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Potential of renewable energy sources in Republic of Srpska

Tijana GLAMOČIĆ, Environment Protection Fund of Republic of Srpska
Dr. Ljubo GLAMOČIĆ, Ministry of Industry, Energy and Mining, RS Government

Outline

- 1. Introduction
- 2. Potential and use of water power in Republic of Srpska
- 3. Potential and use of wind power in Republic of Srpska
- 4. Biomass potential and use in Republic of Srpska
- 5. Possibilities of use and development of solar energy in Republic of Srpska
- 6. Potential and use of geothermal energy in Republic of Srpska
- 7. Conclusion

1. Introduction

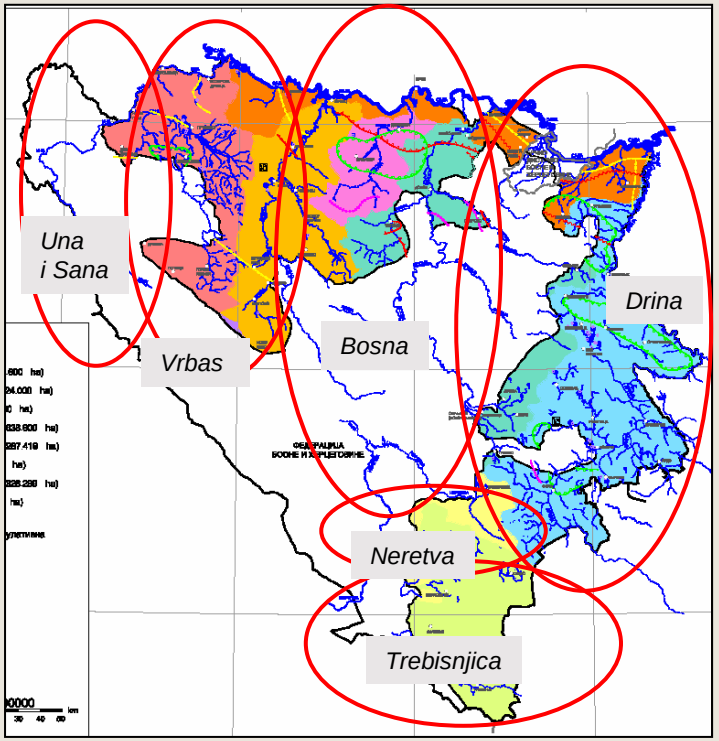
- **Energy sources can be shared in renewable and non-renewable.**
- The **non-renewable** sources include coal, petroleum, natural gas and nuclear energy and **renewable** sources include solar energy, hydropower, wind energy, geothermal energy, bioenergy, biofuels, and ocean energy (wave energy and tidal energy).
- ***Republic of Srpska has determined general objectives of energy development. The essential issues for renewable energy are:***
  - To ensure development of energy sector in terms of CO_2 emission limits, combined with increased energy efficiency and increased use of renewable energy,
  - To develop an effective system of encouraging energy efficiency and use of renewable energy sources (in accordance to local opportunities and obligations that Bosnia and Herzegovina will gain by membership in European Union).

- ***Renewable energy sources are important for the development of the energy sector because they:***
  - contribute to the diversification of energy sources,
  - increase the security of energy supply,
  - encourage economic activity and
  - protect environment.

- ***The purpose of projects using renewable energy sources is wider than just energy-economic benefits because they realize positive effects such as:***
  - reducing emissions of pollutants,
  - waste management (municipal and wood waste, agricultural byproducts and industrial production),
  - creating of new and existing jobs, and
  - opportunity to develop and increase the competition of domestic industry

2. Potential and use of water power in Republic of Srpska

- Because of its natural characteristics (developed relief, the relative high level of rainfall, developed hydrographic network), Republic of Srpska ranks in areas with great hydropower potential.
- Total technically exploitable potential of streams in the Republic of Srpska including the boundary river is **12,948.4** GWh/year.
- Technically exploitable potential, which belongs to the Republic of Srpska is **9962.6** GWh/year.
- Used hydro potential of Republic of Srpska is **2985.8 GWh / year.**
- The remaining unused hydro potential of Republic of Srpska is **6976.8** GWh / year.
- On the basis of Public Invitation in 2005, and later under offer in accordance with the Law on Concessions, The Government of RS awarded the concession for construction of 107 hydro power plants (total of 47 concessionaires), with a total installed capacity of 281.6 MW and estimated total annual production of 1500 GWh/year.
- *So far were built 4 small hydro power plants, and 15 small hydro power plants are in preparation for construction for next building season.*



The most important part of the hydropower potential is located in the basins of the rivers Drina, Vrbas and Trebisnjica, a small part in the basins of rivers Una, Sana, Bosna and Neretva.

All of these watersheds have been investigated for the purpose of exploitation of water resources for electricity generation.

Review of hydropower potential in Republic of Srpska

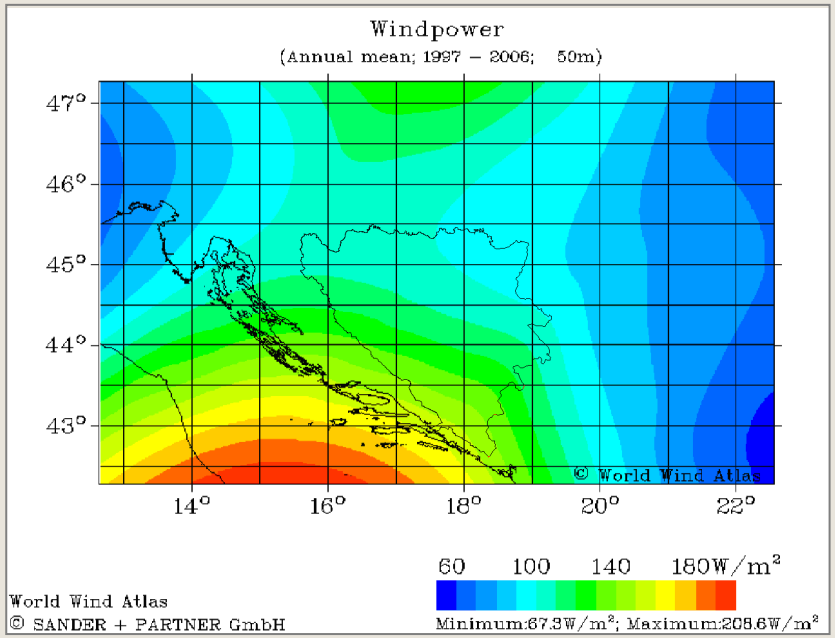
Source: Study in energy sector in Bosnia and Herzegovina

Watercourse / Catchment area	Possible installed power	Possible average annual production
	MW	GWh
Drina	1948,34	4741,37
Vrbas	395,13	1579,28
Trebisnjica	738,08	2438,08
Una i Sana	55,96	269,24
Neretva	48,33	145,23
Bosna	165,76	789,40
Total Republic of Srpska	3351,60	9962,60

- If considered that the total hydropower potential in Republic of Srpska forces, in the area of 0.5 to 10 MW is estimated at about 1500 GWh/year, it can be assumed that large part of the technically and economically exploitable potential for **small hydro power** in Republic of Srpska will be used by 2030 by the realization of projects that have received concessions.

3. Potential and use of wind power in Republic of Srpska

- Until now, the wind power in Republic of Srpska is not used for energy purposes, since there was not built any commercial wind plant.
- The most promising area for further construction of wind plants is southern part of Republic of Srpska, in the region from Kalinovik to Trebinje, in municipalities Gacko, Trebinje, Nevesinje and Berkovići.
- Theoretically usable potential for using wind power is estimated at 640 MW and 1200 GWh/year.
- Technically exploitable potential depends on the conditions of each micro-location (location access and availability of infrastructure).
- Regional Wind Atlas REGIONAL RE-ANALYSIS uses global meteorological data, and the results obtained using this model were not verified with the ground measurements.

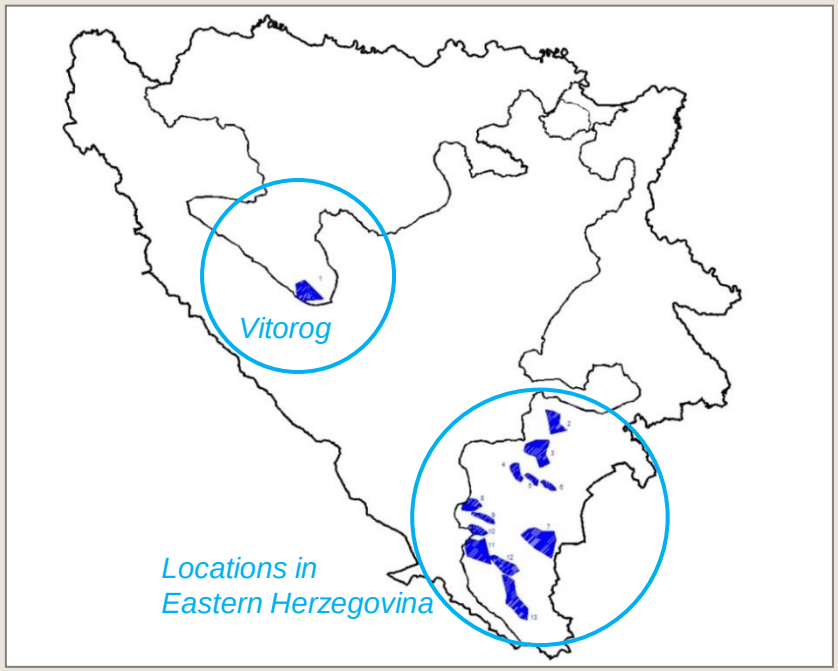


Regional Wind Atlas REGIONAL RE -ANALYSIS

The average annual wind speed at height 50 m above the ground in the period since 1997 to 2006

3. Potential and use of wind power in Republic of Srpska

- For detailed calculations are required detailed measurements of wind parameters on location and at certain height above the ground.
- The highest yield of wind power in Republic of Srpska can be expected in southern part of state, in Eastern Herzegovina.
- According to the Energy Development Strategy, technically exploitable wind potential in Republic of Srpska is about 640 MW deployed at 13 locations.
- It is planned to build wind plants with the total installed capacity of 200 MW by year 2020, and with the total installed capacity of 350 MW by year 2030. Taking into account all locations and combining calculated data on production, total annual production at the observed locations is estimated to 1220 GWh/year.
- *Public Tender for selection of consultants for setting measuring columns at selected locations is currently announced. There was planned construction of one wind farm with capacity 50MW by "Elektroprivreda RS" on chosen location by the end of next year.*



Potential locations for constuction of wind plants in Republic of Srpska: Vitorog, Treskavica, Lelija, Morine, Brnjac, Vucevo, Podbaba, Nevesinje, Krupac, Hrgud, Trestanica, Kmen and Trebinje

Expected production of wind plants in Republic of Srpska on potential locations

Source: Energy institute Hrvoje Pozar, Zagreb

No.	Location	Power, MW	Average wind speed, m/s	Annual production, MWh/year:	Equivalent hours of nominal plant	Factor of utulization
1	Vitorog	28	6,11	51991,8	1857	21,2%
2	Treskavica	74	5,63	115687,5	1563	17,8%
3	Lelija	42	7,33	109300,9	2602	29,7%
4	Morine	36	6,23	69508,2	1931	22,0%
5	Brnjac	22	5,61	34088,6	1549	17,7%
6	Vucevo	18	6,43	36961,7	2053	23,4%
7	Podbaba	124	6,24	240184,8	1937	22,1%
8	Nevesinje	34	6,38	68644,7	2019	23,0%
9	Krupac	28	6,47	58152,1	2077	23,7%
10	Hrgud	32	6,62	69359,6	2167	24,7%
11	Trestanica	60	6,28	117431,9	1957	22,3%
12	Kmen	72	5,91	124570,9	1730	19,8%
13	Trebinje	70	5,86	119234,2	1703	19,4%

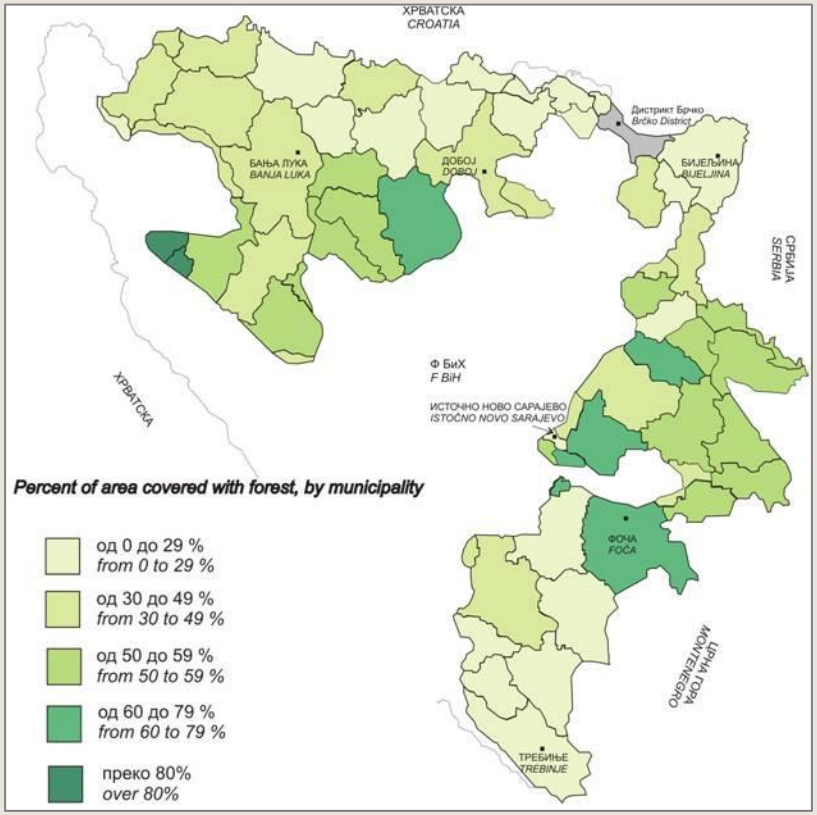
4. Biomass potential and use in Republic of Srpska

- When assessing the potential of biomass it is necessary to observe three main sectors where biomass comes from such as **forestry, agriculture and waste management.**

- *4.1. Wood biomass potential*

- Forests cover about 40% or 2,371,062 ha of the total area of Bosnia and Herzegovina. 53% or 1,250,391 ha are located in Republic of Srpska, which means forests are one of the most important natural resources of Republic of Srpska.
- Only about 60% of the annual allowed cut is realized, or from 7,44 million m³, 4,43 million m³ is cut.
- *Public Corporation "Forests of Republic of Srpska"* manages about one million hectares or about 80% of forest reserves. The remaining forests and forest land are in private ownership.
- Overall stocks of timber during the editing is 181 567 000 m³ of which 62% is deciduous and 38% is conifers. The annual increment is 5 222 700 m³, and the annual allowed cut 3 447 140 m³.

Percent of area covered with forest, by municipality



4. Biomass potential and use in Republic of Srpska

- *4.2. Agricultural biomass potential*

- Agricultural use of biomass for energy purpose is divided into wood waste (perennial crops), animal excrement (livestock) and harvest residue and energy crops (farming).
- Potential from farming ranges from 7.4 to 15.1 PJ/year, assuming separating energy policy from agricultural policy.
- There was considered yield of biogas and 1st generation of biofuels from planting corn, rapeseed and grass.
- The potential of biogas from livestock is calculated based on three-year average of livestock from the statistics (according to Republic Office of statistics of Republic of Srpska, Banja Luka).
- Reference values for the yield of biogas per cubic meter of fresh substrate and the share of methane in the biogas were obtained from the „*Bayerische Landesanstalt für Landwirtschaft*“(*Bavarian State Institute for Agriculture*).
- Used methodologies have shown similar potential from livestock, which ranges from 4.4 to 5 PJ / year.

- *4.3. Waste biomass potential*

- The potential of waste can be estimated by the number of inhabitants and the total waste produced in RS (0.7 to 0.9 kg/per capita of waste per day).
- This annual production of municipal waste in RS is 367-473 thousand tons.
- Assuming that the organic fraction of waste is the same as the one in Croatia (74.5%), then it can be assumed that 0.98 to 1.26 PJ per year could be obtained of landfill gas (200 m3 per ton of organic waste for 20 years, 50% methane in biogas).

- According to the next table, the theoretical annual total biomass energy potential of the Republic of Srpska ranges from 31.08 to 46.24 PJ.
- Excluding agriculture, theoretical potential is reduced from 23.7 to 31.11 PJ.

- *The greatest potential is in:*
  - *the forestry sector and related industries (52-77% of potential, depending on the treatment of husbandry),*
  - *followed by agriculture (20-39%)*
  - *and waste (3-5%).*

Annual theoretical potential of biomass in republic of Srpska

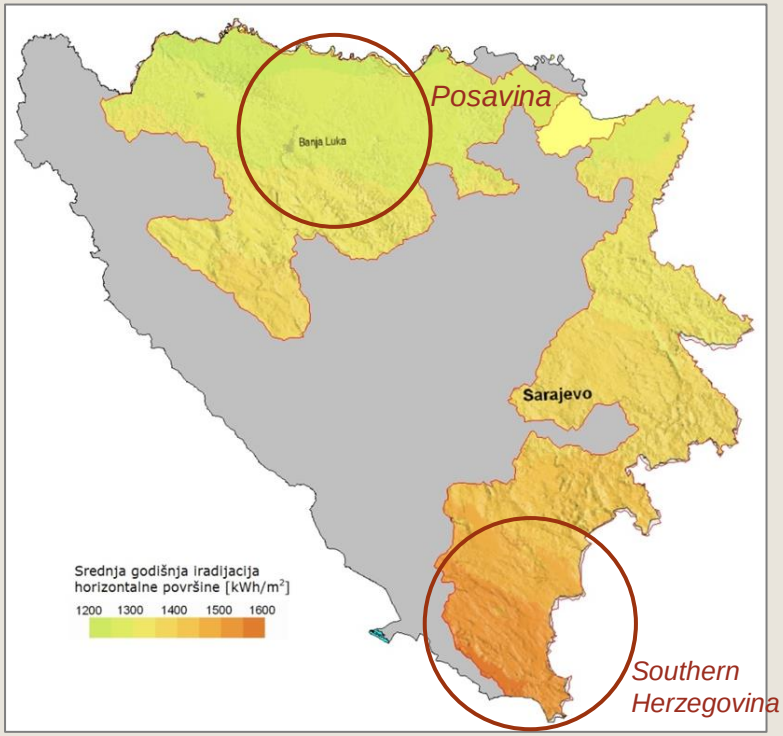
Source: Energy Development Plan for Republic of Srpska to 2030

Source of biomass	Theoretical potential (PJ)	
	from	to
Wooden biomass		
Waste from wood industry	4,88	6,96
Firewood	7,42	9,58
Waste	5,54	7,54
Total forest biomass	**17,84**	**24,08**
Agricultural biomass		
Perennial crops	0,37	0,71
Animal husbandry	4,38	4,96
Crop husbandry	7,41	15,13
Total agriculture	**12,17**	**20,80**
Waste		
Waste cooking oil	0,10	0,10
Landfill gas	0,98	1,26
Total waste	**1,08**	**1,36**
Total biomass PJ	**31,08**	**46,24**

- There is definitely a significant potential of biomass resources that can be used to produce electricity and heat (separately and combined).
- Utilization of biomass cannot be done without an adequate legal framework to stimulate this sector.
- New legislation must be supported by financial mechanisms to lower a cost of investiment of building new plants for renewable energy and improvement of existing power plants on fossil fuel / heating plant in order to facilitate co-combustion and cogeneration.
- *In this moment few "pilot projects" for producing biogas and biofuel are installed. Producing pellets for heating is in common use in Republic of Srpska nowadays.*

5. Possibilities of use and development of solar energy in Republic of Srpska

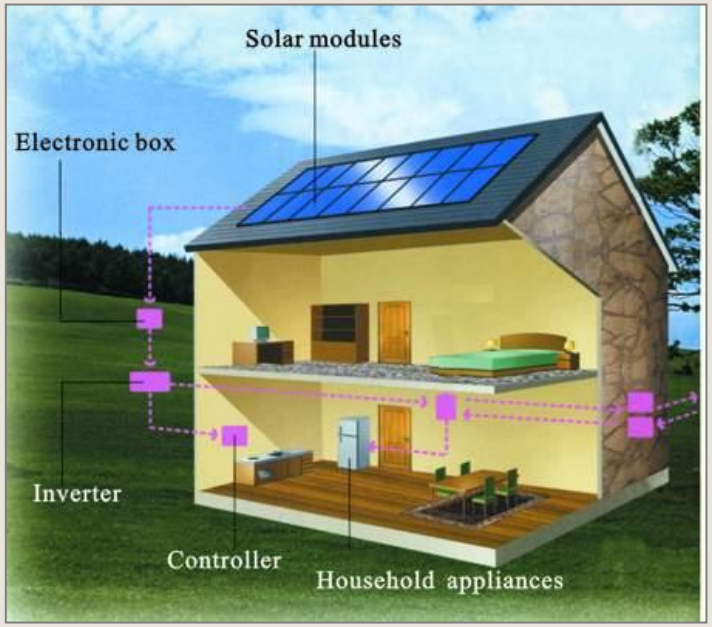
- Solar energy is one of the most accessible and safest energy on Earth.
- The Earth receives 174 petawatts (PW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses.
- Use of solar energy reduces the need for fossil fuels and reduces environmental pollution caused by their combustion.
- In RS amount of radiation is increased by lowering to the south, so that areas of southern Herzegovina generate radiation between 1.5 and 1.55 MWh/m².
- The area around the Posavina can expect radiation from 1.25 to 1.3 MWh/m² of solar energy.
- Month with the greatest amount of radiation received is July when the value of radiation ranging from 6.1 to 7.5 kWh/m². The least daily radiation can be expected in December and from 0.98 to 1.46 kWh/m².
- *Number of hours of sunshine - insolation in northern part of Republic of Srpska is about 2000 hours per year while in the southern part is about 2500 hours per year.*



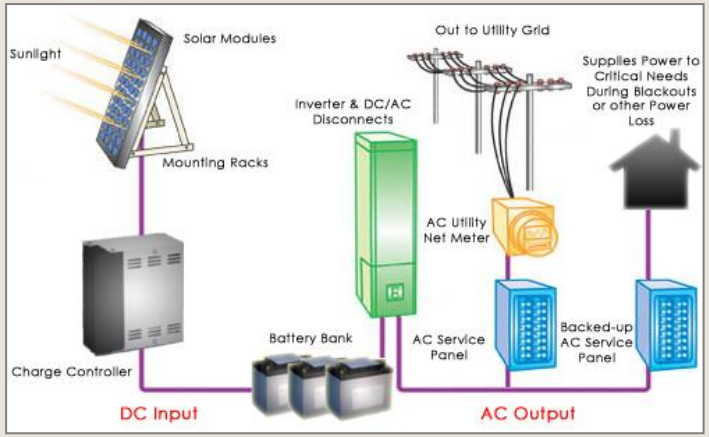
Map of mean annual radiation on horizontal surface (kWh/m²). In accordance with the latitude, the total annual amount of solar radiation, in general, decreases from northwest to southeast.

5. Possibilities of use and development of solar energy in Republic of Srpska

- *5.1. Potentials of use of solar panels in Republic of Srpska*
- The greatest potential for use of solar panels is in family homes, hotels, healthcare institutions and sport facilities. When setting priorities, the installation of solar collectors should be most represented in the buildings that seek to reduce consumption of fuel oil, electricity and gas.



- *5.2. Photovoltaic application of solar energy in Republic of Srpska*
- **Photovoltaic** (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect.
- Depending on the technology, efficiency of conversion of solar energy into electricity is between 4 and 16%.
- **Productivity of photovoltaic system** is expected production of electricity from power stations photovoltaic system in the period of one year for a particular area.



Productivity of photovoltaic system [kWh/kW$_p$] for Republic of Srpska

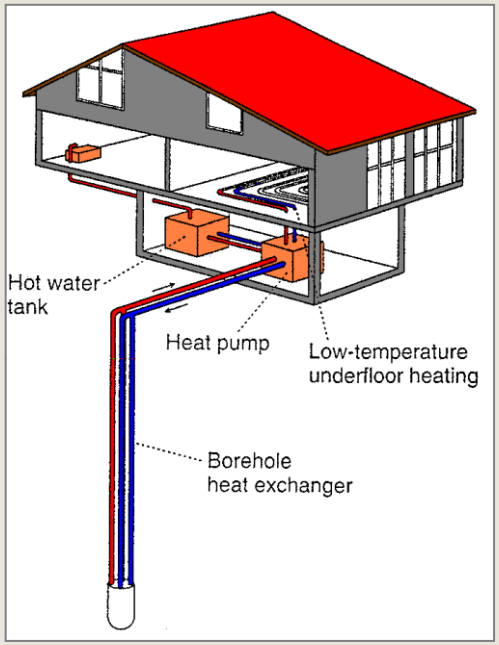
Source: Energy institute Hrvoje Pozar, Zagreb

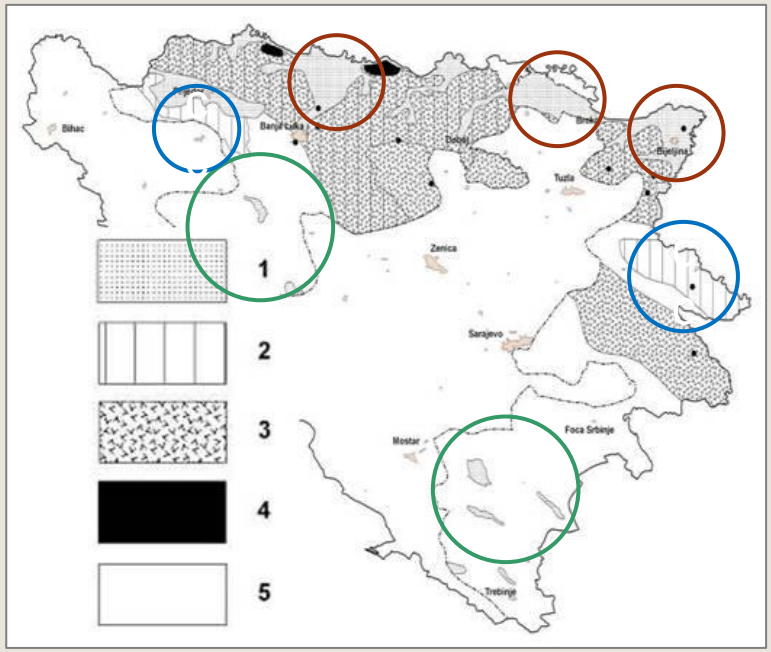
Municipality	Banja Luka		Bijeljina		Trebinje	
Month	monthly	daily	monthly	daily	monthly	daily
January	51	1,6	49	1,6	72	2,3
February	63	2,2	61	2,2	82	2,9
March	94	3	94	3	114	3,7
April	108	3,6	107	3,6	128	4,3
May	123	4	125	4	142	4,6
June	122	4,1	123	4,1	140	4,7
July	141	4,5	138	4,4	157	5,1
August	130	4,2	131	4,2	151	4,9
September	113	3,8	114	3,8	135	4,5
October	85	2,7	90	2,9	110	3,6
November	53	1,8	54	1,8	77	2,6
December	42	1,3	43	1,4	63	2
Average	94	3,1	94	3,1	114	3,8
Total	1125		1129		1371	

- Productivity of photovoltaic system for Republic of Srpska ranges from 1100 kWh/kWp for the northern regions to 1380 kWh/kWp for the southern part (near Trebinje).
- Solar systems are not in greater use because of the lack of incentives for their use.
- Without this stimulation use of photovoltaic system in public institutions (schools, children homes, etc...) can only be expected as demonstrative technology and education of professional staff.
- Photovoltaic systems, combined with other sources of energy are certainly interesting for electricity supply of settlements and facilities that are not connected to the electric network.

6. Potential and use of geothermal energy in Republic of Srpska

- The northern part of the state has significant geothermal potential, while southern and south-east parts have less resources.
- In geothermal reservoirs it is expected water of average temperature 100ºC (80-150ºC).
- *Thermal water is now used primarily in balneological purposes, while use of geothermal energy for space heating is still at the beginning of development.*



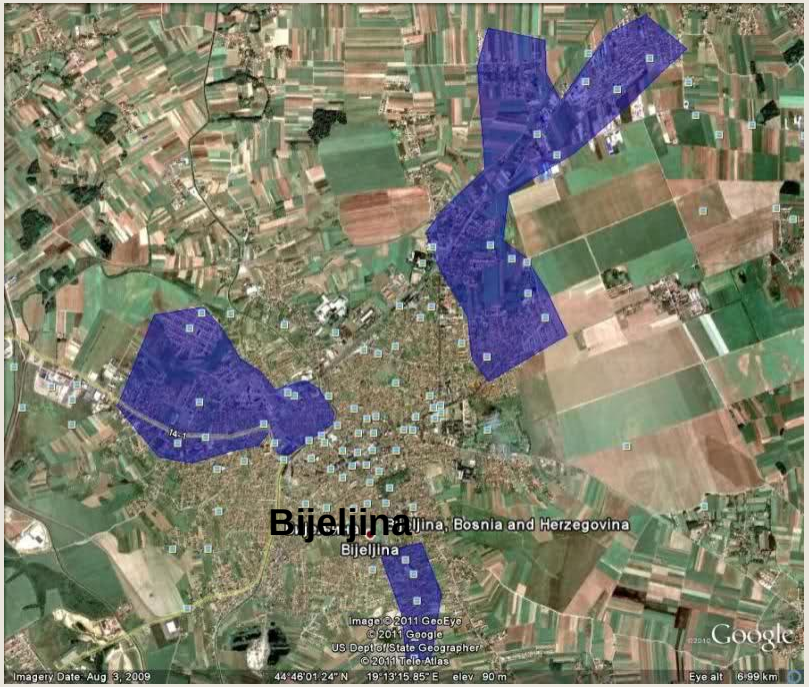


Map of geothermal resources of the Republic of Srpska

1. hydro geothermal site in *alluvial sediments* where geothermal energy can be used by heat pumps
2. hydro or *petrographic* geothermal site in a depth of 300 m where geothermal energy can be used with vertical heat exchangers and heat pumps
3. hydro site in the *Triassic and Cretaceous limestone* and *dolomite* where geothermal energy can be directly used
4. *petrographic* geothermal site in granite rocks where geothermal energy can be used to transmit electricity
5. an area without significant geothermal sites

6. Potential and use of geothermal energy in Republic of Srpska

- The highest density of heat flow values is on the southern edge of the Pannonian basin, and in Posavina, where the values are 30% more than the average of continental Europe.
- On the basis of available data is estimated that the volume of the reservoir made of limestone and dolomite in Semberija, Posavina, Banja Luka and Lijevče field, can form a geothermal **heat power 50-100 MW t.**
- It is considered to be necessary additional investigative work on all wells that show potential for energy production.
- The greatest potential use of geothermal energy in Republic of Srpska is in agriculture, aquaculture, and public utilities such as heating and heating of the village.
- *However, in case of adoption of a legislative framework to encourage the production of electricity from this source it will be possible to improve the economic viability of such projects, and thus probably the construction of such facilities.*



In Bijeljina (north part of RS) is expected to start district heating with geothermal energy and to make the first drilling boreholes by March next year.

Data on existing geothermal sites,

according to „Geozavod“(Geo Office) Zvornik, Republic of Srpska

	Location	Municipality / City	Type of occurrence	I –source (I) – more sources	B- drill (B) – more drills	Estimated yield (l/s)	Type of source	Average temp. (°C)
1	Gornji Seher	Banja Luka	Thermo-mineral water	(I)	(B)	108	outflow	32
2	Slatina	Laktasi	Thermo-mineral water	(I)	(B)	100	pumping	43
3	Laktasi	Laktasi	Thermal water	(I)	(B)	100	outflow	30
4	Kulasi	Prnjavor	Thermal water	(I)	(B)	20	pumping	30
5	Dvorovi	Bijeljina	Thermal water	n/a	B	20	outflow	20
6	Teslic	Teslic	Thermo-mineral water	(I)	(B)	50	pumping	30-38
7	Voljanic	Petrovo	Thermo-mineral water	I	B	2	outflow	24
8	Sockovac	Petrovo	Thermo-mineral water	(I)	(B)	200	pumping	39
9	Visegrad resort	Visegrad	Thermal water	(I)	(B)	90	outflow	34
10	Domaljevac	Samac	Thermo-mineral water	n/a	B	20	outflow	92
11	Ljesljani	Novi Grad	Thermo-mineral water	(I)	B	9	outflow	20-32
12	Prijecani	Banja Luka	Thermo-mineral water	I	n/a	0,1	outflow	16
13	Perin Grad	Sekovici	Thermal water	I	n/a	2	outflow	28

7. Conclusion

- The widest application of renewable energy sources in Republic of Srpska is expected in electricity generation (wind and small hydropower), but also in other sectors (e.g. domestic hot water and space heating using solar collectors, the use of geothermal energy for heating purpose, the use of modern systems for biomass heating etc).
- In terms of developing non-traditional forms of energy production Republic of Srpska has not gone away, but at the present time there is a will to establish a legislative framework that would allow rational management of energy and affirmation of renewable energy sources.
- This year The Republic of Srpska Government has adopted the "*Regulation on production and consumption of energy from renewable sources and cogeneration"*. This act defines the incentives for energy production from renewable sources.
- **„Environment protection Fund of Republic of Srpska"** as an institution that was established to ensure protection of natural values of the environment, supports the rational management of energy production and consumption and affirmation of renewable sources.
- The Fund will support future projects in its implementation taking into account the fact that until 2020 Republic of Srpska has to provide 20% energy savings especially in transport, building and manufacturing processes. Rational use of energy and increase of energy efficiency in buildings and transport reduces the amount of CO_2.
- That make Republic of Srpska one of the countries that consistently comply with signed conventions and take into account all necessary steps that contribute preservation of enviroment.

Think green!

Thank You