182,600 MWh/a.**

The covering rate of the forestry potential thus is about **16%** of the current energy-biomass demand. The maximum covering potential would be **27%** of the biomass demand. Regarding the high demand it can be assumed, that there is no free potential for forestall biomass.

*Useable forestall biomass resources are between **110,000** and **182,600 MWh/a**.*
*Resulting heat load: **85** to **140 MW***
***16%** to **27%** of the current energy biomass demand can be covered.*
This amount of energy should be already in use and there are no further free potentials

6.2 Potentials from the agricultural sector

6.2.1 Agricultural residues

The potential of agricultural biomass from crop residues on the territory of Bijeljina is listed in Table 22. The values are *MWh* of primary energy, but in case of real use, need to be reduced by the efficiency factor of a chosen conversion technology. Additionally, the energy content is calculated in two ways of energy production for:

1. *a scenario based on biomass*
2. *a scenario based on conversion to biogas.*

Table 22: Potentials of the agricultural residues in Bijeljina (Source: Calculation EEE, 2014)

Type	t/a	Combustion scenario MWh	Biogas scenario MWh
Wheatstraw	31,709	152,206	79,274
Barleystraw	7,332	35,194	18,330
Rapeseedstraw	1,245	5,974	3,111
Sunflower	1,082	5,196	2,706
Maizestraw	114,125	547,799	285,312
Total	**155,494**	**746,369**	**388,734**

*Combustion scenario **746,369 MWh.** (Power potential: **21 MWel** and **64 MWth**)*
*Biogas scenario **388,734 MWh.** (Power potential: **12 MWel** and **13.5 MWth**)*

6.2.1 Residues combustion scenario for heat production

The use of *grain straw* in small scale furnaces is problematic because of the low melting point of its ash (800-900°C) and its high content of chlorine. Both factors are causing damage to the furnaces. The conversion of grain straw to useful energy needs special technologies which are only on a larger power scale also economically viable.

Only *maize straw* has an ash melting point which is higher (1 200 °C) and can therefore be used also in small scale furnaces. Nevertheless it needs to be processed and conditioned first and brought into a useable form, like pellets or briquettes.

The theoretical covering rate of the current energy demand is **72%** of the total heat demand. Maize straw can, theoretically, cover **63%** of the heat demand.

This means, that at least the currently used amount of lignite could be replaced by (maize) straw.

*The theoretical covering rate by straw: **72%** of the total heat demand.*

6.2.1 Residues biogas scenario for electricity and heat production

The use of straw for biogas production needs also some processing at the front end of the process. It has to be cut or grinded into small pieces in order to not create problems inside the fermenters. Furthermore, as experience showed, only a maximum share of 20% of straw can be added to the anaerobic digestion to maintain a safe continuous process.

The energy output in a biogas process is lower than in the combustion way, because the digestion is also creating CO_2, which is of no energetic use. The advantage of the anaerobic digestion is the resulting digestate still containing almost all the minerals and nitrogen, which makes it a cheap and very effective fertilizer.

The theoretical covering rate of the current energy demand is about **70 %** of the electricity demand and **14 %** of the heat demand. The share of useable heat drops to 3% if one regards only the heat production through the heating period. For the summer months, different uses need to be found for the co-produced heat.

*The theoretical covering rate of the current energy demand is **70%** of the electricity demand and **14%** of the heat demand.*

6.2.1 Anaerobic digestion of animal manure

Anaerobic digestion of animal manure carries a potential of **16,400 MWh** of electricity and **20,300 MWh** of heat. This would cover 9% of the current electricity demand and 2% of the heat demand. The theoretical electric power potential from animal manure is **2.1 MW**, resulting in a power potential of **2.5 MW** for heat generation.

Since the total live stock is distributed over the territory with few noteworthy concentrations, the chance for economic viable power generation from anaerobic digestion of animal manure seems to be rather small. In the best case a co-fermentation of animal manure, straw and specific green biomass could probably lead to a viable power generation from biogas.

*Theoretical electricity generation potential from manure: **16,400 MWh***
*Theoretical heat generation potential from manure: **20,300 MWh***
*Power potential from animal manure: **2.1 MWel and 2.5 MWth**.*

6.2.2 Specific agricultural biomass production for energy purposes

Biomass for energy generation is one of the possible types of business in farming.

In any calculation of potentials, at least the needed area for food production needs to be excluded. According to experience, farmers are agreeing to use a maximum of 20% of their arable land for energy-biomass production. Thus, depending on the size of the observed territory, the potential of the share of land for energy production can vary between a very low percentage rate and 20%.

The type of energy-biomass to cultivate is depending on the respective type of end use. If the biomass is used in a biogas generation process, the production process will have the same intensity as the one for food or animal alimentation. If the production of combustive material is the goal, extensive forms of cultivation, like short-rotation-coppices (SRC) of willows and poplars can be chosen. SRCs should preferably be sited on areas with low average soil quality and thus low productivity regarding food production. The best quality soils should be reserved for human food production

Of the approximately 48,900 ha of agricultural land, about 27,500 ha are needed for food production, thus remaining 21,400 ha for other purposes. Taking into account also the 20%-scenario described above it seems to be realistic, that an area of 4,000 to 5,000 ha could be used for energy production in the long run.

In case of silo maize for biogas production, the expected energy yield is between 20 and 40 MWh/ha. The same values can be assumed for sorghum. Sorghum is even more resistant to summer droughts than maize. Using the whole share of land for energy production for the cultivation of herbal biogas substrates a biogas plant with the electric capacity of **3.5 MW** could be run.

The energy yield of a SRC is expected to be about **40** to **50 MWh/ha**. In order to replace the currently used lignite by biomass from SRC an area of **10,200 ha** would be needed.

This topic will be discussed closer in the section: Agricultural biomass production

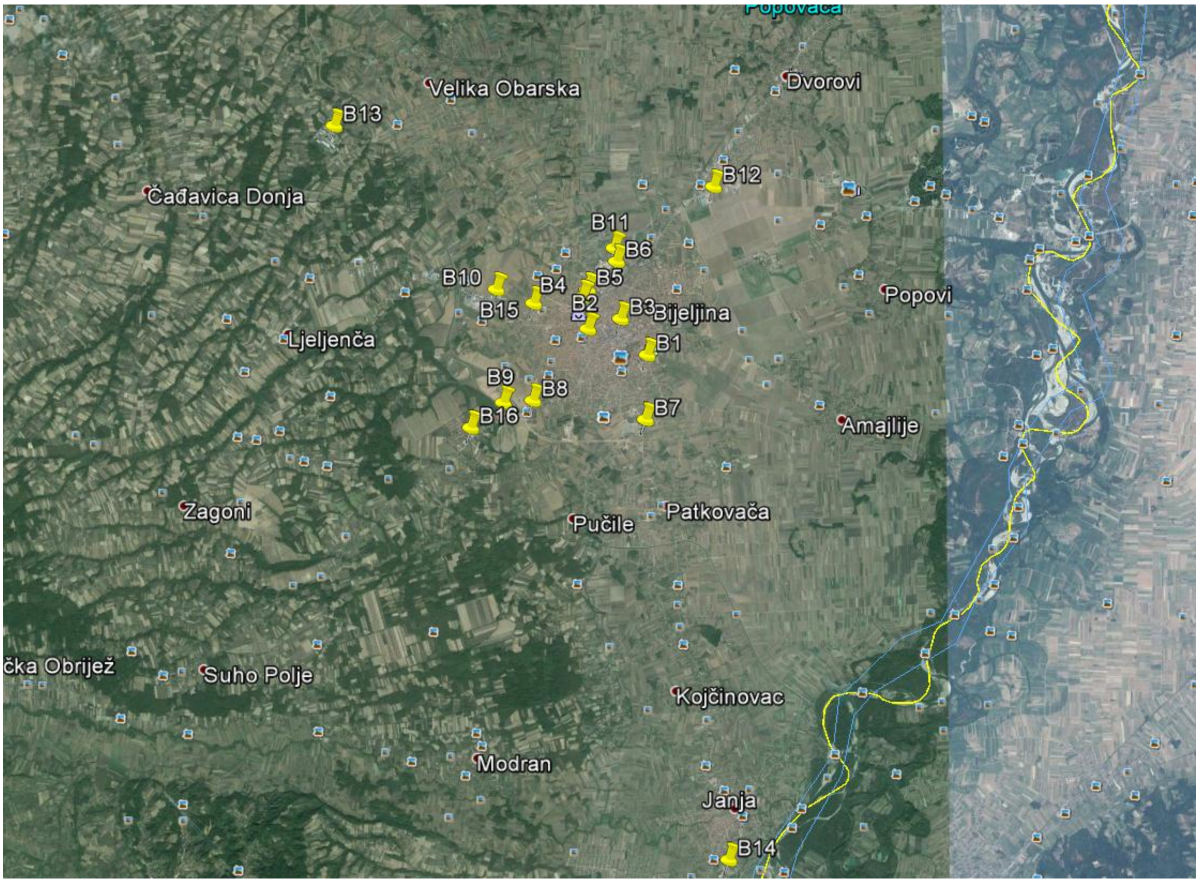
*In the long run, an area of **4,000** to **5,000** hectares could be used for energy production*

6.3 Solar energy potential in Bijeljina

According to the *European solar data service* „Satel-light“, the annual sum of global irradiation on a horizontal surface in the region of Bijeljina is **1 520 kWh/m².** Assuming an average conversion efficiency of 12%, the annual yield of a solar panel with the size of 1 m² can be specified with a value of 182 kWh. A 1 kWpeak facility thus has an output of approximately 1,8 MWh/a.

The analysis of suitable rooftop areas (using satellite images) showed some potential for roof-bound photovoltaic facilities. The total installable power in this case is **4 MW**, which would allow an annual electricity production of **8,500 MWh**. This amount could cover the complete electricity demand for municipal services as street lighting, electric heating in public buildings etc. and about 5% of the total electricity demand.

The locations of the respective rooftops are marked in yellow on the following image.



Graphic 20: The respective rooftops in Bijeljina (Source: Google maps, 2014)

Besides the construction of rooftop facilities there is also the possibility of the construction of ground photovoltaic. In this case a facility with a capacity of 1 MW peak can be installed on an area of 3ha. To cover the current electricity demand of the municipality for public services, for example, a ground facility with the power of 2.5 MW peak is needed.

Installable power on rooftops: ***4 MWpeak***
Annual electricity production: ***8,500 MWh.***

6.4 Organic waste and sewage energy potential

Organic waste and sewage can be a source for renewable energy if they are collected thoroughly and treated systematically. Outside urban areas organic waste is normally composted without creating larger problems. In more or less urban areas the disposal of e.g. used cooking oil through the sewage system can degrade the performance of the sewage system by narrowing the effective diameter of the tubes and thus raise the maintenance costs of the whole system. Because of that many municipalities, mainly in middle and north European countries have started to collect waste oil. The collection is obligatory for hotels, restaurants etc. and voluntary for households. According to experience an amount of 3kg/cap*year can be collected. This cooking oil is converted into biodiesel in a few facilities. Another possibility is to add the waste oil continuously to an anaerobic digestion process to increase the output of biogas.

In the case of Bijeljina the estimated annual amount of waste oil is about **330 t**. Converted into biodiesel, the annual energy yield could be **3,000 MWh**. This amount could cover the energy demand of the municipal fleet and for public transport. The economic viability of a conversion facility would have to be checked.

A conversion into biogas would lead to an annual yield of about **2,000 MWh primary** (of which 640 MWh of electricity, equaling an installed power of 80kWel).

Another type of organic waste is *sewage*. If treated in a central purification plant, the occurring sewage gas can be converted into electricity by use of a gas motor or a micro-gas-turbine. The threshold for an economic viable conversion is the central processing of sewage occurring from about 25,000 inhabitants, which is easily reached or even outperformed by the city of Bijeljina.

In case of Bijeljina, the resulting electric energy from sewage gas is about **1,700 MWh** of electricity. This equals to an installed power of **215 kWel**.

Electric energy from sewage gas: ***1,700 MWh/a***
Installable power: ***215 kW el****.*

6.5 Other potentials (hydro power, wind power, geothermal energy, etc.) in Bijeljina

6.5.1 Wind

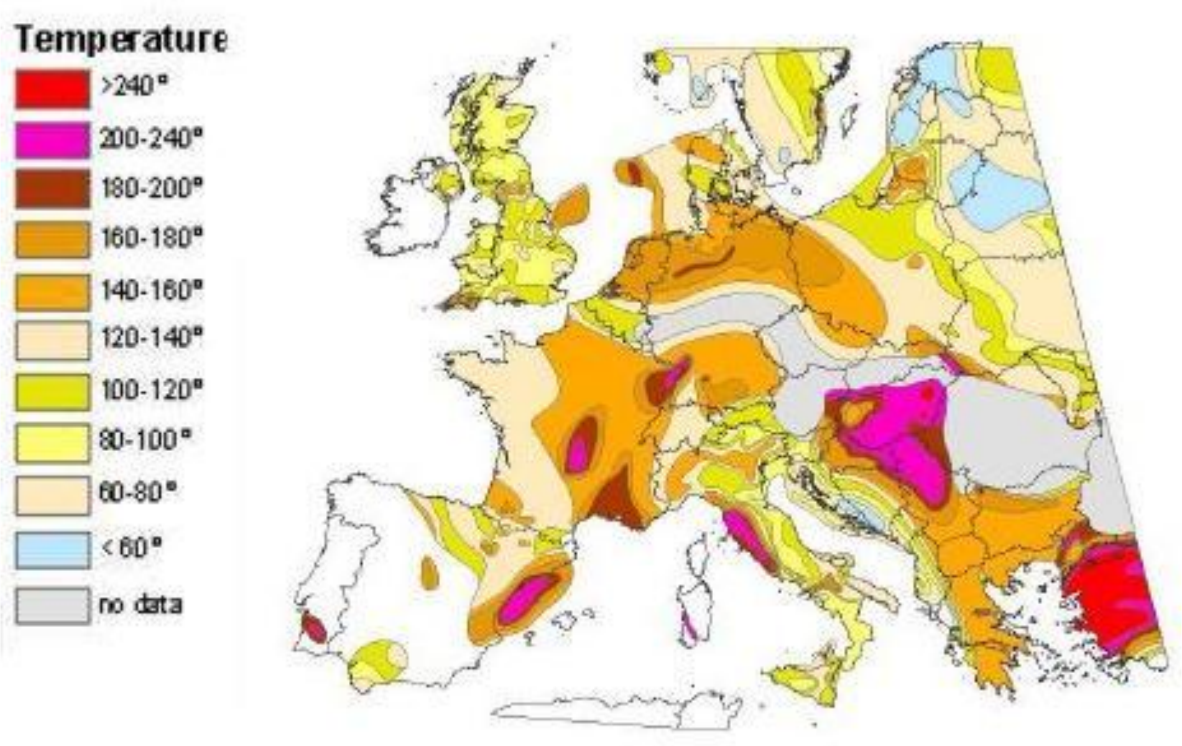
Due to not sufficient average wind speeds in the region, there is no economic viable potential for wind power.

There is no wind potential.

6.5.2 Geothermy

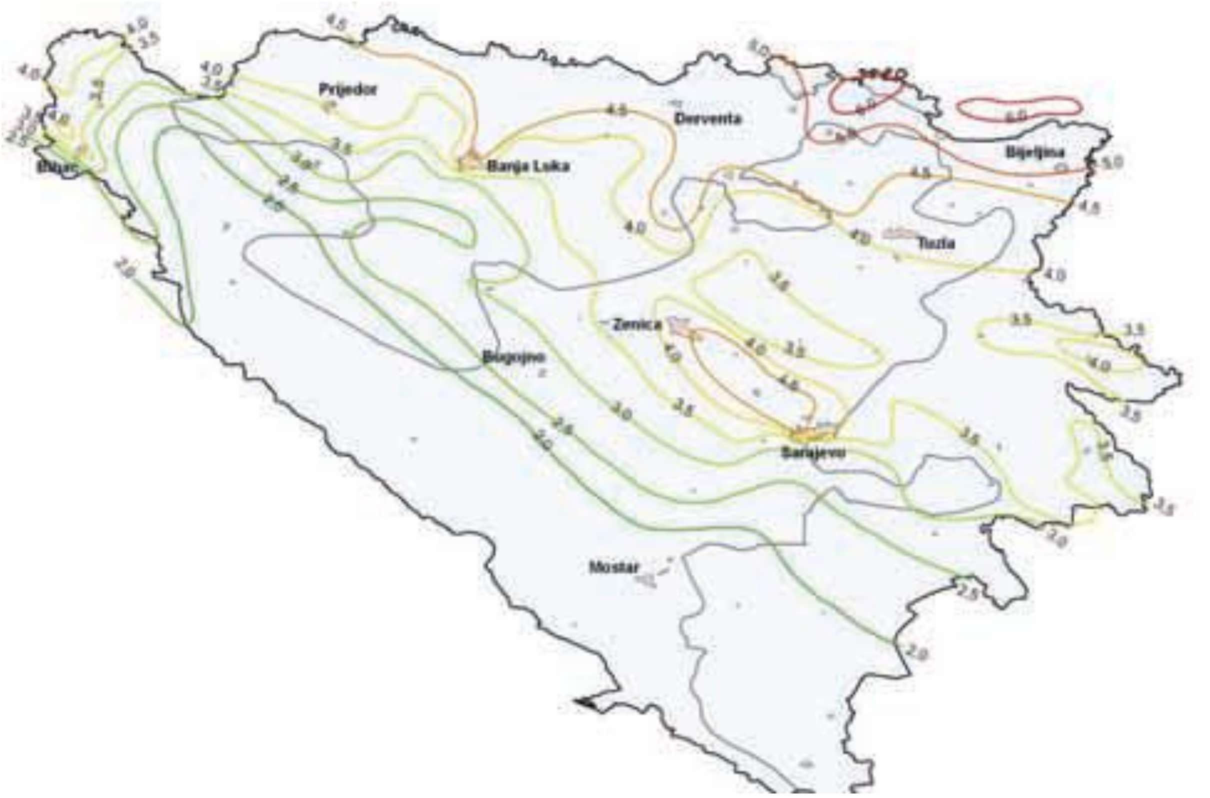
Geothermal energy potentials in B&H have been estimated at **33 MWth**, and northern part of the Republic of Srpska has been estimated as very prosperous region concerning geothermal resources. Region of Semberija is distinguished as very prosperous region.

The main geothermal finding sites are situated in the Triassic and the Cretaceous limestone and they are consisted of reservoirs of geothermal waters with temperature up to 150°C.



Graphic 21: Temperature extrapolated at a depth of 5 km in Europe (Source: http://ec.europa.eu/research/energy/eu/index_en.cfm?pg=research-geothermal-background)

The promising regions for finding, exploitation and utilization of geothermal energy of thermal waters with temperature up to 80°C are: periphery of Višegrad, area Doboj-Maglaj-Teslić, region of Prijedor, Zvornik-Janja. Concerning thermal waters with temperature higher than 80°C, the most promising areas for finding, exploitation and intensive utilization of the geothermal energy are: Semberija, Banjaluka basin, Lijevče polje, peripheries of Brčko, Derventa, Brod, Gradiška and Dubica.



Graphic 22: Geothermal gradients in B&H (Source: Geothermal Power Plants and Possible Development in B&H, Simić, Ikić, 2011)

According to the origin and the type of geothermal energy, Semberija is classified into southern part of the Pannonian Basin. Research of potentialities of this part the Pannonian Basin was conducted in the mid of the last century and several studied have been carried out on the basis of them.

These researches can be divided into several periods and they were conducted with the primary goal of finding of oil:

1. *Period from 1889 to 1915*
2. *Period from 1929 to 1941*
3. *Period from 1948 to 1961*
4. *Period from 1963 to 1973*
5. *Period from 1973*

Thermal water with temperature of 75 °C erupted when the exploratory well had been made in Dvorovi in 1957. And then four more deep borehole were drilled (Bijeljina, Dvorovi DV-1, Popovi, Ostojićevo) and it has been established that there are rock masses with thermal water. Thermal waters temperature in the finding sites in Semberija moves from 60°C to 130°C and the amount is estimated as thermal equivalent to 40 million tons of oil.

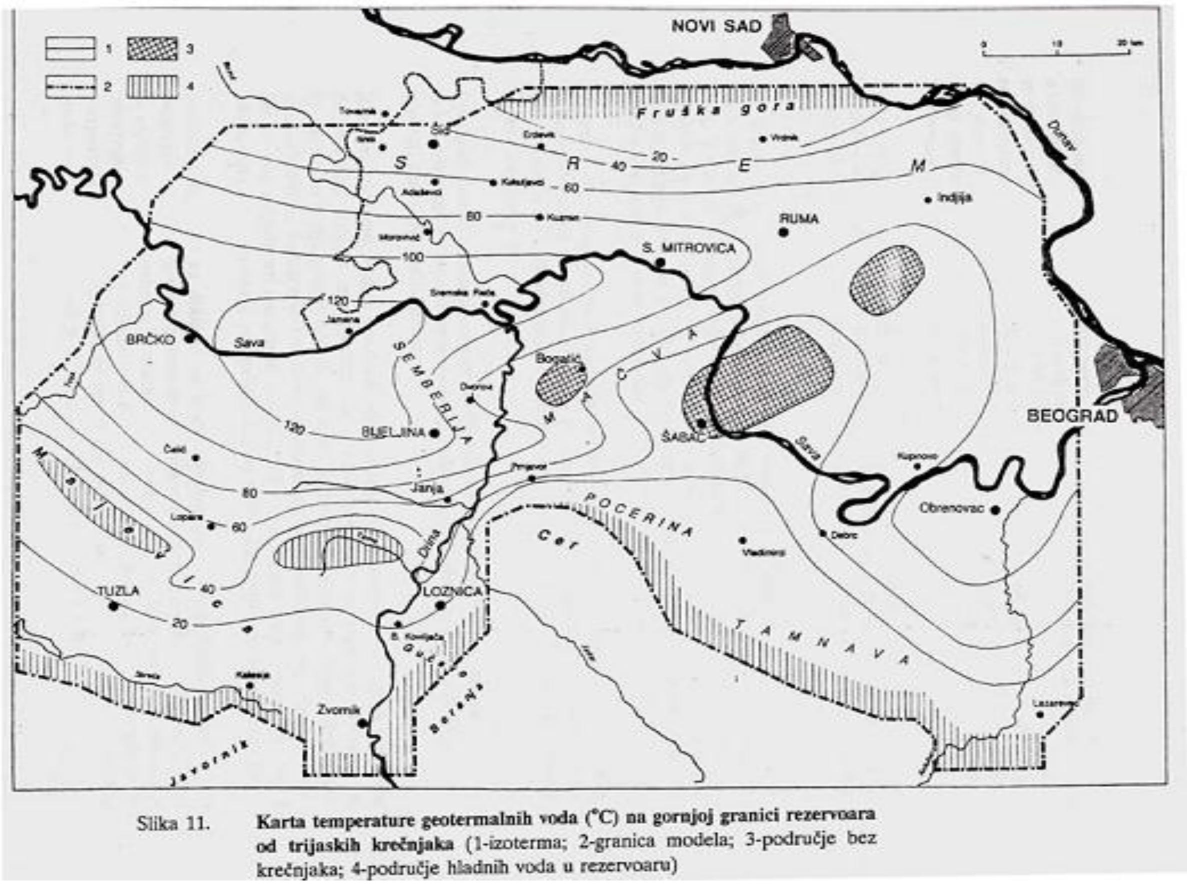
The results of making deep exploratory wells in the region of Semberija and Mačva shows that the Triassic and Cretaceous carbonate sediments have very good collector characteristics.

Geothermal finding sites and their potentials

1. The finding site of geothermal energy in alluvial sediments in Semberija (inside of phreatic aquifer of drinking water)- geothermal resource is heat of drinking water of geothermal origin. Phreatic aquifer water (which is used for drinking) has temperature from 12 to 14 ºC. This heat is used by means of heat pumps for groundwater. Prognosis of geothermal energy reserves calculated through aquifer water reserves amounts from 0,4x1012 KJ/year to 2x1012 KJ/year. Considering the exploitation possibilities of phreatic aquifer, the number of geothermal energy users is practically unlimited.
2. The finding site of geothermal energy in Plio-Quarternary and Neogene's sediments (inside sediment rock masses of the Plio-Pleistocene and the Neogene age) – geothermal resource is rock mass heat with function of hydro-geological insulator and heat of thermal water in artesian aquifer inside sandy horizons in the mentioned sediments. Temperature of this water moves from 15 to 20 ºC. Geothermal potential of this whole packet is about 5x106 tones of thermal oil equivalent. If this system is used by means of vertical borehole heat exchangers (the work of heat pumps in the closed systems), the number of possible users of this geothermal resource is practically unlimited.
3. The finding site of geothermal energy in the Upper- Triassic limestone – geothermal resource is heat of thermal waters in artesian aquifer. Temperature output >75ºC. Exploitation of these thermal waters is used for heating and balneotherapy in Dvorovi. The assumption is that the finding site of these thermal waters spreads throughout the whole territory of the Municipality of Bijeljina. Geothermal potential of these waters amounts around 230x106 tones of thermal oil equivalent. Expected energy reserves of this reservoir is estimated to 57x106 tones of thermal oil equivalent, and reserves only in thermal water around 2x106 tones of thermal oil equivalent. Exploitation from these reservoirs can be carried out only by the way of vertical and sidelong borehole or ''binary'' system.
4. The finding site in the Mid- and Upper-Triassic limestone and dolomite – geothermal resource is heat of thermal waters in artesian aquifer. The assumption is that these rock masses represents the main hydro-geothermal reservoir on the territory of Bijeljina (based on the results of the research made in Mačva and making of the deep borehole in Semberija). Temperature outlet from this reservoir will be 80-130ºC. The reservoir potential is about 1170x106 tones of thermal oil equivalent. Expected geothermal energy reserves in it (rock +water) amount around 315x106 tones of thermal oil equivalent, and only in thermal water around 2x106 tones of thermal oil equivalent. Exploitation is possible by the way of vertical and sidelong boreholes and ''binary'' system. On the base of this geothermal finding site it is possible to form geothermal sources for the largest consumers of heat power 50-100 MWt. (Source:

Milivojević Mihailo, Energy Potential of Geothermal Resources in Semberija, Faculty of Mining and Geology, Belgrade, 1986).

The geothermal potential of Bijeljina and its environs is excellent. The geothermal gradient is one and a half times higher than the European Continental average, and it correlates with the best European territories. The chart below shows that the area can be directly connected to the southern region of the Pannonian Basin with outstanding potential.



Graphic 23: Connections of Semberija with the Pannonian Basin (Source: Milivojević Mihailo & Martinović Mića, Possibilities intensive exploitation of geothermal energy in Semberija and strategy development - Projection and Development of Economic Potential of Spas, Tourism and Catering Industries in the Republic of Srpska, 1996).

Geothermal resources Semberije were discovered in 1957. The later development of exploration wells in Dvorovi came after an eruption of thermal water with a temperature of 75°C. After that, they drilled four deep wells (Bijeljina, Dvorovi Dv-1, Popovi, Ostojićevo) during which the presence of rock masses with thermal water, but no one was without service. The temperature of the thermal water sites in the Semberije of 60°C - 130°C and the amount is estimated as the thermal equivalent amount of about 40 million tons of oil.

The current level of research indicates that geothermal energy can be a source of energy for all the needs of low temperature to 100°C. Complete utilization of geothermal energy includes a wide range of areas from which the most important are: *heating, cooling, Balneology, agriculture, industry, aquaculture, tourism* and so on.

A detailed analysis of the level of conceptual design shows the possibility that the geothermal energy can be used for the whole heating system in Bijeljina (23,600 + housing industry). For these purposes, the required amount of thermal water is **T = 80 °C, 850 l/sec**. The maximum heat output of the geothermal heating system for such a complete heating system is **280 MW.**

Geothermy is one of the most promising renewable energy sources in the region. The usability of geothermal hot water is depending on the spring delivery and the temperature level of the geothermal wells.

To use the geothermal water for district heating as well as for electricity production by means of an organic-rankine-cycle (ORC) process the necessary drillings need to be brought down to a depth of at least 1,500 m, according to the data submitted by the urban municipality of Bijeljina. In these depths temperature levels of at least 80°C, needed for ORC electricity generation would be reached. An applicable working fluid at the given temperature level is perfluoropentane.

The electric efficiency of an ORC-process is between 8% and 18% of the thermal primary input, depending on the temperature level and the delivery of the wells.

Referring to the submitted data, the resulting electric capacities can be expected to be within a range of 4 MW to 20 MW (based upon the thermal capacities of 50 to 100 MW). The minimum electricity production from this potential is ***34,400 MWh***, the minimum heat production in form of district heat is ***75,000 MWh***.

*The minimum electricity production from this potential is **34,400 MWh**, the minimum heat production in form of district heat is **75,000 MWh**.*

6.5.3 Hydropower

According to the submitted data by the municipality of Bogatić, the hydropower potential of the Drina at the Bosnian-Serbian border is about **93 MWel**, with an annual electricity output of about **340,000 MWh**.

*The hydropower potential of the Drina at the Bosnian-Serbian border is about **93 MWel**, with an annual electricity output of about **340,000 MWh**.*

6.6 Comparison of already available resources & current energy demand in Bijeljina

56% of the energy demand is covered by fossil sources and 44% by renewable ones in the form of biomass.

The most used energy carrier is biomass with a share of 44% of the total energy consumption. Only 1% of the electricity is used for heat applications. If heat applications are excluded, the electricity demand drops to a value of about 171,300 MWh/a. Thus, the power demand for electric heating equals at least 1.2 MW, whereas the power demand for non-heat applications equals 21.5 MW.

Only 1/3 of the total demand for biomass can be obtained from local sources in the form of forestall biomass, the remaining 2/3 are obviously coming from outside the project region. Thus, the potential of forestry is already in full use and the energy development has to concentrate on other resources for energy supply.

- Lignite, as a fossil energy carrier with noxious emissions, due to insufficient combustion in inefficient furnaces, needs to be replaced as fast as possible.
- Rising the share of local biomass in energy supply
- The co-generation of electricity and heat from local resources can provide electricity to the grid and clean, non-fossil heat in an expanded district heating system for the city.

Substitution of lignite

From the point of view of renewable energy supply there is a big potential for heat supply by agricultural residues. The problem in the use of this resource could be that they have to be processed and compressed before being used as pellets or briquettes in furnaces.

Rising the share of local biomass in energy supply

The large potential of agricultural residues can and should be developed in various ways. It can be used for direct combustion or as a co-substrate for anaerobic digestion. In case of electricity generation from biomass it has to be made sure, that also the resulting heat from the process gets used in a productive way.

Co-generation of electricity and heat from local resources

Heat and electricity from geothermy are bound to high exploration costs and are depending on temperature levels and abundance of the developed wells. This potential needs closer research and cannot be treated sufficiently in this study.

Photovoltaic on rooftops can deliver 8,500 MWh/a

The potential of organic waste and sewage treatment can deliver 2,300 MWh/a

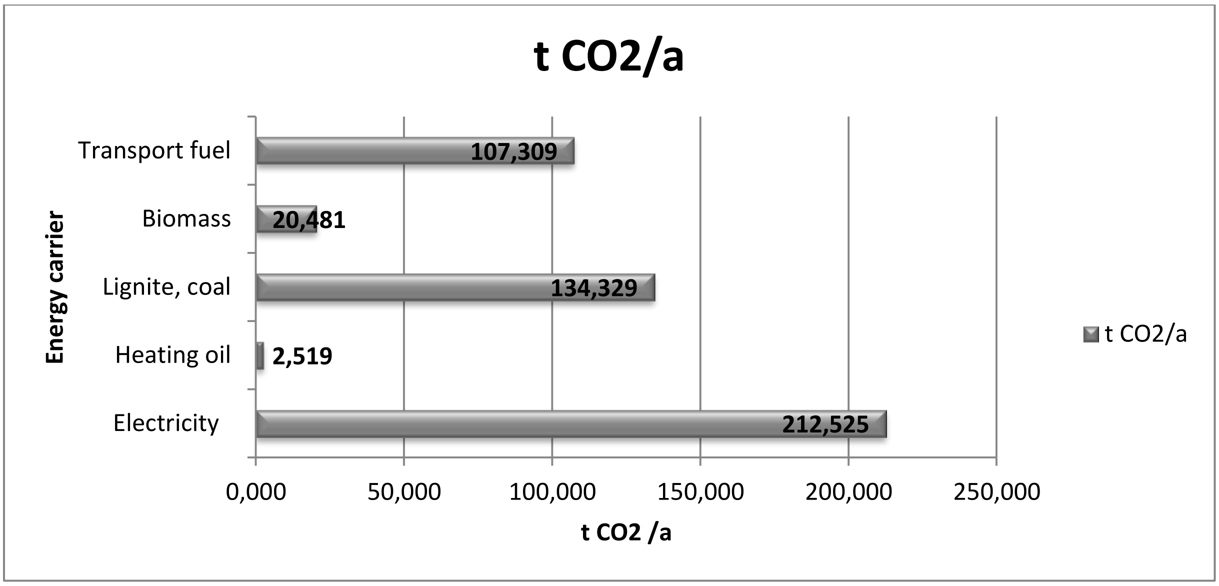
Agricultural residues as well as silage can be used for co-fermentation in biogas plants, but the development of this potential needs to be sketched in scenarios for agricultural use in combination with feasibility studies, which will follow later on. The resource scenarios are outlined in the following chapter regarding biomass production scenarios.

In any case, the city of Bijeljina has the sufficient size and is structured in a way that co-generation and heat distribution in a district heat grid could be economically viable and should be checked by a feasibility study.

The development path should focus on the reduction of lignite and thus raising the share of local biomass in energy supply, also by implementing co-generation of heat and power.

6.7 CO_2 emissions

The CO_2 emissions are calculated according to the directions of GEMIS (**G**lobal **E**mission **M**odel for **I**ntegrated **S**ystems). GEMIS was first released in 1989, and is continuously updated and extended since then. It is used by many parties in more than 30 countries for environmental, cost and employment analyses of energy, materials and transport systems. The calculation according to GEMIS do not only consider the CO_2 emissions during the generation or combustion process, but also the emissions which are occurring in the provision chain but also in the disposal route and is thus a full lifecycle emission analysis tool for products and energy carriers.



Graphic 24: CO2 emissions by energy carriers in Bogatić (Source: Calculation EEE, 2014)

The highest share in CO_2 emissions is held by electricity with a rate of 45%, followed by lignite with a share of 28% and transport fuel with a share of 22%. The emissions of biomass are located at a share of only 4%, compared to its share in energy supply, which is 44%.

6.8 Estimated energy costs

Based on the calculations regarding the energy demand, also the average annual costs for energy supply have been calculated. The results are shown in Table 23.

Table 23: Estimated energy costs by energy carriers in Bijeljina (Source: Calculation EEE, 2014)

Energy carrier	Energy costs in €	*Share*
Heating oil	939,644	*1%*
Lignite	6,452,538	*10%*
Biomass	6,146,107	*9%*
Electricity/other	10,294,242	*15%*
Transport fuel	43,939,538	*65%*
Total	**67,772,069**	*100%*

6.9 Agricultural biomass production scenarios

As stated in the section 6.2.5: *"Specific agricultural biomass production for energy purposes"*, the theoretical as well as the technical potential of agricultural biomass is depending on scenarios. The scenarios are depending on the chosen development path for energy production and the aspects of sustainability.

According to experiences in Austria and Germany, farmers are ready to use a rate of 20% of their farmland for the production of biomass for energy purposes.

6.9.1 Scenario 1: Bogas – potentials and possibilities

The information regarding the production potential for green maize is showing a range between 22 and 40 t/ha*a. Based upon this range 20-40 MWh of biogas per hectare can be expected. For the following calculation a value of **31 t/ha*a** (average) will be used, which results in an output of primary energy of **30.7 MWh/ha** in the form of biogas, capable to generate **10.1 MWh** of electricity which can be fed into the electric grid and **11.4 MWh** of useable heat, if a gas engine with an electrical efficiency of 33% is used. The remaining difference consists of the facility´s own requirements and some losses. The same values can be inserted also for sorghum.

6.9.1.1 Biogas from silages for power generation

For a biogas facility with 1 MW electric power (generated by a gas engine) an area of 790 ha is needed for providing the substrate in form of silages from maize or sorghum.

In a non-sustainable-scenario, the 20% rate of the existing farmland is represented by 9,800 ha. For the sustainable scenario, which takes into consideration also the necessary farmland for food production, the 20% scenario ends up in 4,300 ha of farmland.

- The possible power capacity for the non-sustainable scenario is 12 MWel and 14 MWth. The facilty is capable to produce app. 99,100 MWh of electricity and app. 111,200 MWh of useable heat.
- The possible power capacity for the sustainable scenario is 5 MWel and 6 MWth. The facilty is capable to produce app. 43,000 MWh of electricity and app. 48,000 MWh of useable heat.

*Non-sustainable scenario: **99,100 MWh el** and **111,200 MWh th***

*Sustainable scenario: **43,000 MWh el** and **48,000 MWh th***

6.9.1.2 Biogas from silages and maize straw mix for power generation

Using a mix of maize straw from the current production of corn-maize is a possibility to reduce the demand for farmland for producing biogas substrates. In this case the maize straw needs to be processed (cut and shredded) before being fed into the fermenters. According to the experiences in the biogas plant in Strem (Austria), a maximum of 20% of the needed silage can be replaced by maize straw without creating problems inside the fermenters.

For obtaining the same power capacities in biogas production, the demand for farmland in the no-sustainable, 12 MWel scenario is reduced by 1,960 ha and in the sustainable, 5 MWel scenario, by 860 ha.

6.9.1.3 Biogas for direct use or biogas upgrading for obtaining natural gas quality

Biogas can also be used directly for heat applications or transported in a biogas-grid to the location, where the co generated heat from power generation can be used.

Another practiced possibility is the refinery of biogas by upgrading. A biogas upgrader is a facility that is used to concentrate the methane in biogas to natural gas standards. The system removes carbon dioxide, hydrogen sulphide, water and contaminants from the biogas. Raw biogas produced from digestion is roughly 60% methane and 29% CO_2 with trace elements of hydrogen sulphide (H_2S); it is not high quality enough to be used as fuel gas for machinery. The corrosive nature of H_2S alone is enough to destroy the internals of a plant. The solution is the use of biogas upgrading or purification processes whereby contaminants in the raw biogas stream are absorbed or scrubbed, leaving more methane per unit volume of gas. There are four main methods of upgrading: water washing, pressure swing absorption, selexol absorption, and amine gas treating.

The most prevalent method is water washing where high pressure gas flows into a column where the carbon dioxide and other trace elements are scrubbed by cascading water running counter-flow to the gas. This arrangement could deliver 98% methane with manufacturers guaranteeing maximum 2% methane loss in the system. There are several facilities in Europe which are upgrading biogas and feeding it into a the natural gas grid. The economic viability is depending on the feed in tariffs in the respective country.

Upgrading of biogas, based on the data used above would deliver:

- 210,300 MWh of biomethane (2.1 million m³) per year in the non-sustainable scenario
- 92,200 MWh of biomethane (920,000 m³) per year in the sustainable scenario

Non-sustainable scenario: ***210,300 MWh of biomethane***

Sustainable scenario: ***92,200 MWh of biomethane***

6.9.2 Scenario 2: Short rotation coppices - Potentials and possibilities

A short rotation coppice (SRC) is the practice of cultivating fast-growing trees on farmland with harvesting periods between 3 and 5 years. The coppices consist of willows or poplars, in dry areas also of locusts. The harvest is normally done with a field chopper and the wood chips need to be dried in order to gain a reasonable heating value.

For further calculations the „20%-scenario“ as described before is used.

6.9.2.1 Power generation from SRCs

Wood chips from SRC can be used for fuelling a combined-heat-power process. The electrical efficiency of such a CHP unit is about between 15% and 30%, depending on size and used technology, most facilities have efficiencies around 20%, so this ratio is also used for the calculation.

Power generation can be done either by external combustion of the biomass and the compression and expansion cycle of a working fluid (steam turbine, ORC, stirling motor etc.) or by thermal gasification of the biomass and the internal combustion of the resulting gas in a gas engine .

- The possible power capacity for the non-sustainable scenario is 12 MWel and 36 MWth. The facilty is capable to produce app. 78,300 MWh of electricity and app. 235,000 MWh of useable heat.

- The possible power capacity for the sustainable scenario is 5 MWel and 16 MWth. The facilty is capable to produce app. 34,200 MWh of electricity and app. 103,000 MWh of useable heat.

Non-sustainable scenario: ***78,300 MWh el.*** *and* ***235,000 MWh th***

Sustainable scenario: ***34,200 MWh el. and 103,000 MWh th.***

6.9.2.2 Heat generation from SRCs

Wood chips from SRCs are used in buildings for operating central heatings or for providing district heat by an energy central.

Another possibility, already practiced, is the use of processed SRC-wood for the production of pellets (for central heatings) and briquettes (for single furnaces).

- For the non-sustainable scenario 78,300 t/a of biomass with an energy content of 391,600 MWh could be harvested
- In the sustainable scenario 34,300 t/a of biomass with an energy content of 171,600 MWh could be harvested.

Non-sustainable scenario: ***391,600 MWh***

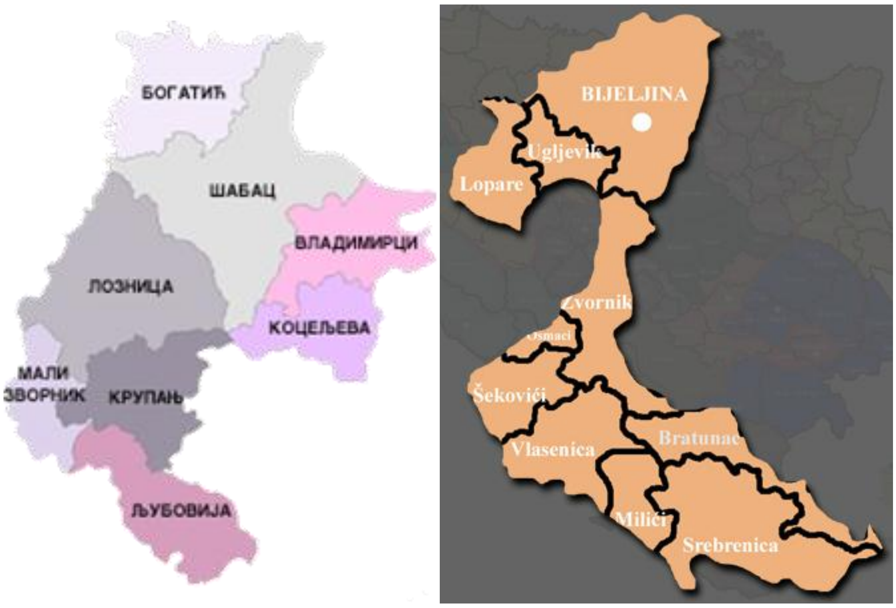
Sustainable scenario: ***171,600 MWh***

7 Summary

The cross border energy concept of Bogatić and Bijeljina can be created by having comparable data of both regions and by contrasting strengths and weaknesses, as well as opportunities and threats.
As a result of this analysis, the energy concept can provide strategies and shape desirable measures in order to improve energy efficiency and the use of renewable and regional resources, based on an intensive exchange of information regarding best practice examples.
To sum up the energy concept, following a overview of both region are given. Based on this data the feasibility studies will be developed for each region.

7.1 General data of Bogatić and Bijeljina

Geographically, climatically and in spatial distribution of settlements, of the two concept regions do not differ very much and the conditions for biomass production and the use of solar energy are similar.

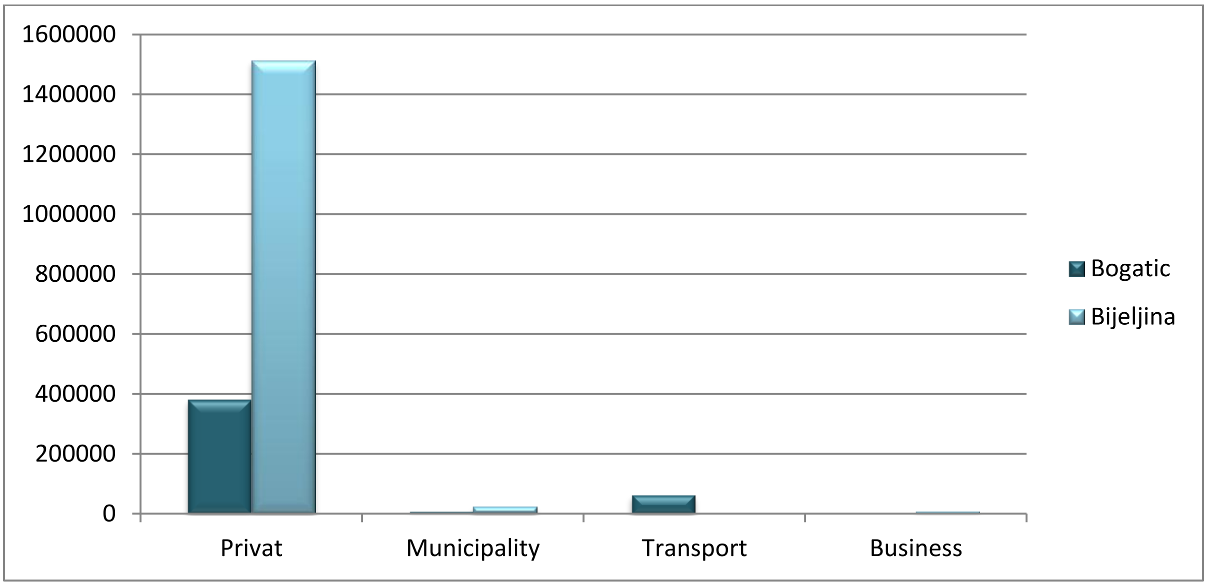


Graphic 25: The two concept regions and their municipalities. Bogatić on the left and Bijeljina on the right.

Bogatić is smaller in area and has fewer inhabitants than Bijeljina, so the method of comparing both regions is the use of key figures, mostly per-capita-values.

7.2 Energy demand of Bogatić and Bijeljina

Graphic 26 is showing the distribution of the main demand groups in the municipalities. The differences are huge based on the demographic and economic situation in both of them.



Graphic 26: Distribution of energy demand in the two concept regions by energy demand groups (Source: Calculation EEE, 2014)

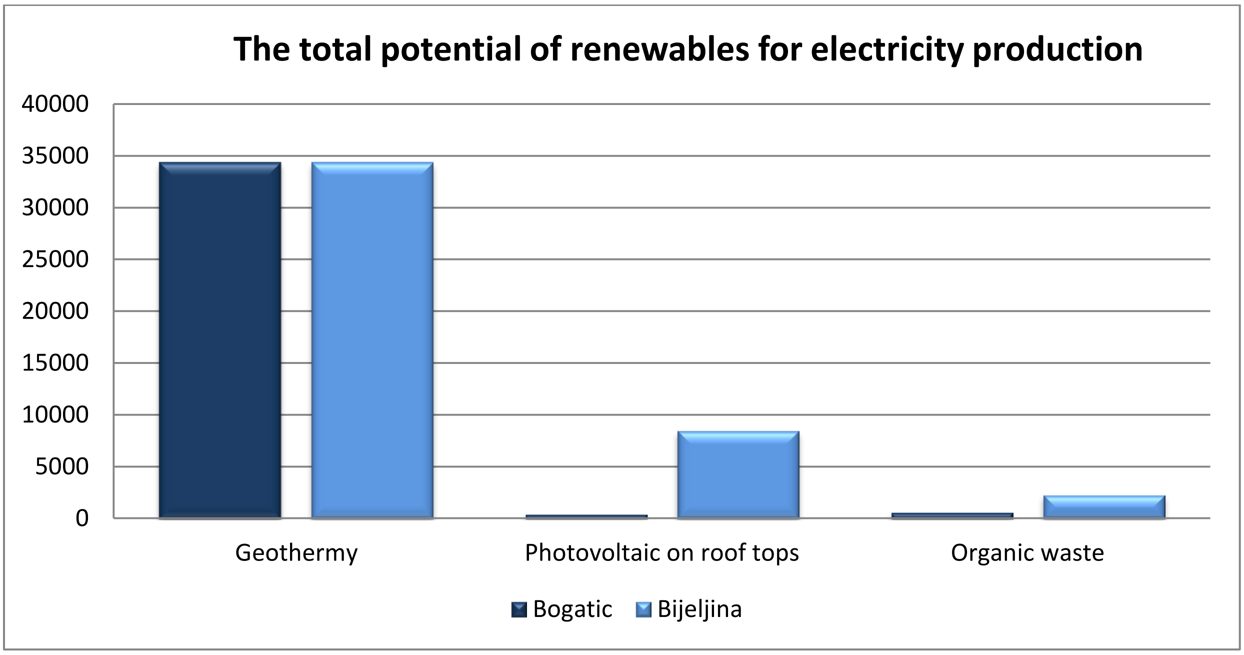
Based on the calculation, private sector has a very high share of the energy demand. While in Bogatić the energy supply for the households is done mainly by electricity, based on the law electricity price, in Bijeljina the heat supply is made by lignite and coal.

7.3 Resources and potentials of Bogatić and Bijeljina

The renewable energy potentials were calculated in both municipalities based on the received data. The data are calculated for:

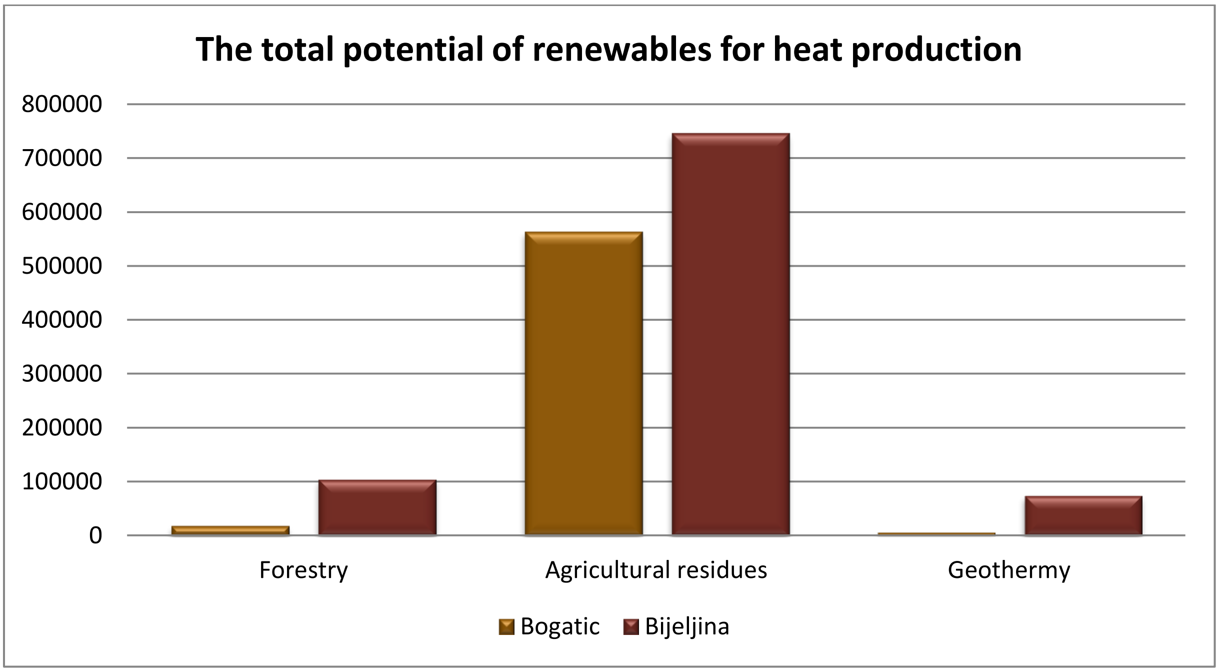
- Forestry
- Agriculture
- Geothermy
- Solar radiation

All potentials are also considered regarding their capacity to cover the energy demand or certain aspects of the demand. All calculated potentials do have theoretical values, because there are always economic and technical limitations for their use. In any case the results are showing chances and possibilities for the use of renewable resources and, on the other hand, limitations in their availability and practical use.



Graphic 27: Potential of local renewables for electricity production (Source: Calculation EEE, 2014)

As seen in the Graphic 27, there is huge theoretical potential for electricity production from geothermy, but it needs to be developed.



Graphic 28: Potential for local resources for heat production (Source: Calculation EEE, 2014)

The potential for heat production from forestry is considered to be already in use, but there is a vast potential for heat production from agricultural biomass. The potential of heat from geothermy is estimated from the data of existing wells.

Regional or local energy supply can be optimized by using, or preparing to use, up to now unused energy potentials, as for example „waste-heat“ of industry production processes or currently unused heat as by-product of electricity-generation.

Energy production and energy supply should gain a higher impact on the regional added value. Plans to mobilize the potentials of forestall and agricultural biomass have to be developed and implemented.

The development plan based on agriculture scenarios will be included in the next ***implementations studies***.

7.4 Agricultural biomass production scenarios

As stated in the respective chapters, there is a higher annual demand for biomass in both concept regions, than can be produced by forestry. Additionally there is also a big share of lignite in heat provision with the respective effects on health and environment.

The following summarizing scenarios will outline the possibilities and limits of agricultural biomass production for energy production. The economical effectiveness will have to be cleared in the next report which will contain feasibility studies for facilities, which will be based on the results of the development plan.

The scenarios are based on the assumption that up to a maximum of 20% of the available farmland can be used for energy production. All scenarios are containing a sustainable variant and a non-sustainable variant. In the sustainable variant the average area for nutrition is subtracted from the total farmland area. The non-sustainable variant is based on the entirety of the farmland.

7.4.1 Scenario 1: Biogas – potentials and possibilities

According to varying information, the yield of green maize can be expected between 22-40 t/ha. For the calculations an average yield of 31 t/ha is used. This value can also be applied for the cultivation of sorghum.

Based on this, the average yield of primary energy in form of biogas from silages is 30.7 MWh/ha.

33% of this amount can be converted into electricity by a gas engine, which will, additionally, convert further 37% of usable heat. At the moment, this type of commonly used technology has the highest efficiency in electricity production from biogas.

For a biogas power plant with 1 MW electric power an area of 790 ha is needed for providing the substrate in form of silages from maize or sorghum.

In a non-sustainable scenario, the 20% rate of existing farmland is represented by 15,500 ha. For the sustainable scenario, which takes into consideration also the necessary farmland for food production, the 20% scenario ends up with 8,500 ha.

- *The possible total power capacity for the non-sustainable scenario is 17 MWel and 20 MWth. With this power capacity, **157,000 MWh** of electricity and **176,200 MWh** of usable heat can be produced.*

- *The possible total power capacity for the sustainable scenario is 10 MWel and 12 MWth. The total energy production expected is **86,000 MWh** of electricity and **96,000 MWh** of usable heat.*

7.4.1.1 Biogas from silages and maize straw mix for power generation

Using a mix of maize straw from the current production of corn-maize is a possibility to reduce the demand for farmland for producing biogas substrates. Experience has shown that a share of 20% of straw can be processed in a biogas facility running on silage. Before being fed into the fermenters, the straw needs to be shredded.

For obtaining the same power capacities in biogas production, the demand of farmland can be reduced in the non-sustainable scenario by 3,100 ha and in the sustainable scenario by 1,710 ha.

7.4.1.2 Biogas for direct use or biogas upgrading for obtaining natural gas quality

Biogas does not need to be obligatory processed at the location of its production. It can also be transported in pipelines to be used for direct heat applications or for feeding one or more external CHP-units and generating power and heat on the respective lower demand levels.

Another practiced possibility is the refinery of biogas by upgrading. A biogas upgrader is a facility that is used to concentrate the methane in biogas to natural gas standards.

There are several facilities in Europe which are upgrading biogas and feeding it into a the natural gas grid. The economic viability is depending on the feed in tariffs in the respective country.

Upgrading of biogas, based on the data used above would deliver:

- ***333,300 MWh** of biomethane (3.33 million m³) per year in the non-sustainable scenario*
- ***184,400 MWh** of biomethane (1.84 million m³) per year in the sustainable scenario*

7.4.2 Scenario 2: Short rotation coppices – potentials and possibilities

Also the short rotation coppices (SRC) scenario is based on the 20% of farmland ratio.

7.4.2.1 Power generation from SRCs

For power generation fuelled by SRC-wood chips an average electrical efficiency of 20% is assumed. In contrary to biogas processes where the ratio of electricity and heat is approximately 1: 1.1 the ratio for solid biomass is app. 1:4.

The possible power capacity from SRCs for the non-sustainable scenario is 19 MWel and 57 MWth. The energy production potential is 124,100 MWh of electricity and 372,300 of usable heat.

The possible power capacity from SRCs for the non-sustainable scenario is 19 MWel and 57 MWth. The energy production potential is ***124,100 MWh*** *of electricity and* ***372,300 MWh*** *of usable heat.*

In the sustainable scenario the power capacity is 10 MWel and 32 MWth, resulting in an average annual production of ***68,400 MWh*** *of electricity and* ***206,000 MWh*** *of usable heat.*

7.4.2.2 Heat generation from SRCs

In case of heat production by combustion in furnaces the following amounts of biomass and energy contents can be expected:

In the non-sustainable scenario 124,000 t/a of biomass with an energy content of 620,500 MWh could be harvested. The heat load potential is 415 MWth.

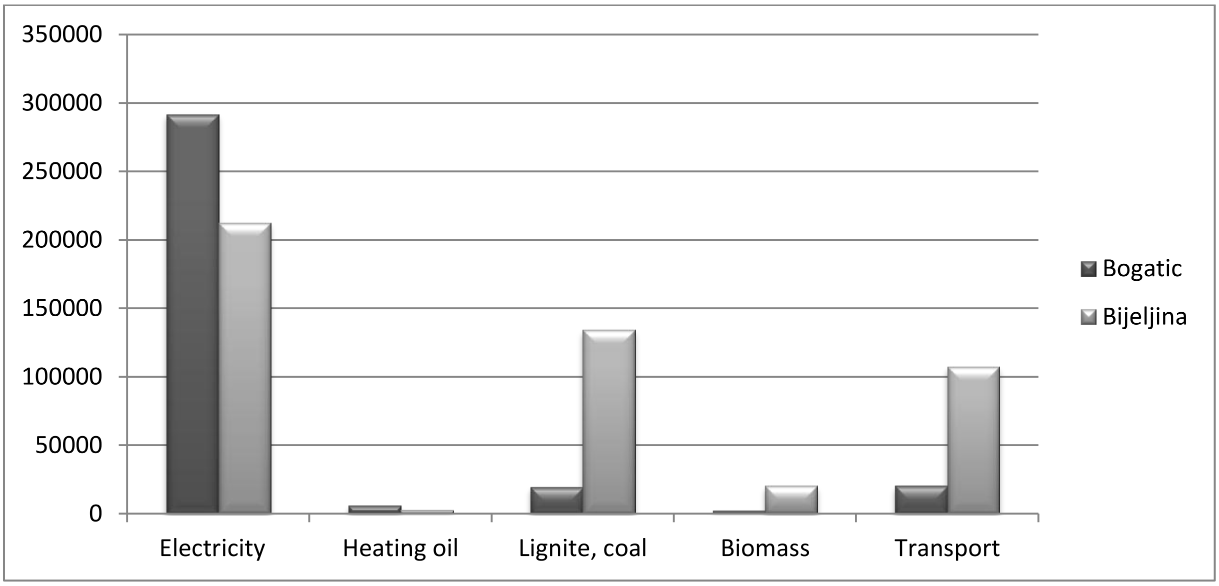
In the non-sustainable scenario 124,000 t/a of biomass with an energy content of ***620,500 MWh*** *could be harvested. The heat load potential is* ***415 MWth****.*

The obtainable amount in the sustainable scenario are 68,500 t/a of biomass with an energy content of ***342,700 MWh*** *with a heat load potential of* ***230 MWth*** *.*

7.5 CO_2 emissions of Bogatić and Bijeljina

The emissions are calculated according to the directions of GEMIS, therefore the evaluated data are calculated on the common way.

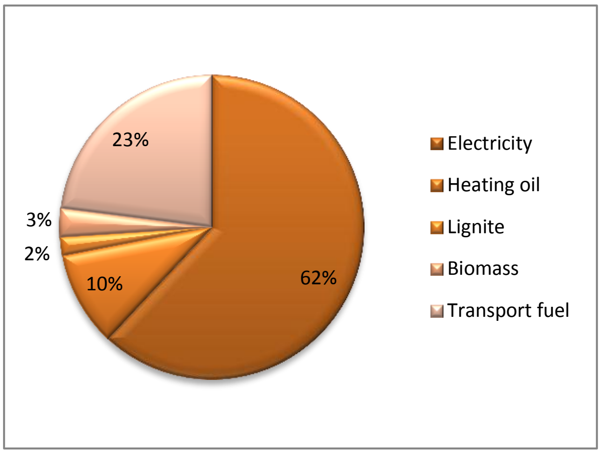
As seen below in the Graphic 29, the electricity has the highest share of the CO_2 emissions, in Bogatić up to 86% and in Bijeljina up to 45%.



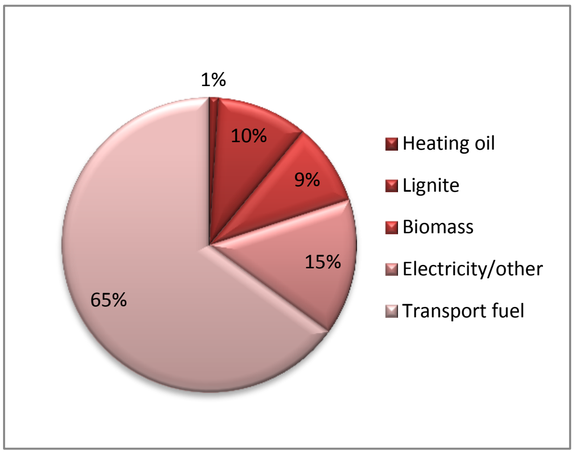
Graphic 29: CO2 emissions by energy carriers in Bogatić und Bijeljina (Source: Calculation EEE,2014)

7.6 Estimated energy costs of Bogatić and Bijeljina

The estimated energy costs where calculated based on the main energy cariers in both regions. The the energy costs shows big differences in the breakdown. Based on the low prices for electricity, it has the main share on the energy costs. Another situation is seen in Bijeljina, where the main energy carrier is transport fuel in case of energy costs.



Graphic 30: Estimated energy costs in Bogatić (Source: Calculation EEE, 2014)



Graphic 31: Estimated energy costs in Bijeljina (Source: Calculation EEE,2014)

8 Saving potentials and possible measures

Energy saving potentials are aimed at the target to decrease certain parts of the current demand and thus, in the long run, to decrease energy costs, which are expected to rise significantly within the next 5 to 10 years.

Another aspect is that when Serbia will become also member of the European Union within next few years, it will be bound to the Europe 2020 strategy, which enforces an increase in energy efficiency and in the use of renewable energy sources. The strategy also includes penalty payments for member-states which do not reach the specific goals. Taking all these aspects into consideration, the municipality of *Bogatić* could act as a model region for the implementation of renewable energy.

Energy from local resources are not expected to rise as strongly, compared to fossil fuels, because they are not bound so tightly to the global energy prices, but the activation of saving potentials can also lead to a better covering rate by local resources.

Taking these aspects into consideration, the urban municipality of *Bijeljina* could act as a model region for the implementation of renewable energy in Bosnia-Herzegowina.

8.1 Increase of energy efficiency

By energy efficiency focusing on:

- ✓ Reducing energy demand by increase in energy efficiency and thus increase of cost efficiency in municipalities
- ✓ Rising of awareness for energy efficiency in the population by communication successful municipal efficiency projects. The focus should be laid on cost reduction
- ✓ Disseminating information on energy efficiency and cost reduction effects on household level.
- ✓ Cross border information on best practice regarding energy efficiency.

8.1.1 Saving potentials in the economy sector /offices and administrations

Motivation of the users

The motivation of the working people in economy sector as well as in the offices of administration is a very important factor of the energy saving potential. Through the motivation, the employees should be sensitizing for difference saving possibilities and a lasting behavior change should be reached. Furthermore, this will rose to high energy savings without big capital investment and without losing of comfort. This awareness won't only bring savings for the enterprises, but will also affect the use of energy in private sector.

1) *Ventilate properly*

Basically, the intermittent ventilation or the vertical transverse system should be placed on the first places in the case to bring fresh air to the rooms. These ventilation systems are especially more effective than the constantly ventilation over the day. During the ventilation, it is recommended closing the thermostatic valves to keep the warm air in the rooms. The effect of the cold air form the outside is, that it would be fall down on the thermostatic valves, which caused in opening of them and losing energy efficiency.
Further savings can be achieved by closing the doors of the heated space to the corridors, staircase or storehouses to keep the warm air / heated air in the rooms, which eventually could be open by the vertical transverse systems.

2) Room temperature controlling

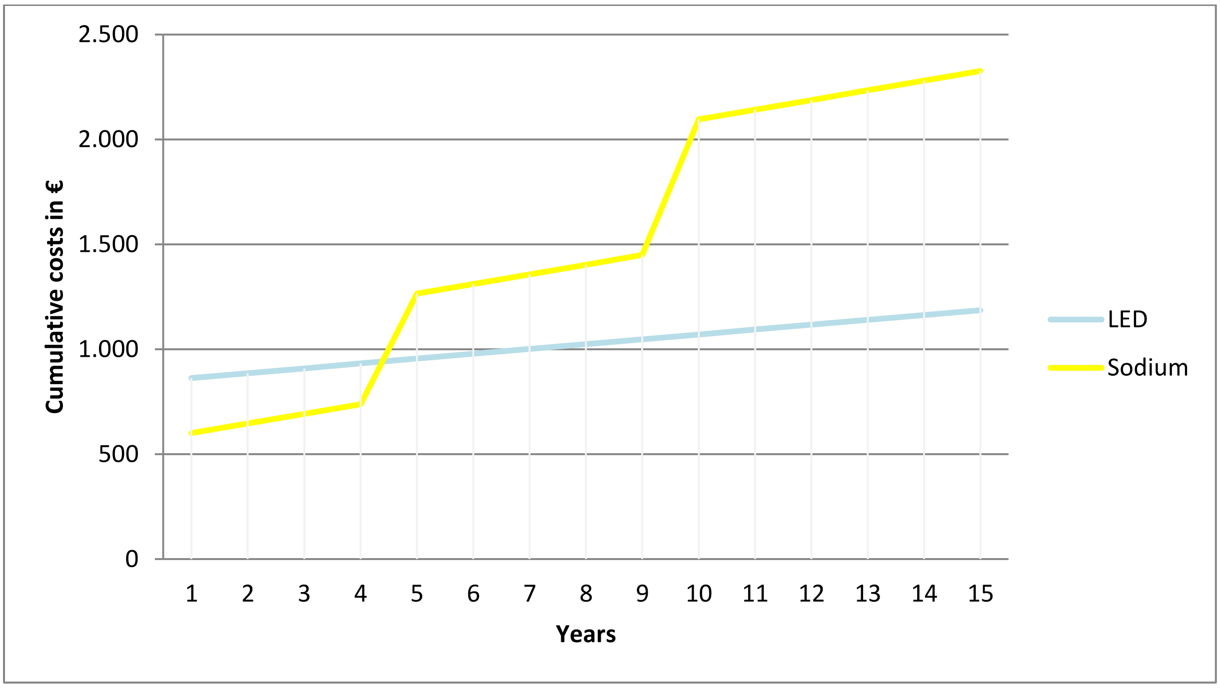
There are typically different specific indoor temperature figures for certainly rooms. Based on it, for living spaces as well as for the offices are recommended about 20 – 21 °C and for the night setback about 16 – 18 °C. Furthermore, it should be also tried to adapt the temperature of the rooms to the actual needs so as the temperature should be fit to the office time. As a rule of thumb for the potential energy savings can be assumed that each degree Celsius over the ideal temperature causes in a higher heating demand of about 6%.

3) Electrical equipment

The located electronic equipment that is located in office rooms, eg. computer, printer, scanner, copier – by them should be take a look over the input power mainly of the facilities in the standby mode. Most of the machines are in the back-up mode und are stood by for hours which caused to high costs, as if the equipment would be switched on only for the working process. It should be try to shut down such devices once in a while if they are not in use and mainly besides the offices hours. (Source: EnergieAgentur.NRW, Energy Globe)

8.1.2 Replacing mercury and sodium lamps by LEDs for street lighting

The per capita value of the energy demand for street lighting is 77 kWh/cap. This value is similar to the average value in Austria, which is 76 kWh/cap, if mercury or sodium lamps are used. Replacing these lamps by LED technology the per capita value is reduced to at least **50%** or even **30%** of the former demand (depending on the former used illuminate). The investment for LED technology are rather high at the moment, the replacement is done by a step by step strategy. Graphic 32 is comparing the use of Sodium lamps and LEDs over the average lifetime of a LED, which is regularly 3 times longer than a sodium bulb. The calculation was made for an Austrian municipality, based upon investment and energy prices in Austria. For Serbia, the investment and maintenance costs (replacing the old, used up sodium bulb by a new one every 4-6 years) are assumed to be not much different, but the energy costs at the moment are a lot cheaper, thus the average gradient of the functions should be more flat.



Graphic 32: Comparison of the costs for street lighting (Source: EEE, 2013)

8.1.1 Thermal insulation of buildings

The thermal insulation of buildings can save up to 40% of the annual heating energy. About the half of this saving potential can be achieved by insulating the upper storey´s ceiling. This can be done also easily by self-construction. In this case the payback period for an average household is about 2-3 years, considering a 50/50 mix of lignite and fuel wood.

The delivered data are showing, that the average energy-index of households is beyond 300 kWh/m²*a. This is a rather high value, if one regards, that the energy-index for households in a stock of buildings of different ages in Austria is around 140 – 160 kWh/m²*a. A new standard building has even an energy-index of 60 – 90 kWh/m²*a. So the potential of energy savings by thermal insulation of buildings is very high and is exceeding the empiric value of 40% energy saving.

The costs of the thermal insulation of 1 m² of the upper storey´s ceiling is around 11.- Euro. Taking into account, that the effect of the measure reduces the heat demand by 25% this would lead to an average saving of about 2.- Euro/m²*a. The payback period in this case would be 5-6 years.

Thermal insulation of buildings can save at least up to 40%.

By energy supply focusing on:

- ✓ Regional or local energy supply should be optimized by using, or preparing to use, up to now unused energy potentials, as for example „waste-heat“ of industry production processes or currently unused heat as by-product of electricity-generation.

- ✓ Energy production and energy supply should gain a higher impact on the regional added value. Plans to mobilize the big potentials of forestall and agricultural biomass have to be developed and implemented and also plans to use organic waste from households, municipalities and industry for energy production.
- ✓ Mutual support and assistance in planning and construction of efficient energy supply facilities.
- ✓ Enforcement of the use of solar thermal energy in households, municipalities and industry.
- ✓ Replacing heating oil by regional or local biomass, preferably in combination with solar heat.

8.1.2 Replacement of old boilers and furnaces

Common single furnaces for the combustion of lignite and firewood have an average efficiency of 30% to 50%. State-of-the-art furnaces are achieving boiler efficiencies between 70% and 80%. A replacement of old furnaces by new ones could therefore lead to energy and cost saving potentials up to 50%. Taking into consideration, that the average heat demand of a household in Serbia is about **36 MWh/a**, this increase in efficiency can lead to an annual reduction of heat costs of about **350,- Euro** (in case of a 50/50 mix of lignite and fuel wood) for an average household. The payback-period in this case is about 3-4 years.

Replacement of old boilers and furnaces can lead to a reduction of heat cost by 350 €/a.

8.1.3 Substitution of electricity by use of solar energy for hot water supply

The energy demand for hot water provision is about 15% to 20% of a household´s total heat demand. In many cases the energy for water heating is provided by electricity. Although electricity is very cheap at the moment, the price for it is expected to rise significantly.

About 2/3 of the hot water demand can be covered by solar heat, thus saving the electric energy for providing it. The most simple and affordable way to provide hot water from April to October is a thermo-siphon which is operated only by solar heat and gravity. The costs for one unit are varying between € 200,- and 700,- , depending on the size.

Up to 2/3 of the hot water demand produced with electricity can be replaced with solar energy.

8.1.4 Increase of energy efficiency in the field of sewage water

The pump system of the sewage water can occasionally recover higher saving potentials. A constantly control of the pump inlets on transfers can contribute to avoid unnecessary running times of the pump and thus saving electric power. This obtains to pumps, whose amount of the flow rate could be adapted over cutback of the throttling.

In the pump station partially float switches can be found which control the switching on and off of the pump. These switches can stuck and should be replaced therefore throughout contact – free water-level measures

The pumps work significantly more efficiently when they are approached by the smoothly starter or started up respectively operated by frequency changer which stimulated the start-up streams and the rotation speed will fits on the power of requirement. The rotation regulation spares the machines and appliance which causes in the ideal management of the existing capacity and saves substantial energy.

8.2 Cross-border – strategy

Because of the similarities of both regions, a joint strategy for inter-regional development, based on energy efficiency and the use of regional resources for energy supply is recommended. To enforce a cross border strategy a platform for the interaction of promoters, stakeholders and other actors could be created.

Harmonization of the dimensions of energy demand and energy supply is suggested to be the core point of the cross border strategy. The measuring value for this effort should be the key figures of demand and supply, as calculated and presented in the previous chapters of this current concept.

The harmonization strategy should lead to, in the best case same but at least similar, optimum key figures in energy demand, energy efficiency and energy supply in both cross border regions.

In detail, the joint strategy has to bundle the following goals:

8.2.1 Information and cooperation

On the decision-making side, it is necessary to create of a cross border platform for the main actors in responsibilities, information exchange and harmonization of measures, as well as for the formulation of further goals in development.

On the operative side the cross border platform needs to provide energy monitoring tools to find and analyze best practice examples (probably obligatory) on municipal level (public buildings , street lighting etc.) but also (on a voluntary base) for private households and industry.

8.2.2 Communication policy

Targeted information is needed in the municipality, in order to force the saving potentials and substitute possibilities of fossil fuels through biomass in households.

The public should be educate of thermal insulation, efficiency of the thermal boiler, utilization of solar energy as well as standby-losses, in a form of publication in and in the local media, or to included them to public information sessions.

The information should especially include:

- average costs of the measures
- funding opportunities
- expectable reduction of the energy costs after the implementation of the measures

8.3 Energy-Accounting-System (EAS)

The implementation of an EAS offers a useful monitoring and evaluation tool for the energetic quality of the buildings and energy constructions. It provides important data for the selection and planning of improvement actions and it is a basis for cost and energy savings. The EAS can be a management system in the finance, building and the environment in the community field.

The EAS itself is defined as a regular recording and evaluation of energy costs mainly in the field of public objects, e.g. buildings, properties and facilities. Furthermore, in the progress of the EAS, the estimated data are carried out based on different fields and aspects.

The European center for renewable energy Güssing Lts. (EEE) developed an online energy accounting system advantageous for communities.

The online software of the EAS for municipalities is used to acquire energy-related data from community-owned buildings and facilities, as well as to evaluate and investigate any weaknesses or behaviour of the users.

The software is available on the address: http://www.eee-info.net/ebh. There are no installation required. Only a current browser is necessary for all functions of the EAS (Internet Explorer 6.0, Mozilla Firefox 1.5, Opera 9.0, etc.)

As the detailed description of the utilization as the manipulation techniques of this online EAS could be available from the EEE, if there is any interest of it.

In order to have a sustainable and successful EAS, it is compulsory to employ a person in the community responsible for this system. This person should be responsible for a regularly administration and entering of the required data. Another possibility would be to give the responsibility of this management to an external person, wherein the internal processing would be a major advantage.

Graphic 33: Screenshot of the EAS as an example (Source: EEE 2014, http://www.eee-info.net/ebh)

After the decision is made for the handling with this system as well as determination of the cycle of the administration (quarterly, semi-annually, annually, …), the working with this system can start.

In order to get the results of the evaluation as soon as possible, it is recommended to enter at the beginning the data for the last 3 years in order to identify the saving measures immediately.

Thanks to a regular examination with the topic of the energy, the behavior of the users could be changed and will lead to better awareness's. The education of the awareness can cause to non-investment measures by cost savings up to 20%. Of course there are necessary special investments measures, which can lead to saving potentials depend on the building or construction.

LIST OF GRAPHICS

LIST OF TABLES

LIST OF REFERENCES

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