Solar Energy Potential in Pannonian Part of Serbia and Croatia

Review

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Abstract – *Renewable energy sources have their share in the energy balance of almost every country, but not as much as they should compared to the given energy potential, although they allow the application of clean technologies and pollution reduction, reduce energy dependence on fossil fuel markets and enable the development of new technologies and supporting infrastructure that create new jobs. The primary interest of society as a whole is a rational energy use. With increasing population and growing demands for energy production and consumption, as well as the fact of the limited fossil fuel resources whose utilization leads to environmental pollution (the emergence of the greenhouse effect and global warming) there is an interest in increasing the participation of renewable energy sources (RES) in energy sector. A share of RES in the energy balance of the country has its own energy, socio-economic and environmental benefits. RES provides application development and deployment of new technologies and supporting infrastructure, and therefore enables possibilities for new jobs, which directly contributes to economic development at local, regional and national level.*

Keywords – *renewable energy sources, power, heat, solar energy.*

1. INTRODUCTION

Renewable energy sources have their participation in energy balances of almost every country, not to the extent possible against available energy resources, although they allow an application of clean technologies, reduce pollution and energy dependence on fossil fuel markets, enable development of new technologies and support infrastructure to create new jobs.

Rational energy management is one of the primary interests of society as a whole. There is an interest in increasing the participation of renewable energy sources (RES) in energy sector, along with increasing population and growing demands for energy production and consumption, as well as the fact of limited resources of fossil fuels whose use leads to environmental pollution (the emergence of the greenhouse effect and global warming).

Unlike conventional technologies, renewable energy sources use many dispersed sources of energy, compatible with the idea of using a "smart grid" as a technical solution for the power distribution system.

The Pannonian part of Serbia and Croatia consists of Vojvodina Province and Slavonia. Due to the fact that collection of energy related data in Croatia is fully centralized, some energy data are unavailable at regional level and therefore cannot be included in analysis.

The interest in increasing the use of RES is recognized in both countries at national and regional level and documented by energy strategy acts: Strategy of energy development of the Republic of Serbia until 2015 [1] and Program of realization of the energy development strategy of the Republic of Serbia for Vojvodina Province (2007-2012) in RES domain [2], and Energy Development Strategy of the Republic of Croatia (Green book) [3].

Technically usable energy potential of RES in Serbia is estimated to over 3.83 Mtoe, in Vojvodina Province it is 1.293 Mtoe [4] and for Croatia this value is around 1.045 Mtoe [3].

When focusing on solar energy potentials it is important to mention that the intensity of solar radiation in Serbia and Croatia is one of the highest in Europe. It goes up to 1850kWh/m^2 and 1750kWh/m^2 in southern Croatia and southern Serbia, respectively [5].

According to the above mentioned data, it is obvious that there is an interest in an increase of RES involvement in energy balances of each country with focus on solar energy potentials.

2. ENERGY NEEDS OF VOJVODINA PROVINCE AND SLAVONIA

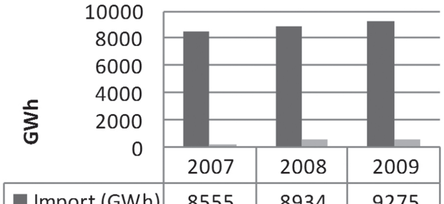
Primary energy for Vojvodina Province in 2010 was 4.216 Mtoe, which is 17% more than the available primary energy estimated for the year 2009 (3.607 Mtoe). The structure of energy is mostly the same, with oil having the largest share of 42.6% and RES with only 2.4% [4], [6].

Projected net energy imports in 2010 were 3.008 Mtoe, which is about 21% more than in 2009 (2.494 Mtoe). Import dependency in 2010 was about 72.2%, which is 2% higher than in 2009 (70.2%). For these reasons, the available potential of renewable energy as fuel for energy transformation should be used in Vojvodina Province [4], [6].

Projection for Slavonia on primary energy and thermal energy cannot be obtained at regional level. However, data are available at national level. In 2008, Croatia used 9.860 Mtoe of primary energy with 43.6% of oil as the largest share but with 12.3% in RES coming mainly from large hydroelectric power plants and only recently a small share from non-conventional RES production. Similarly to Vojvodina Province, Slavonia largely depends on the transmission network electricity import. The total installed electric power in Slavonia is only 143 MW. Although Croatia has a large share of hydroelectric power plants in electricity production (up to 60% depending on the hydrology), none of those 26 large power plants with over 2100 MW of installed electric power are located in Slavonia. Therefore, the share of RES in the overall electricity consumption in Slavonia is currently only 2.2% coming mainly from several recently installed biomass and biogas CHP plants.

2.1. ELECTRIC POWER

Vojvodina Province is supplied with electricity from three facilities for combined heat and power (CHP) production located as part of the Pannonian CHP. The total installed electric power of generators is 425 MW, while net power is 363 MW. These capacities have the status of peak sources and their operation depends on the needs of the electric power system. Electricity generated in CHP on the territory of Vojvodina shall be delivered to the network of the Electric Power Industry of Serbia (EPIS), and it represents domestic energy production. The difference between the amount of electricity demand in Vojvodina and the amount of domestic electricity production is called electricity "import". Figure 1 shows that domestic electricity production is almost negligible compared to electricity taken from the transmission network [1,2].



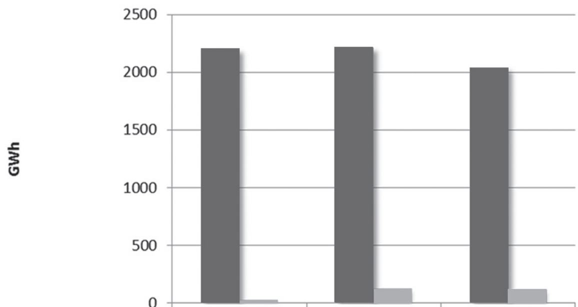
	2007	2008	2009
Import (GWh)	8555	8934	9275
Production (GWh)	262	591	623.1

Fig. 1. The ratio between production and "import" of electricity in Vojvodina Province [6]

Due to the history of the power system development in former Yugoslavia, Slavonia is supplied with electricity mainly from a single 400/110 kV transformer station Ernestinovo and the respected 400 kV network with only a small share of electricity production located locally. Production capacities in the Pannonian part of Croatia are represented by:

- CHP plant Osijek, which consists of the steam turbine block with installed capacity 45 MW and two gas-turbine blocks with installed capacity of 2x25 MW and,
- Industrial plants “Belisce dd” with installed capacity of 31 MW and “Sladorana dd Zupanja” with installed power of 10 MW,
- Four new biogas plants, two in Ivankovo and two in Tomasanci – each having 1 MW of installed electric power,
- Cogeneration power plant “Strizivojna Hrast” that operates on wood biomass with 3 MW of installed electric power, and
- Photovoltaic power plant “Lovric” with installed power of 0.01 MW.

Annual electricity consumption for the period from 2007 to 2009 is shown in Figure 2.



	2007	2008	2009
Consumption (GWh)	2195.358	2213.752	2039.548509
Generation (GWh)	24.402	125.153	113.454

Fig. 2. Electricity production and consumption in the Pannonian part of Croatia [7]

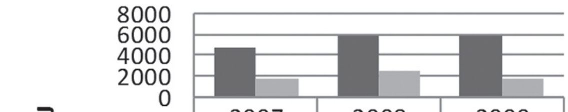
According to Figure 2, electricity production in Slavonia increased from 24.4 GWh in 2007 to 113.5 GWh in 2009, while consumption was slightly reduced from 2195.4 GWh in 2007 to 2039.5 GWh in 2009. [3]

New RES power plants Ivankovo 2, Tomasanci 2, Strizivojna Hrast and a photovoltaic power plant Lovric have been installed recently (from 2009 to 2011) according to the general rapid growth of RES electricity production based on the 2007 incentive tariff scheme for RES electricity in Croatia. This growth is expected to continue in near future.

2.2. THERMAL ENERGY

Thermal energy is generated in 20 thermal power plants and 3 CHP plants as parts of the Pannonian CHP in Vojvodina Province. The most common energy source used in the production of thermal energy is natural gas, which has increasingly replaced other fuels, leading to enhancement of environmental protection.

In Vojvodina Province, district heating is available in 21 settlements and it provides 140,000 users with heat.



	2007	2008	2009
Heating plants (TJ)	4759.11	5758.36	5806.5
CHP (TJ)	1645.66	2521.92	1783.56

Fig. 3. Thermal energy production in Vojvodina Province from 2007 to 2009 [8]

Figure 3 shows an increase in thermal energy produced in heating plants, while production of thermal energy from CHP is three times less than in heating plants.

There are no available data on thermal energy for Slavonia at regional level.

2.3. RENEWABLE ENERGY

Unlike conventional technologies, renewable energy sources use many dispersed sources of energy for energy production. Use of RES enables a real possibility for achieving energy independence and stability, as well as reduction of energy dependence on the fossil fuel import.

A technically usable energy potential of RES in the Republic of Serbia is estimated to be over 3.83 million toe (tons oil equivalent) per year, where the participation of each renewable energy source in this potential is as follows:

- around 2.4 million toe per year (62.7% of the total potential) is located in the utilization of biomass; whereby the potential of wood biomass is approximately 1.0 million toe while agricultural biomass makes more than 1.4 million toe,
- around 0.4 million toe per year (10.4% of the total potential) is located in small river streams where small hydropower plants can be built,
- around 0.2 million toe per year (5.2% of the total potential) represents the existing geothermal resources,
- around 0.19 million toe per year (5% of the total potential) is located in wind power,
- around 0.64 million toe per year (16.7% of the total potential) is located in the utilization of solar radiation [8].

When it comes to using the potential of renewable energy sources in Vojvodina Province, the share of

RES in energy production was planned to be 7.7% in 2010. The total potential of RES in Vojvodina Province is around 1,293 ktoe per year and divided by the sources (Figure 4) it is as follows:

- 768 ktoe per year is located in biomass,
- 150 ktoe per year is located in biofuels,
- 3 ktoe per year is located in biogas,
- 65 ktoe per year is located in wind energy,
- 22 ktoe per year is located in geothermal energy,
- 7.7 ktoe per year is located in small hydropower plants,
- 85 ktoe per year is located in large hydropower plants, and
- 34 ktoe per year is located in solar energy [4].

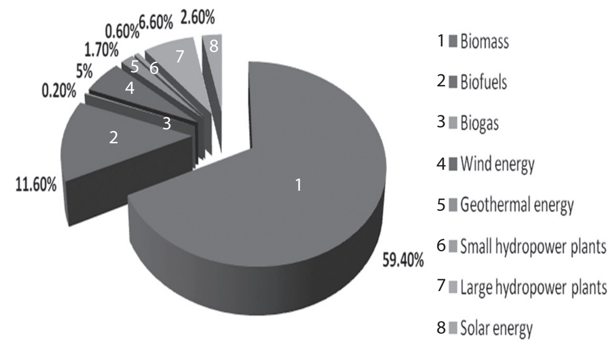


Fig. 4. Participation of different renewable energy sources in the total renewable energy potential of Vojvodina Province in 2010 [4]

Possible thermal energy production from RES in Vojvodina Province is around 44,890 TJ per year, i.e. 35,000 TJ per year from biomass, 90 TJ from biogas, 1,800 TJ from geothermal energy, 6,600 TJ from municipal waste and 1,400 TJ from solar energy [4].

Possible electric energy production from RES in Vojvodina Province is around 2,266 GWh per year, i.e. 360 GWh per year from biomass, 20 GWh from biogas, 750 GWh from wind energy, 90 GWh from small hydropower plants and 990 GWh from large hydropower plants [4].

The share of RES in total energy consumption in Vojvodina Province was around 2% in 2009, i.e. 0.09 Mtoe.

In 2009, total energy production from RES was 0.019 Mtoe, whereby biofuels (biodiesel), geothermal energy, solid biomass, and firewood were 0.004 Mtoe, 0.002 Mtoe, 0.000 Mtoe and 0.0013 Mtoe, respectively. According to Energy Balance of Vojvodina Province, solar energy did not participate in primary energy production [6].

According to the Strategy of Energy Development of the Republic of Croatia, total possible energy production from RES in Croatia is estimated for reference years 2010, 2020 and 2030, respectively. The data is presented in Table 1.

Table 1. RES energy potentials in Croatia [9]

RES	2010	2020	2030
Biomass and Biogas [ktoe]	433	809	1,641
Biofuels [ktoe]	60	228	343
Wind energy [ktoe]	24	227	378
Small hydropower [ktoe]	9	23	37
Large hydropower [ktoe]	503	567	567
Geothermal energy [ktoe]	4	132	204
Solar energy [ktoe]	12	126	331
Total [ktoe]:	**1,045**	**2,112**	**3,502**

Note: All data presented in Table 1 and Figures 4 and 5 hold for the entire Croatia. However, although there are no available data at regional level for Slavonia, due to high potentials on biomass, biogas and biofuel production we can expect at least 50% of share of RES production of Croatia in Slavonia, with up to 20% of share in geothermal and solar energy and unfortunately no real potentials in hydropower and wind energy.

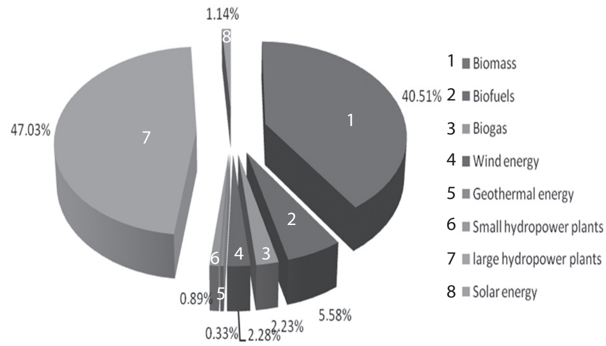


Fig. 5. Participation of different renewable energy sources in total renewable energy potential of Croatia (2010) [9]

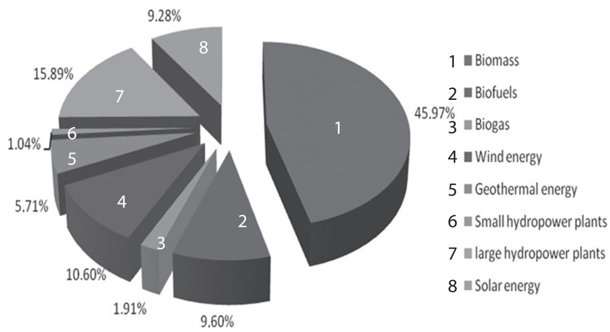


Fig. 6. Expected participation of different renewable energy sources in total renewable energy potential of Croatia (2030) [9]

Due to the incentive scheme for RES electricity production in Croatia, this market is growing rapidly and the expected installed electrical RES capacities in Croatia in 2020 are 1,575 MW with expected energy production of over 4,820 GWh/a, but mainly (over 2,800 GWh/a) in wind power plants which are due to limited wind potentials not located in Slavonia. In Slavonia, we can expect over half of 135 MW of planned installed biomass power plants in Croatia with expected energy production of over 1,020 GWh/a and a smaller share of overall 35 MW in waste power plants with expected energy production of 260 GWh/a and 20 MW in geothermal power plants with expected energy production of over 150 GWh. 45 MW of photovoltaic power plants with expected energy production of over 50 GWh are expected in Croatia by 2020, highly depending on installation prices and the tariff scheme development.

3. SOLAR ENERGY POTENTIAL IN SERBIA AND CROATIA

During solar system design, one of the main factors is solar radiation data at specific locations. These data imply:

- information on latitude and longitude of observed point/location on the Earth's surface,
- its elevation, slope angle relative to the horizontal plane,
- orientation, location, etc.

Solar database (PV GIS) is supplemented with data on the average state of atmospheric pollution and cloud cover obtained from meteorological satellites. When this database is implemented in the calculations of solar radiation, very precise data on solar radiation can be obtained for each point of the Earth's surface, taking into account even the relief and shadows.

The intensity of solar radiation in Serbia and in Croatia is among the most important ones in Europe. For example, the annual sum of global irradiation is from 1,300kWh/m2 in northern Croatia and 1,400kWh/m2 in northern Serbia to 1,850kWh/m2 in southern Croatia and 1,750kWh/m2 in southern Serbia. Possible annual electricity generation by 1kWpeak systems is from 975kWh/kW in northern Croatia and 1,050kWh/kW in northern Serbia to 1,375kWh/kW in southern Croatia and 1,300kWh/kW in southern Serbia [5].

3.1. SOLAR ENERGY POTENTIAL IN PANNONIAN PART OF SERBIA AND CROATIA

The potential of solar energy for the Pannonian part of Serbia and Croatia is shown in Figure 1. It can be seen that the values of solar radiance in this area range between 1,300 kWh/m2 and 1,700 kWh/m2.

Solar radiation has the lowest value in northern and western parts of Vojvodina Province, and the highest in the southern and eastern part. The other part, which makes up most of the province, has an irradiance equal to the average irradiance for the province. Sombor and Vrsac are the regions with the lowest and the highest solar radiation, respectively.

In the Pannonian part of Croatia, the situation is similar to the one in Serbia. The location with highest irradiance is south-eastern part of Slavonia, and the location with the least irradiance is north-west part of Slavonia.

According to the annual irradiation sum, the Pannonian part of Serbia as well as Croatia is divided into three regions. Three characteristic and representative cities in the Pannonian part of Serbia are chosen and these are Sombor, Novi Sad and Vrsac. In the Pannonian part of Croatia, they are the following: Virovitica, Osijek and Zupanja. Solar radiation has the lowest value in northern and western parts in both regions (Vojvodina Province and Slavonia) and the highest in the southern and eastern part.

Average monthly solar radiation for Sombor, Novi Sad and Vrsac are shown in Figure 7.

The month with the highest irradiance is July and from Figure 6, it can be seen that Sombor has irradiance of 179.8 kWh/m2, Novi Sad has 187.55 kWh/m2 and Vrsac has 188.79 kWh/m2. The coldest month is December, where irradiation values are 40.69 kWh/m2 in Sombor, 48.98 kWh/m2 in Novi Sad and 51.46 kWh/m2 in Vrsac [6].

Average monthly solar radiation data for Virovitica, Osijek and Zupanja are shown in Figure 8.

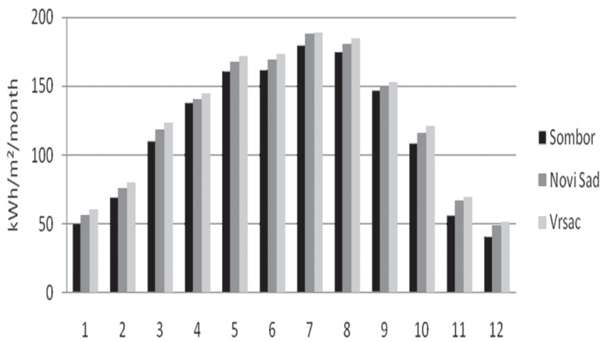


Fig. 7. Average monthly radiation data for Sombor, Novi Sad and Vrsac (optimal angle) [5]

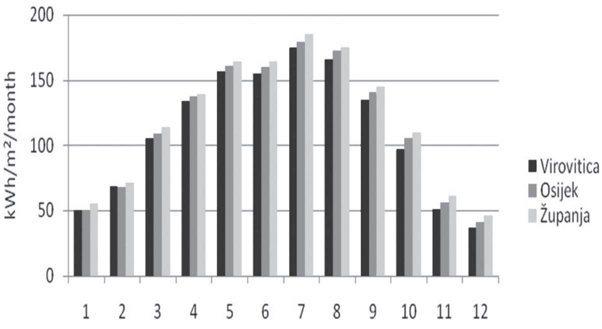


Fig. 8. Average monthly radiation data for Virovitica, Osijek and Zupanja (optimal angle) [5]

The month with the highest irradiance is July and from Figure 8, it can be seen that Virovitica has irradiance of 175.46 kWh/m2, Osijek has 179.49 kWh/m2 and Zupanja has 184.14 kWh/m2. The coldest month is December, where irradiation values are 37.2 kWh/m2 in Virovitica, 40.92 kWh/m2 in Osijek and 6.81 kWh/m2 in Zupanja [6].

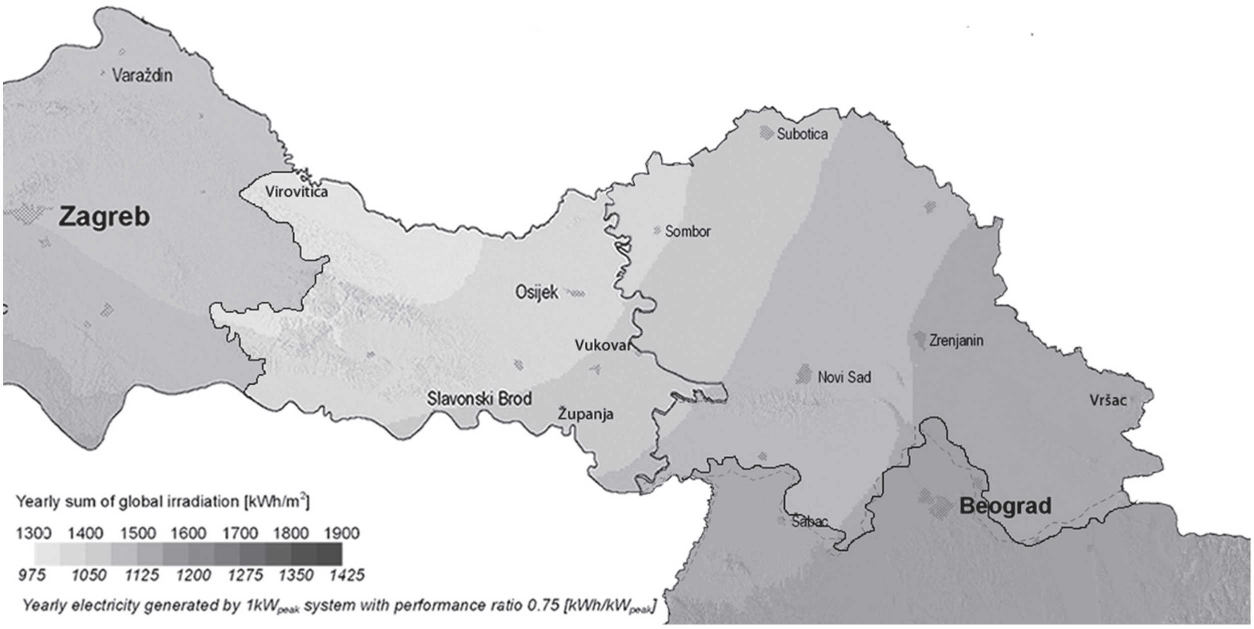
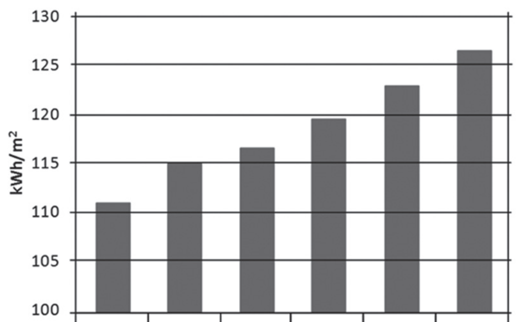


Fig. 9. Solar energy potential in the Pannonian part of Serbia and Croatia [5]



	Virovitica	Osijek	Sombor	Zupanja	Novi Sad	Vrsac
Average annual solar radiation [kWh/m²]	110.98	115.017	116.55	119.64	122.92	126.67

Fig. 10. Average annual solar radiation (kW/m2) [5]

The average annual solar radiation for optimal angle for Sombor, Novi Sad and Vrsac is 116.55 kWh/m2, 122.92 kWh/m2 and 126.67 kWh/m2, respectively.

The average annual solar radiation for optimal angle for Virovitica, Osijek and Zupanja is 110.98 kWh/m2, 115.017 kWh/m2 and 119.64 kWh/m2, respectively.

Annual irradiance, as well as monthly irradiance in Vojvodina region is slightly higher than in Slavonia, as shown in Figures 5-7. Data for Figures 5-7 are obtained through PVGIS [5].

As can be observed from Figure 1 and Figure 7, average annual sun radiation mainly depends on the geographical coordinates due to the fact that most of the region is plane with similar altitude and climate conditions [11].

4. TRENDS

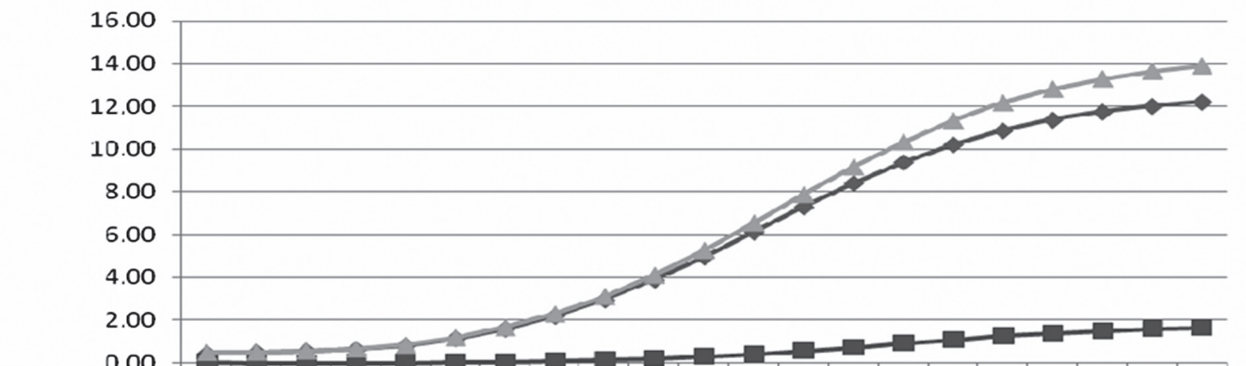
The technical potential of solar energy on 1% of the land area of Croatia is estimated at 830 TWh/a (3,000 PJ/a), or around 10 times of today's primary energy consumption in Croatia, according to the Energy Development Strategy of the Republic of Croatia (Green book)[3]. Assuming that 60% of that energy is used for thermal energy production and 40% for electricity production [9]:

- the technical potential of thermal energy from solar collectors and passive use of solar energy (solar architecture) is 175 TWh/a (630 PJ/a),
- the technical potential of electricity production from photovoltaic systems and solar thermal power plants amounts to around 33 TWh/a.

The technical potential for the Pannonian part of Croatia can be determined for 1% of the mainland and with previously mentioned assumptions, taking into account that all projections are given for the Republic of Croatia as a whole [2]. The total area of the Pannonian part of Croatia is 14,258 km2. The technical potential of solar energy in this territory is 197 TWh/a, with average annual solar radiation of 114.9 kWh/m2 for 1% of the territory. The technical potential of solar energy used for thermal energy production is 118.2 TWh/a (which is 60%) and for electricity production it is 78.8 (40%) [9].

Since the projection for Vojvodina Province is not given in the Energy Balance and the Energy Development Strategy of the Republic of Serbia in AP Vojvodina, according to the methodology of the Croatian Strategy (mentioned in the previous paragraph), the technical potential of solar energy is the average annual solar radiation of 122.05 kWh/m2 to 1% of the territory of Vojvodina Province (total area of 21,506 km2) that can be used to produce 314.98 TWh/a of electricity from solar energy. From this amount, 60% is attributed to the technical potential of thermal energy production, which is 188.99 TWh/a, and 40% is to be used to produce 125.99 TWh/a of electricity.

In Serbia, in 2010, the Provincial Secretariat for Energy announced two tenders for granting stimulating funds of up to 80% of investments for the use of solar thermal collectors, both for public sector, i.e. budget users (high school student dormitories), and for private sector in tourism. More than 20 installations of solar hot water systems, small and medium capacity were expected to be built in 2011 [4].



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PTV [PJ]	0.45	0.51	0.56	0.64	0.81	1.14	1.60	2.20	2.96	3.89	4.96	6.12	7.30	8.41	9.39	10.22	10.87	11.37	11.75	12.02	12.21
FN [PJ]	0.05	0.01	0.01	0.02	0.03	0.04	0.07	0.10	0.14	0.21	0.30	0.42	0.57	0.74	0.93	1.11	1.28	1.42	1.53	1.61	1.66
Ukupno	0.50	0.52	0.57	0.66	0.84	1.19	1.66	2.30	3.11	4.10	5.27	6.55	7.87	9.16	10.32	11.33	12.15	12.79	13.27	13.62	13.87

Fig.11. Dynamics of growth for solar energy utilization in Croatia by the year 2030 [9]

In the field of utilization of solar energy, the Energy Sector Development Strategy of the Republic of Croatia sets the following two objectives:

- For solar thermal systems, by the year 2020, the situation in the Republic of Croatia must be equal with the one between Germany and Greece observed per number of residents today (the target is 0.225 m2 per capita),
- For photovoltaic systems, by the year 2020, the situation in the Republic of Croatia must be equal with the one in Spain observed per number of residents today (the target is 11.71 W per capita), and by the year 2030, with the one in Germany (over 45 W per capita).

Table 2. The increase in solar energy utilization in Croatia by the year 2030 [9].

	2010	2020	2030
Solar energy – STC (PJ)]	0.5	4.96	12.21
Number of residents that use STC (1.5 m^2 of solar collector per capita)	67 691	660 000	1 653.01
Average m^2 per 1,000 capita	23.8	225.00	563.53
Solar energy – PV (PJ)	0.01	0.3	1.6
Installed power (MWp)	1.5	45.66	252.66
Average power (W) per capita	0.34	10.38	57.42
Solar energy – total (PJ)]	**0.51**	**5.27**	**13.87**

The assumed growth rate of using STC systems is 47% per year until 2010, and after 2020 the growth rate is expected to slow down to about 10% annually. The assumed growth rate of using PV systems is 68% per year until 2020, and by the year 2030 it is forecast to be by 20% per year. The total number in the control years is shown in Table 2 and the dynamics of growth is presented in Figure 8.

The calculations took into account that the average insolation in Croatia is around 1.37 MWh/m2/a. For STC systems, it is assumed that 1.5 m2 of solar collectors per capita could be installed, and 1,825 hours of peak power of photovoltaic systems could be obtained annually (with maximum radiation, an average of 5 hours a day all year round) [9].

5. CONCLUSION

Investment in the energy segment in the field of RES enables Vojvodina Province and Slavonia to reduce energy dependence on the fossil fuel market using their own available renewable resources. Application of RES enables the development and application of new technologies and supporting infrastructures, and thereby creation of new jobs, which directly contributes to economic development at local, regional and national level of each country.

The significance of replacing fossil fuels with renewable energy can be seen in several aspects:

- reducing emissions of harmful substances and encouraging sustainable development,
- energy effects (reduction in consumption of imported energy sources and threats to the environment),
- engagement of domestic investment capital, in order to encourage domestic production and development of equipment for the use of RES,

- a possibility that domestic economy participates in offers from foreign investors investing in RES,
- creating new jobs,
- application of RES provides a realistic chance of achieving energy independence and stability of the country reducing thereby their dependence on imported energy,
- use of clean technologies.

As mentioned earlier, according to Energy Balance of Vojvodina Province, the share of RES in total energy consumption in Vojvodina Province was around 2% (0.09 Mtoe) in 2009, while in total energy production it was 0.019 Mtoe and solar energy did not take part in primary energy production. It is expected that the percentage of RES used in total energy consumption in Vojvodina Province can be raised up to 20% in the next decade, by combining the methods of introducing new and renewable energy sources, systematically implementing the measures with the purpose to increase energy efficiency as well as to use new technologies.

For Croatia, there is no available data on the regional level but it is expected that at least 50% of the share of RES production of Croatia will be located in Slavonia, with up to 20% of share in geothermal and solar energy.

The intensity of solar radiation in Serbia and in Croatia belongs to the highest ones in Europe. It goes up to 1,850kWh/m2 in southern Croatia and 1,750kWh/m2 in southern Serbia [5],[10],[11].

At regional level, Sombor and Virovitica are regions with the lowest and Vrsac and Zupanja with the highest solar radiation. In July, which is the month with the highest values of solar radiation, Sombor and Virovitica have irradiance of 179.8 kWh/m2 and 175.46 kWh/m2, respectively, while Vrsac and Zupanja have irradiance of 188.79 kWh/m2 and 184.14 kWh/m2, respectively. Annual irradiance as well as monthly irradiance in Vojvodina Province is slightly higher than in Slavonia due to geographical coordinates and the fact that most of the region's territory is plane with similar altitude and climate [5].

The technical potential of solar thermal energy in Slavonia is 118.2 TWh/a, and the technical potential of electricity production is around 78.8 TWh/a [4]. In Vojvodina Province, the technical potential of solar energy has a higher value and it goes up to 190.3 TWh/a in thermal energy production and 126.9 TWh/a in electricity production.

In 2010 in Serbia, there were stimulating funds that offering up to 80% of investment for using solar thermal collectors for public sector (high school student dormitories) and for private sector in tourism. In 2011, more than 20 installations of solar hot water systems were expected to be built. Prediction for utilization of solar energy for electricity production has not been given yet [8]. There are no future predictions on regional level.

In future predictions for solar energy utilization in Slavonia, STC systems utilization will have assumed growth rate of 47% per year until 2010. After the year 2020, the growth rate is expected to slow down to 10% annually, while the assumed growth rate of PV systems utilization is 68% per year until 2020, and by the year 2030 the growth will be 20% per year.

Due to data analysis, it could be noticed that in comparison to Slavonia, Vojvodina Province has an advantage regarding energy data availability since collection of data is possible for Vojvodina as an administrative unit. On the other hand, Slavonia is facing the problem of energy data collection since it is fully centralized in Croatia.

Compared with the Croatian Energy Strategy, it was observed that Serbian as well as Vojvodina's Energy Strategy in the RES domain could be improved by using the Croatian methodology and procedures.

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