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SUMMARY OF THE USING SOLAR ENERGY ON THE GLOBAL LEVEL AND IN THE REPUBLIC OF SERBIA

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Abstract: *This work shows an overview on current renewable energy resources, paying special attention to solar energy. Also, an overview of perspective for the further development of their usage has been given. Global potentials have been analyzed in the area of renewable energy resources as well as available potentials in the Republic of Serbia. During the last years, the usage of the renewable energy resources has been increased so that the Europe Union Directive 2009/28/EC forsees the increase of renewable energy resources' participation in the total energy consumption until 2020, year up to 20%. Technically utilized energy potential of the renewable energy resources (OIE) in the Republic of Serbia is very significant and estimated on over 6 million tons equivalent of oil (ten) annually. However, the renewable energy resources' participation in the total energy balance, excluding big power plants as well as biomass, has still been on a low scale. The usage of renewable energy resources is one of the key components of sustainable development which provides rational economic, ecological and social effects.*
Keywords: *renewable energy resources, solar energy, production, energy fuel*

INTRODUCTION

The term of renewable energy resources refers to the energy resources which could be found in the nature and are renewable completely or partly and these are as follows: solar energy, waterflow and wind energy, biomass, geothermal energy and etc.

Renewable energy resouces are used for the production with about 1% of energy production in total in the world. Development of the renewable energy resources, in particular solar, water and wind energy and biomass – is the main aim of the energy politics of European Commission – European Commission department for energy and transport.

Europe Union has brought several directives which refer to the renewable energy resources: Directives 2001/77/EC, 2003/30/EC and 2009/28/EC. In the last directive, it is forseen that until the year of 2020. The renewable energy resources participate with at least 20% of total energy consumption in the Europe Union. This directive also forsees that until the year of 2020, the usage of the renewable energy in transport (biogas, electric energy and hydrogen produced out of the renewable resources) will be at least 20% of total fuel consumption in the Europe Union [7].

The Republic of Serbia has adopted numerous documents in the area of the renewable energy resources and created the favourable conditions for a significant increase of production and consumption of these energy resources but the energy production from the renewable energy resources has still been insufficient. The usage of the renewable energy resources in Serbia is very important due to the scarce potential of conventional energy resources. Furthermore, the usage of these resources contributes to even more efficient usage of own potential in energy production which is important in decrease of the emission of "gases of the green garden effects", decrease of fossil fuel import, development of the local industry, especially in rural areas and opening of new working post. Solar energy is a form of energy with the biggest potential.

Solar energy presents an inexhaustable ecological energy resource whose global potential multifunctionally undergoes the world's needs for the electricity.

AVAILABLE POTENTIAL OF RENEWABLE ENERGY – Global production

The most important energy of 20 century was oil. In the world's primary energy consumption oil has participated with about 31.5%, coal with about 28.8%, gas with about 21.3%, renewable energy with about 13.3% and nuclear energy with about 5.1% (See Figure 1) [1].

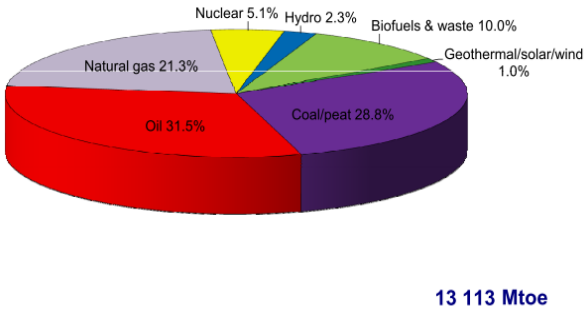

Figure 1. Share of total primary energy supply in 2011. - Source: IAE, 2013

Global demand for renewable energy continued to rise during 2011 and 2012, despite the international economic crisis, ongoing trade disputes, and policy uncertainty and declining support in some key markets. Renewable energy supplied an estimated 19% of global final energy consumption by the end of 2011, the latest year for which data are available. Of this total, approximately 9.3% came from traditional biomass, which is used primarily for cooking and heating in rural areas of developing countries. Useful heat energy from modern renewable sources accounted for an estimated 4.1% of total final energy use; hydropower made up about 3.7%; and an estimated 1.9% was provided by power from wind, solar, geothermal, and biomass, and by biofuels (See Figure 2) Renewables are a vital part of the global energy mix[2].

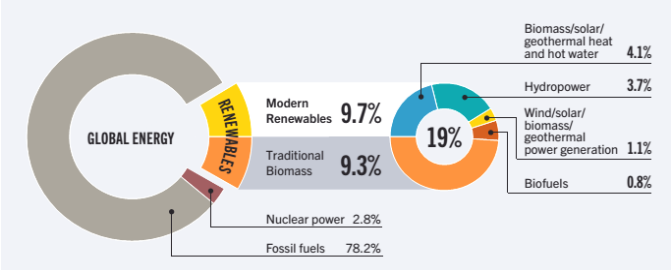

Figure 2. Estimeted renewable energy share of global final energy consumption 2011. Source: GLOBAL REPORT, 2013

Renewables have accounted for an ever-growing share of electric capacity added worldwide each year, and in 2012 they made up just over half of net additions to electric generating capacity. By year's end, renewables comprised more than 26% of total global power generating capacity and supplied an estimated 21.7% of global electricity, with 16.5% of total electricity provided by hydropower (See Figure 3.) While renewable capacity rises at a rapid rate from year to year, renewable energy's share of total generation is increasing more slowly because many countries continue to add significant fossil fuel capacity, and much of the renewable capacity being added (wind and solar energy) operates at relatively low capacity factors [2].

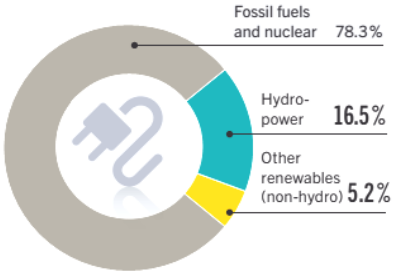

Figure 3. Estimated renewable energy share of global electricity production end 2012. - Source: GLOBAL REPORT, 2013.

		2010	2011	2012
Investment in new renewable capacity (annual)[1]	billion USD	227	279	244
Renewable power capacity (total, not including hydro)	GW	315	395	480
Renewable power capacity (total, including hydro)	GW	1,250	1,355	1,470
Hydropower capacity (total)[2]	GW	935	960	990
Bio-power generation	GWh	313	335	350
Solar PV capacity (total)	GW	40	71	100
Concentrating solar thermal power (total)	GW	1.1	1.6	2.5
Wind power capacity (total)	GW	198	238	283
Solar hot water capacity (total)[3]	GW_{th}	195	223	255
Ethanol production (annual)	billion litres	85.0	84.2	83.1
Biodiesel production (annual)	billion litres	18.5	22.4	22.5

Figure 4. Average annual growth rates of renewable energy capacity - Source: GLOBAL REPORT, 2013

During the five-year period 2008–2012, installed capacity of many renewable energy technologies grew very rapidly, with the fastest growth in the power sector. Total capacity of solar photovoltaics (PV) grew at rates averaging 60% annually (See Figure 4). Solar PV experienced continued price reductions in 2012 due to economies of scale and technology advances, but also due to a production surplus of modules. Combined with the international economic crisis (which has helped

drive policy changes) and ongoing tensions in international trade, these developments have created new challenges for some renewable energy industries and, particularly, equipment manufacturers [2].

Total renewable power capacity worldwide exceeded 1,470 gigawatts (GW) in 2012, up about 8.5% from 2011. Hydropower rose to an estimated 990 GW, while other renewables grew 21.5% to exceed 480 GW. Globally, wind power accounted for about 39% of renewable power capacity added in 2012,

followed by hydropower and solar PV, each accounting for approximately 26% (See Figure 5). Solar PV capacity reached the 100 GW milestone to pass bio-power and become the third largest renewable technology in terms of capacity (but not generation), after hydro and wind. [1].

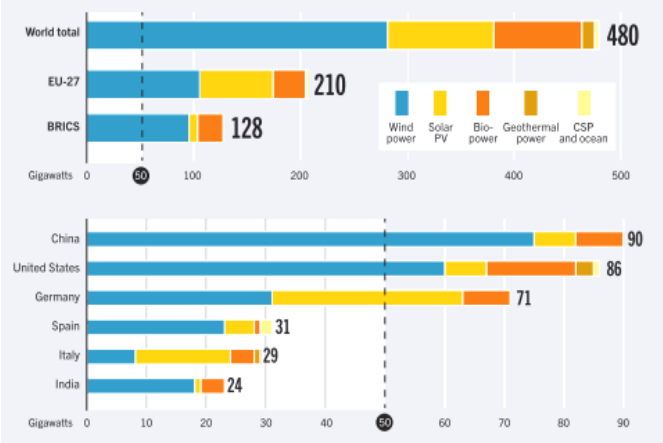

Figure 5. Renewable energy capacities – source: GLOBAL REPORT, 2013

The solar photovoltaic (PV) market saw another strong year, with total global operating capacity reaching the 100 GW milestone in 2012. The market was fairly stable relative to 2011, with slightly less capacity brought on line but likely higher shipment levels, and the more than 29.4 GW added represented nearly one-third of total global capacity in operation at year's end 2 (See Figure 6) [1].

Eight countries added more than 1 GW of solar PV to their grids in 2012, and the distribution of new installations continued to broaden. The top markets are Germany, Italy, China, the United States, and Japan were also the leaders for total capacity. By year's end, eight countries in Europe, three in Asia, the United States, and Australia had at least 1 GW of total capacity. The leaders for solar PV per inhabitant were Germany, Italy, Belgium, the Czech Republic, Greece, and Australia (See Figure 7).

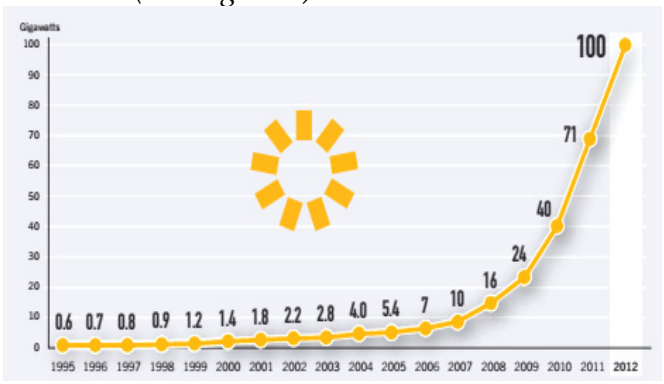

Figure 6. Solar PV global capacity, 1995 - 2012 – source: GLOBAL REPORT, 2013

Europe again dominated the market, adding 16.9 GW and accounting for about 57% of newly installed capacity, to end 2012 with 70 GW in operation. For the second year running the EU installed more

PV than any other electricity-generating technology: PV represented about 37% of all new capacity in 2012. [1].

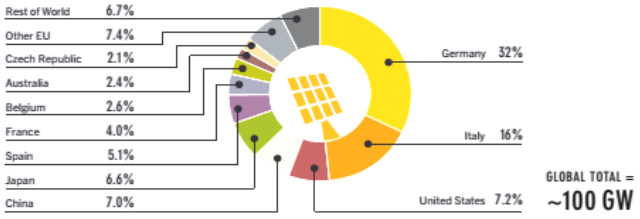

Figure 7. Solar PV global capacity, shares of top 10 countries – source: GLOBAL REPORT, 2013

The number and scale of large PV projects continues to increase. By early 2013, about 90 plants in operation were larger than 30 MW, and some 400 had at least 10 MW of capacity. The world's 50 biggest plants reached cumulative capacity exceeding 4 GW by the end of 2012, and at least 12 countries across Europe, North America, and Asia had solar PV plants over 30 MW. More than 20 of these facilities came on line in 2012, including the world's two largest: a 250 MW thin film plant in the U.S. state of Arizona and a 214 MW plant in Gujarat, India. Germany held on to its lead for total capacity of facilities larger than 30 MW, with a cumulative 1.55 GW in operation by year's end, followed by the United States, France, India, Ukraine, China, and Italy. Several projects are planned around the world that range from 50 to 1,000 MW in scale [1].

Solar PV is starting to play a substantial role in electricity generation in some countries, meeting an estimated 5.6% of national electricity demand in Italy and about 5% in Germany in 2012, with far higher shares in both countries during sunny months. By year's end, PV capacity in the EU was enough to meet an estimated 2.6% of total consumption, and global capacity in operation was enough to produce at least 110 TWh of electricity per year [1].

Available potential of renewable energy in the Republic of Serbia

In the Serbia's primary energy consumption oil has participated with about 23.2%, coal with about 54.1%, gas with about 11.7% and renewable energy with about 11% (See Figure 8.) [5].

In Figure 9, shows the shares of different energy sources in electricity production in Serbia. The diagram shows that around two-thirds of electricity generation from fossil fuels, ie. coal, while other sources significantly represented hydro (with a share of 21.2%), mainly due to conventional large hydro [5].

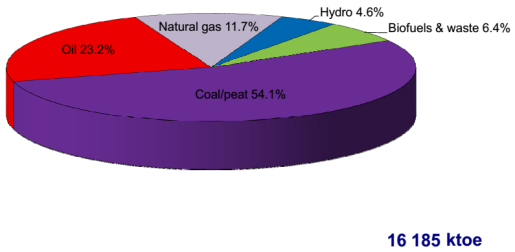

Figure 8. Share of total primary energy supply in 2011. - Source: IAE, 2013

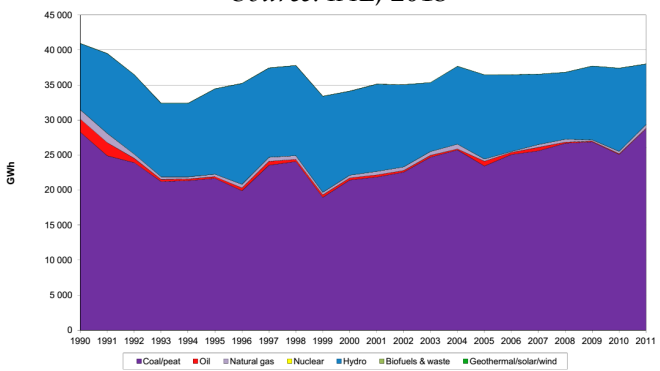

Figure 9. Estimated renewable energy share of global electricity production end 2012. - Source: IAE, 2013

As far as exploitation of renewable energy sources in the Republic of Serbia is considered, these sources are widely underutilized although having a substantial potential. This is particularly true if water energy conversion is excluded. Some estimates show that total renewable energy sources technically available for exploitation are approximately 6 Mtoe annualy. For electrical energy conversion however, the major potential lies with wind, solar and water energy conversion [4].

Renewable energy structure in Republic of Serbia:

- *Biomass 3.3 Mtoe - 65% of total potencial;*
- *Water energy 1.7 Mtoe - 15% of total potencial;*
- *Geotermal energy 0.2 Mtoe - 4% of total potencial;*
- *Wind energy 0.2 Mtoe - 4% of total potencial;*
- *Solar energy 0.6 Mtoe - 12% of total potencial;*

The Republic of Serbia of all available technical potential of renewable energy is already using 33% (0.9 Mtoe of used water potential and 1.06 Mtoe of the potential of biomass), See Figure 10 [3].

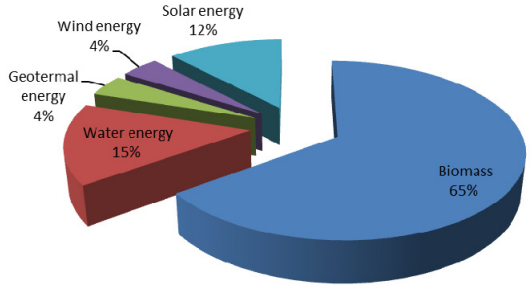

Figure 10. Renewable energy structure in Republic of Serbia – Source: National aims and plan of the Republic of Serbia's

The republic of Serbia has a significant solar potential. With the solar irradiation ranging from the average of 1.1–1.7 kWh/m²/day during January to 5.9 - 6.6 kWh/m²/day during July on a horizontal plane, the Republic of Serbia has the basic element for solar power utilization. Considering the facts shown above, the irradiation on a horizontal plane of 1200 kWh/m²/year (for northwest regions) and 1550 kWh/m²/year (for south regions) can be expected.

These data can be further optimized by using planes at an elevation angle or solar tracking plane (positioning to the sun path). This means that optimizing the photovoltaic plane positioning and angles enables from 1560 kWh/m² /year up to 2000 kWh/m²/year irradiation in the Republic of Serbia depending on the location (Figure 11 and 12) [4].

According to relevant international institution data, the Republic of Serbia has substantial solar energy potentials. By establishing legal and technical regulations, as well as sublegal acts considering enhanced pricings, foundations for investments in the area of renewable power sources

were created. A constant decrease in technology prices and a relatively high price of energy generated using photovoltaic systems are making photovoltaic systems attractive for investment.

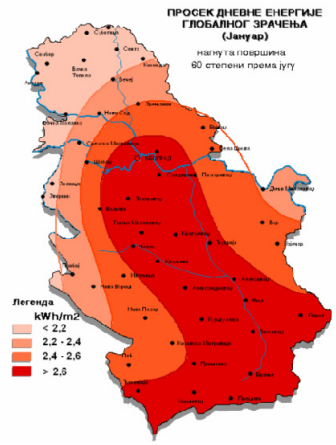

Figure 11. Average daily energy irradiation on January, on a 60 deg, kWh/m²

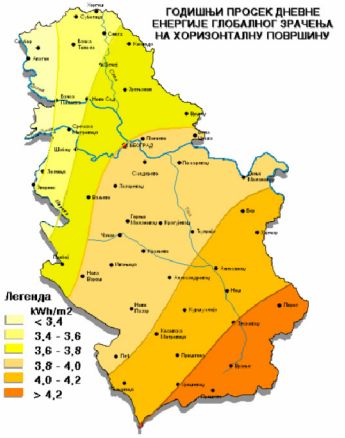

Figure 12. Annuale average daily energy irradiation ona horizontal plane, kWh/m²

NATIONAL STRATEGY AND ENVIRONMENTAL ASPECTS OF THE USING OF RENEWABLE ENERGY

Serbia's energy import dependence in 2010. year was about 33,6%. In the future, the most important it would be to provide secure, high quality and reliable supply of energy and substances and to decrease energy dependence of the country [4].

Reserves of fossil substances, as oil and gas, are very scarce (less than 1% of the total amount of energent reserves in Serbia), and the biggest reserves are in the low quality lignites (about 92% in the total balance of reserves) [4].

National aims and plan of the Republic of Serbia's renewable energy resources usage have been determined within the Law of Energetics. The aims are established according to the energy needs, economic possiblities and obligations of the Republic of Serbia taken over according to the ratified international agreements. [4].

Ratification of the Contract regarding the energy union founding, Serbia has accepted the obligation to bring and pass the plan of application of the directive 2001/77/EC about promoting the production of electricity from OIE and directive 2003/30/EC about promoting the biogas usage and other fuels in the transort sector [6].

Development of the pure, efficient and safe energy supply, promotion of the energy usage method which pollutes less the environment, managing the natural resources and creating industries, services and societies that influence less on the environment – all these are important investments in the future. Since the environment pollution recognizes no limits, fight for the environment and preserving the environment, actually is the fight for the whole continent, but not the fight for the whole planet.

In the process of joining the Europe Union, the electroenergetic sector of the Republic of Serbia will also meet the obligatory and adittional financial costs of the emission of CO_2. At this moment, the Republic of Serbia as a developing country, has no international obligation of decreasing gas emission with the effect of green garden (GHG), but in the moment of joining the EU membership, it will probably be obligatory to limit, i.e. to decrease the emission of the green garden gases.

Working on the structure change of energents for the production of electricity, i.e. significant increase of participation of renewable energy resources which will bring to much lower specific emission of the green garden gases.

CONCLUSION

In the future, global society development will greatly depend on the condition in which the area of energetics is. Problems that all countries in the world more or less confront with are connected to energy providing and preserving the environment. Explosion of human population on the Earth causes constant increase of energy needs, especially electricity demand. The trend of needs' increase on the global level is about 2,8 % annualy [5]. On the

other hand, the current structure of the primary resources of electricity cannot provide, on the global level, such a trend of electricity production increase. The reason for this are current eco problems directly caused by fossil combustion and nuclear fuels, on which is based current electricity production in the world. Beside that, existing dynamics according to which the fossil fuels have been exploited , will in the near future also bring to the exaustion of its resources.

Direct consequence of these contradictory conditions of production and consumption is the constant increase of electricity cost, with which, even on the present level, is being created ecological and economical justified needs of including alternative resources in the global strategy of energetics' delevopment. These energetic flows forced very developed countries to invest huge capital and hire many professionals in the deveopment of the system for using renewable recources of electricity (solar power stations, wind power stations, biomass and biogas power stations, geothermal power stations). As a result of such investments, the technology has been adopted as well as industry for the tecnical reliable conversion of some primary renewable resources. Beside that, international protocols and obligations regarding the CO_2 emission decrease (Kyoto protocol) and local eco problems, forced the Governments of many countries to motivate, with different subsidies , building of eco pure power plants which use renewable resources. This kind of politics has brought to exceptional popularization and fantastic trend of increasing paricipation of certain renewable resources in the total production of electricity. Rapid increase of the photo potential industry in the world with the growth of production capacity and favourable political climate in countries such as Germany, Spain, Japan, China, Italy, Corea, Greece, etc. promise bright perspective of photo potential technology in Serbia as well. However, photo potential industry requires favourable and stable political conditions for constant and sustainable development. Rapid and rashly changes in conditions and amount of subventions and political attitudes could bring into question positive developing trend. Taking into consideration the present importance of photopotential technologies, their long term potentials and time needed for these technologies to develop, the development and application of these technologies completely justify and encourage state support and subventions. Apart from this, the photopotential industry can highly contribute to economy of a country by opening new working posts as well as causing the development of small and medium companies.

REFERENCE

[1.] **** : REN21, Renewables 2007 - 2012: Global Status Report, http:// www.ren21.net/*

[2.] **** : REN21, Renewables 2013: Global Status Report, http:// www.ren21.net/*

[3.] ****: Energy balance of the Republic of Serbia for year 2012, http://www.merz.gov.rs/lat/dokumenti/energetski-bilans-republike-srbije-za-2012-godinu.*

[4.] *http://www.merz.gov.rs/lat*

[5.] *http://www.iea.org/*

[6.] *Government of the Republic of Serbia: Law on Energy, Sluzbeni Glasnik RS No. 84/2004.*

[7.] *Government of the Republic of Serbia: Law on Ratification of the Treaty establishing the Energy Community between the European Community and the Republic of Albania, Bulgaria, Bosnia and Herzegovina, Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Romania, Serbia and the United Nations Interim Mission in Kosovo in accordance with Resolution 1244 United Nations Security Council, Fig. Gazette of RS ", no. No. 62/2006.*

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