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Comparative Analysis of the Economic Assessment of Energy Potential for the Sustainable Development: "Energy Green" at Bridges, Fields and Overbridges

MihajlovićBožidar, SnežanaKirin
(Faculty for SME management, University of Belgrade, Belgrade, Serbia)

Abstract: Serbia basically has mineral resources (mainly zeolites), agriculture with organic food production and energy. When it comes to energy, 16.7 MWh of electric power is lacking in Serbian surroundings. It is a real challenge for domestic and foreign investment. If Serbia this year starts with investments in Energy production, not only 20% of fossil fuel consumption will be eliminated by 2020 (obligations under the Kyoto agreement), but the ability to export energy in the amount of 2.5 to 3 billion Euros annually. Alternative energy sources are a special direction of development. The aim of this paper is to present the results of such studies to the scientific and professional audience.

Key words: energy; alternative energy; energy efficiency
JEL codes: Q20

1. Introduction

Alternative energy resources represent a special direction of development. The purpose of this paper is to inform scientists and experts about our investigations and research.

To that effect, and within established political relations in the world, global problems in world economy are manifested through the lack of: *nutrition, energy, and mineral raw material.*

Serbia has got the first two agents and it could become one of the leading countries in region regarding nutrition and energy. Thus, energy represents the biggest challenge for Serbian country and economy. Natural resources are exhaustible, and developing new technologies and manufacturing alternative (renewable) sources of energy is taking place. Naturally, the most developed world countries take precedence. Small countries are left with managing and using what they know about, resources they already have and the products they will meet in a very strong competition in world market. Therefore, an important question of power rationalization in our condition is posed.

Energy efficiency represents decrease in power utilization per product unit with no influence on quality of products and services. Precondition for meeting this requirement presumes institutional frames in order to achieve

Mihajlović Božidar, Ph.D., Full Professor, University of Belgrade; research areas/interests: economy, finance, energetic resource, business science. E-mail: mihajlovic.bozidar@open.telekom.rs.
Snežana Kirin, Ph.D., Research Associate, University of Belgrade; research areas/interests: risk assessment, decision making, management; E-mail: snezanakirin@yahoo.com, skirin@mas.bg.ac.rs.

this level of reasonable treatment, by means of legal, structural-organizational and financial economy reforms in respective conditions of energy sector.

Serbia has signed several very important documents regarding utilization of fossil fuels. Our country has also signed several Protocols within International Renewable Energy Agency (IRENA). Moreover, Serbia participates in constitutive conference of this international institution that took place in Bonne on January 26 and 27th, 2009.

Main goal of IRENA is to become major motive power in rapid transition towards widespread and sustainable utilization of renewable energy worldwide.

The second important document is so-called "Green Book", namely—European Strategy for Energy Source Safety, forecasting that, by 2020, 20% of fossil fuels will be replaced by biofuels in road transport sector (Website of Ministry of Mining and Energetics of Serbia).

The third important document is ratification of The Treaty establishing the Energy Community that Serbia signed in 2005, in Athens. This Treaty, according to Article 20, binds signatory states to establish directive ES 2003/30. This directive implies introducing regulation of minimum content of biofuels in motor vehicle fuels (Strategy of Energetic Development in Serbia until 2015).

Furthermore, Serbia has ratified Kyoto protocol forecasting reduction in greenhouse gases and necessary utilization of renewable energy sources. EU has the obligation to reduce CO_2 emission by 8% until 2012 (Strategy of Energetic Development in Serbia until 2015).

Research carried out in several west companies has shown that oil utilization with nowadays intensity could last 60-80 years more (Strategy of Energetic Development in Serbia until 2015).

Fiscal policy of EU states is established through tax concessions.

2. Possibility of Oil Production out of Oil Slates in Serbia

In the late 80s, and before, researches have been carried out in oil slates in Aleksinac. Total capacities were estimated 2 billion tones of slate. Beobanka financed this project. If this quantity was to be refined, around 200 million tons of oil could be produced and that would fulfill decades-long need for oil. Likewise, oil slate deposit in south Serbia, Vranje namely, is significant. Furthermore, research on improving technology process of oil production in oil slates was carried out simultaneously, financed by United Belgrade Bank of that time, and it was made evident that, technologically, a high-quality product can be made in pilot production plant. Economy price of oil out of oil slates was somewhat over $40 per barrel, and it was then one of the reasons why more in-depth research was not carried out and why the construction of oil production plant was not continued any further. Oil price of that time in world market was $22-25 per barrel. Otherwise, the quality of Aleksinac slate, compared to the slate used worldwide, is richer in oil and amounts to 10-12%. If economic calculation was to be searched for in the accelerator, the long-term investment would be payable (Strategy of Energetic Development in Serbia until 2015).

Canada's experience in with oil production out of oil slates: Canada is in a possession of large deposits of oil slate used for oil production. Namely, deposits amount to 170 billion barrels. US imports around 1.8 million barrels a day (National Geographic from Serbia 2009).

Production process: Canadian experts made oil wells and put higher-profile pipes in them. Taking into consideration that slates are generally under the surface covered with sand, bringing water vapor to oil slates, heating and melting of slates occur, and they are thus lighter than sand and emerge onto surface, gathering into collecting lake. Liquid is then pumped out of there, practically crude oil, and is brought to refineries for cleaning

out of remaining sand particles, and is further refined. The costs of such refining are not high, and the location of the deposit and refinery capacity, as well as supply safety, is of great advantage while delivering to the consumers in the vicinity (National Geographic from Serbia 2009).

Furthermore, research of west companies shows that there are rich deposits of oil slate in Kosovo and Metohija. The estimates are based on satellite snapshots. Our experts have also confirmed this information (Website of Ministry of Mining and Energetics of Serbia).

3. Demand for Electricity in Europe and European Territory

There is a deficit in electricity supply in Europe for several years now. The problem is especially highlighted in southeast Europe. According to EFT group data, European territory is faced with increasing deficit in energy caused by lack of investment in new production capacities over years. Investment cycle in European territory has started, but new power plants will be put into operation in 2012. Due to greater demand for electric power compared to the supply, the price of electricity will be higher. The lack of electric power supply in European territory is at rate of 3% in relation to annual demand, and that is a problem because it is expected that, during 2012, crisis will be reduced and new production capacities will be introduced.

Serbia, with its new capacities for electric power production, will be mostly oriented towards southeast Europe, but there will be enough electricity to be offered to west European countries. That will also be the target group. The following table shows the lack of electric power in our area:

Table 1 Necessary Capacity in Electric Power Distribution of Southeast Europe

Country	GW	Country	GW
Romania	3.36	Greece	3.00
Bulgaria	1.82	BiH	0.99
Hungary	1.75	Albania	0.88
Croatia	1.21	Macedonia	0.62
Serbia	1.46	Montenegro	0.25
Kosovo	0.58	Total:	16.70 GW

Source: EPS, Belgrade, 2010, adapted by BozidarMihajlovic.

Analysis in southeast Europe show low energy efficiency and unreasonable consumption. It amounts to almost 40% compared with developed countries in the west. Even if the situation enhances, there will be no higher figures because the values of unreasonable consumption are high. Big need for electric power consumption will still exist, and it might be a good chance for Serbia to invest in its capacities. This is also emphasized by the fact that there is a constant tendency of growth in energy sources and electricity consumption in Europe. A great deal of attention is now paid to alternative sources of energy, and Germany leads the way.

4. Capacities for Electric Power Production in Serbia

Reliable supply of energy to consumers under economically most favorable and ecologically most acceptable conditions implies a long-term assessment of needs for energy, on country level, based on insight into the reached level of energy development and current state of energy capacities, available energy potential, tendency of energetic development in the world, expected technology progress in area of energetic and reliable perception of

economy growth of Serbian citizenship. It is the basic presumption for coordinated development of energetic and economy in general in order to create branch structure of energetic sector and provide safety and cost-effectiveness of supplying economy and citizenship with power.

The basic aim of reforms in energetic system is to establish, in terms of quality, new working conditions, operation and development of energy production sector that will encouragingly affect economy development in Serbia, environmental protection and integration of local energy sector into regional and European energy market (EPS Republic of Serbia).

Table 2 Installed Power in Power Plants (at Transmission Point)

	Installed net power MW			
	With capacities in Kosovo	%	Without capacities in Kosovo	%
Coal thermal power plants	5.171	61.52	3.936	55.16
Thermal power plants–heating stations (gas, fuel oil)	336	4.00	336	4.71
Hydroelectric power plants	2.898	34.48	2.863	40.13
All EPS thermal power plants	8.405	100.00	7.135	100.00

Source: EPS, Belgrade, 2010.

Table 3 Distribution Grid

	With capacities in Kosovo	Without capacities in Kosovo
Length of grid (km)	158.045	138.471
Transformer installed power (MVA)	30.911	28.301

Source: EPS, Belgrade, 2010.

When distribution grid is in question, almost all southeast European countries face the problem with transmission grids. Conditions are also to be improved because there is a loss of electric energy.

Based on aforementioned, it may be concluded that EPS undertakes all the measures to achieve energy effectiveness that they are in charge of. The biggest issue is the rate of charging the consumers, primarily citizens. For demonstration sake, citizens owe over 70 billion dinars, and three new excavators can be bought for that kind of money on the level of capacity recently installed in Kolubara (National Geographic from Serbia 2009).

Table 4 Electric Power Consumption in Serbia

No.	Consumption category	Achieved		Index
		2006.	2007.	4/3
		2	3	4
1.	Final consumption in Serbia	26.932	27.156	101
	- supply for average and high voltage	7.461	7.677	103
	-supply for low voltage	19.471	19.479	100
2.	Supply for other systems	2.051	2.021	99
3.	Loss in transmission and ED grid	5.905	5.753	97
4.	Pumping and one's own consumption	1.514	1.440	95
5.	Gross consumption	34.351	34.348	100

Source: Documentation from EPS, adapted by BM.

Price issues were always present in business of all companies affecting social state of the country. That is

also the case with EPS. Monitoring prices in European centers, there is a bigger discrepancy compared to equivalent value of dinar. It is obvious that it is the reason why everything depends on purchasing power of consumers, on one side, and that bigger taxation on prices of economy companies would significantly reduced their competitive ability, on the other. There is a question, Till when will this last, since constructing capacities in terms of electric power is almost 10 years late.

4.1 Coal Supplies and Hydropotential

Serbia is in a possession of significant coal supply. There is a regular utilization of existent deposits in actual conditions, as follows:

Table 5 Coal Production Capacities in 000 t

	With capacities in Kosovo	Without capacities in Kosovo
Open-pit mines	44.900	36.950

Source: EPS, Belgrade 2009.

As it was mentioned, the most recent research shows that Serbia has enough coal for electric power production. Lignite is mostly used in quality structure. Open-pit mines in Kostolac itself have enough coal for following 60 years, now being utilized. In unexplored deposit Dubravica there is 600 million tons of it. Kolubara field has enough coal as well.

Coal gasification, as a new method of protection against carbon dioxide, will provide environmental protection, and it is expected that new capacities of thermal power plants will be built, and driving fuel will be gasified coal.

Most part of coal consumption refers to that of heating households. Currently, our country is spending around 2.5 million tons of brown coal. One third of households use coal. There are 400,000 households in Serbia using coal or wood for heating, including distance heating, also using coal instead of gas or fuel oil (EPS Republic of Serbia).

4.1.1 Hydropotential in Serbia

Research carried out so far show that, out of total quantity of water flow in Serbia, only 9% is formed on the territory of Serbia, and 91% are transit waters. Danube is 2,845 km long from its fountainhead to Black Sea, and 581km flows through Serbia. Thanks to that, there are two hydroelectric power plants built on convenient locations, and the third one, reversible one is planned to be built. The following table shows the hydropotential of our rivers:

Table 6 Hydropotential in Serbia

Water flow	Technically available potential (GWh)	
Drina	1.472	*
Danube, upstream from Novi Sad	1.045	
Sava	530	
Lim	439	
Velika Morava confluence	2.505	
BeliDrim confluence	517	
TOTAL	6.508	
Small hydroelectric power plants	1.699	**
Total	8.207	

Note: * calculation shows half of remaining potential belonging to Serbia; ** power from 0.1 to 10 MW.

4.2 Construction of Small Hydroelectric Power Plants—Perspective of Serbia Development Out of Renewable Sources of Energy

Renewable sources of energy are a real challenge to those involved in electric power production without environmental pollution. Namely, produced conventional kWh out of coal and oil, apparently cheap, has immense consequences for environmental protection because the country is to invest large sums of money into recovery of damage done to environment, caused by such capacities. Authorities in our country are aware of that, and year 2015 is priority in strategy of development of renewable sources of energy, along with hydropotential. What's more, "Strategy of Development of Energetic in Serbia until 2015" document cites that "increased utilization of renewable sources, except for obvious economic effects such are reducing consumption of imported energy sources and environmental pollution, there is a local capital involved, and small and middle size companies, as well as local production of equipment for utilization of these sources of energy are encouraged".

According to data obtained from Ministry of Energetic, currently only 10% of total energy produced in Serbia, or 0.86% of million tens (ten is equivalent to oil quantity), is gained out of renewable sources, and total, or almost total production is done by big hydroelectric power plants, such as Djerdap 1 and 2, etc.

Economic calculation of constructing mini hydroelectric power plants implies the following relations:

Regarding construction costs, one watt of installed power equals €1. Therefore, €10,000 invested in construction may produce power plants of 10 kW. It is enough energy to supply a household. Total mini project involves 60% of money for machinery necessary for electric power production. The rest of the money goes for civil works. Furthermore, small hydroelectric power plants, of 1.5 MW, for example, can be built within 9 to 12 months. Recently, an investor has provided €7 million for construction of three mini power plants of total 3.6 MW. It necessitates water flow of 2.2 m^3/s, which is provided by our every mountain spring or small river. Total water flow in Serbia in mini hydroelectric power plants construction may provide cca 500 MW of electric energy. The most convenient areas for building mini hydroelectric power plants are in Kragujevac, Uzice and Nis. Yet, saving money by building mini hydroelectric power plants and their connection to Serbian electricity grid with 500 MW power is a €50 million sum compared to building thermal power plants with the same amount of power (Strategy of Energetics Development in Serbia until 2015).

Economic cost-effectiveness of building mini hydroelectric power plants certainly depends on their size. Mini hydroelectric power plants of 2MW will pay themselves off within 5 to 7 years. It costs around €2 million, as previously mentioned.

Problems potential investors in constructing mini hydroelectric power plants face are absurd, to say at least. Their requirements are efficiently resolved in Ministry of Energetic within 15 days or so, but big issues are related to obtaining permits for location and civil permits. Those permits are issued by local self-government, namely municipalities. Although according to law provisions they are bound to issue all necessary documents, many of them fail to do this under the pretenses that they do not have applied plan for space. Waiting for a permit may last for a year or more. Serbia has already signed respective documents with EU and it is bound to produce at least 20% of energy out of renewable sources until 2020. Serbia is now behind Europe 15 to 20 years, and produces only 2 to 3% of energy out of renewable sources.

5. Economic Aspects of Using Wind for Electric Power Production, Especially Observing Germany

Electric power produced by using wind is the purest form of energy. Even with significant improvements in the area of using this type of energy, wind is used worldwide only by countries with explored potential or those having financial possibilities to invest in research and production of wind energy. Serbia would be able to produce 2.3 billion KWh of electric power by using wind and the profit would be around €120 million (Strategy of Energetics Development in Serbia until 2015).

Wind power plants have become interesting again as a powerful power resource. Namely, besides US and European countries—Germany, Italy, Spain, and Denmark have started to use technologies for utilizing wind power in 1980s. The best propellers were made in Netherlands, and the highest quality generators were made in Denmark. To that effect, the most interesting fact is that one of the leading Denmark companies has used asynchronous motors made by Sever from Subotica and it used to install them into its final product exported to US market. Within 8 years, from 1991 to 2001, the average annual growth of wind power capacities was around 30%, while the installed power was quadrupled from 1999 to 2005. Wind power plants have the short period of investment construction, seasonal peak production of electric power overlaps seasonal peak consumption, and production is done with minimum environmental pollution.

Research carried out by professor Marko Popovic shows that cost-effective electric power production using wind generator needs minimum mean annual speed of wind of 5 m/s on 50 m above ground. There are locations in Serbia that are explored and estimated that they have the best conditions for wind power plant construction. Those are the areas of Midzor Mountain, Suva Mountain, Vrsackibreg, Stara Mountain, Krepoljin near DonjiMilanovac, Tupiznica, Jastrebac, Deli Jovan, etc. Research was carried out in Dolovo village, Vojvodina, as typical location convenient for further analysis in the other areas. For example, area of BelaCrkva can be used for installing wind generator of 100 MW power, and in the area of Indjija the one with 20 MW power, and so on. Total potential of wind power plants that may be constructed in Serbia would be of 1,300 MW power (Website of Ministry of Mining and Energetics of Serbia).

6 KW wind generator could produce 16,500 kWh of electric power. Research shows that the most profitable would be to construct and combine solar module and wind power plant in our households. Thus, a great deal of utilization of natural resources of sun and wind would be provided, with significant financial effects.

Our experts, also, are proud to inform that Serbian meteorologists have developed worldwide-acknowledged method of airflow modeling, primarily because of more accurate weather forecasts. The method can be used also in wind power production, because, according to that airflow model, specified areas in Serbia are interesting for wind energy utilization.

Over 100,000 MW was installed for wind energy worldwide. 60,000 are in Europe alone. It is estimated that, by 2011, 160,000 MW will be installed, and China and India lead the way.

Economic aspects of wind power plants construction: Windmill construction is very expensive. Investing in, for example, wind park costs around $1.7 to 2 million per plant. Considering that there is no such production in our conditions, it is proposed that kWh cost of wind power pants be 11.5 euro cents. Average, distribution cost of electric power from HPPs and TPPs is 5.7 cents per kWh. Who will pay the remainder of kWh gained from wind power plants? Rich countries subsidize wind power plant construction; Germany, Austria and Denmark have gone furthest, as well as China, India, California, and Texas (National geographic from Serbia 2009).

Electric power cost compensation cannot be made only on side of individual consumers, households. Here, also, a method of price dispersion ought to be used in accelerator, namely, on side of all users of electric power, meaning both households and economy. Serbia has anticipated respective support to "green power" production, which will be discussed later.

Research shows the answers to a question—why is the construction of renewable sources of energy late? Namely, it is about inexplicable conduct of municipalities and local communities that have not, or have just started issuing location and civil permits.

Currently interested investors have provided around $150 million for wind power plant construction. The first one will be connected to electric power system of Serbia by the end of 2011, and the other ones during 2012 and 2013 (Strategy of Energetics development in Serbia until 2015).

In order to resolve the issues in procedures of obtaining documentation for construction of these, Serbian Wind Energy Association–SEWEA was founded.

German experience: Electric power production out of renewable sources in Germany is constantly increasing. According to data provided by German Energetic Association, eco-electric power production is increased to 41.4 billion kWh. Thus, renewable sources of energy in total German production constitute 13.3%. Comparing these facts with the ones in possession of Serbia, values are incomparable because, as mentioned previously, it does not have any plants producing electric power using wind.

Germany, has the production of 24,000 MW wind power. It is 10% of total installed power of its electric power industry, which, of course, does not provide satisfaction for Germans. They plan to use at least 50% of total produced electric power from renewable sources—wind, sun or sea wave power (RWA–Energy corporation in Germany (Igor Mihajlovic)).

In order to accomplish that, Germans have developed measures for promoting wind power plant construction. Namely, besides determining the basic rules in terms of regulations, Germany has also made a decision, due to long-term interest for electric power safety and stability, that "they will pay a bonus of 10 eurocents to everyone who uses wind and connect at least 1 kWh to the grid" (professor Egbert Bake, interview made by "Politika"). Thus, the country encourages investors to consider this and increase the capacities of that renewable energy type.

Germans also detected that there is a smaller problem with wind power plants when it comes to stronger cyclones. The problem was resolved by shutting down the power plants during these weather conditions, and possible lack of KV is restituted from other production sources.

6. Solar Energy as a Natural Resource in Production of Renewable Sources of Energy, Especially Observing Germany

Solar energy in Serbia is used only for heating of apartments or greenhouses. Our research is directed towards developed countries' experience with a strong financial potential. Solar energy could completely meet the needs of humankind only if such ways of mass utilization of provided potential are found. Majority of our public experts is not familiar with methods of electric power production using solar energy and this is a chance for highlighting important features, shortly. National Geographic magazine (September 2009 issue) describes the location of Nevada Solar One. When it is sunny and high temperatures are expected, and engineers are obliged to monitor solar cells, namely parabolic mirrors, that direct sunlight towards long steel pipes through which oil flows, heating them up to 400°C. From "mirror field", hot liquid goes into giant radiators extracting heat and turning water into steam. Steam initializes turbines and dynamo-engine, producing up to 64 MW for voltage grid, enough

electric power to supply 14,000 households (National Geographic from Serbia 2009).

American experts have also come to an interesting conclusion. Namely, humankind nowadays needs around 16 terawatts of energy (one terawatt = trillion watts). It is expected that, by 2020, that need would go up to 22 terawatts. Solar energy on inland part amounts to 120,000 terawatts. It practically means that solar energy is inexhaustible and limitless (National Geographic from Serbia 2009).

Innovations in production: Experts are also very close to finding solution regarding utilization of such great solar and heat potential of Sun. the same magazine (National Geographic) cites that there are two ways for overcoming the problem of solar potential utilization. The first involves steam production through parabolic ducts, like the ones in Nevada, or through fields of flat, computationally guided mirrors, so called heliostats, which focus sunlight on receiver on the top of the huge tower. The other way includes sunlight directly to be turned into electric power by photo-voltage (PV) panels made of half-finished products such is silicon.

Now more in-depth research was carried out about the way solar energy power plants will operate when it is cloudy! Research about systems that are to be used for energy storage when it is cloudy (when solar energy cannot be so efficiently used) is almost finalized.

In Serbia, there are preconditions for production of thermal and electric energy using sunlight. Namely, regarding insolation, there is higher intensity for 20-30% compared to European average Based on number of sunny days, which is 267 days per year, Serbia has an average insolation of 1000 kWh per square meter. Considering economy power of the country, capacities for supplying hotels and tourist facilities with solar power can be constructed. Alternatively, each house could have a single collector of 20 m² on its roof. There are 370,000 houses in Serbia, and if every other house has a solar collector, it would provide a several billion kWh production.

Research also shows that photo-voltage solar module of 3 kW can produce 28,500 kWh of electric power (Strategy of Energetics Development in Serbia until 2015).

Examples of production and utilization of solar energy in Germany: Germany is a leading producer of solar energy equipment. Germans are so successful that, nowadays, it is estimated there is 53% of total PV energy worldwide is obtained on solar panels between the Baltic Sea and the Black Forest (German: *Schwarzwald*) which is 200 km long and 600 km wide.

PV equipment industry for solar energy has provided ten thousands of working positions in last few years, thus achieving very high growth rate. There are more than 300,000 PV systems in Germany (Source: RWA—German energy corporation, documentation by Igor Mihajlovic). Systems are spread all over the country thanks to encouragements by the country itself. Electric power companies are obliged to buy 20 years at a price that is 3 times higher than the market price. German PV systems provide around 3,000 MW of electric power, which is 1,000 times more than in 1990 (RWA—Energy corporation in Germany (Igor Mihajlovic)).

The point of stimulant for production of solar, wind and hydro energy is in so-called "feed-in tariff", according to which all related to such production are guaranteed to be paid off by local electric power company. Companies are obliged to buy solar energy at the rate of €0.49 per kWh. It is almost 3-4 times higher than the price on the market, as mentioned previously.

Germany will also, by its corporations, take around €400 billion for construction of solar power production plants in Sahara. Likewise, Germans are almost about to solve transmission of thus produced electric power because transmission costs are high due to the distance between consumers and base production. Experts from Siemens Company state that top-level technology will successfully solve the problem of electricity transmission, because modern electric long distance lines will reduce energy loss to acceptable 7%. According to some

estimates by German experts, solar mirror in a desert, size 360×360 km, can collect enough energy for fulfilling the needs of the whole planet (National Geographic from Serbia 2009).

7. Economic Aspects of Construction of Energy Power Plants Using Waste

High rate of climate instability, caused by global warming caused by people themselves, is a great environmental issue worldwide. Unfortunately, people have made many mistakes in their greedy economy development, so global technological boom has taken its toll, not considering current economy recession. In the world, annual amount of 30-50 million tons of waste of all sorts is dumped, and most part of it goes to developing countries. EU, aware that so-called e-waste is the fastest growing category of waste, has determined rules for a clear responsibility of each electronics producer to take over responsibility also for the waste left behind their products.

Situation with using waste is no better in Serbia. Annually, around 460,000 tons of hazardous waste in Serbia is brought to dumps in various towns. 2.314 tons of that waste annually goes to medical waste in Belgrade, not to mention other towns.

According to data provided by World Health Organization, developed countries with established system of waste handling have daily amount of 0.35 kg of medical waste per one hospital bed. It is 0.70 kg per bed in our country.

Considering all relevant facts, Ministry of Energetic has undertaken necessary measures for utilization of such waste for thermal and electric power production. Namely, in the area of Uzice, there is a big dump for waste disposition and it has capacities that can satisfy complete area in next 12 years or so. In addition, the waste from other neighboring towns will be brought there.

In order to protect environment of beautiful Zlatibor, energy power plant is about to be constructed on thus collected waste and the issue of environmental pollution will be solved, and receiving capacity of dump "Duboko" will be prolonged for following ten years. It is efficient and non-polluting matter supported by the fact that there is such a facility, in Vienna, almost in downtown. There is no doubt that this project in Uzice will be successful, and other towns can also, by means of EU or similar funds, solve this problem.

€40-60 million will be invested in energy power plant in Uzice, depending on chosen technology. Calculations show that around 250 tons of communal and other waste will be deposited in the dump on daily basis, and it is the quantity that can be used for construction of energy power plant of 8-10 MW. Price per kWh would be 3.33-6.5 eurocents, and it would be cost-effective.

Otherwise, only 3% of waste is recycled in Serbia. Also, power plants using communal waste for water vapor production and electric power production startup cannot use plastic material and bottles. That type of material contains a substance called vinyl chloride, which is, when burnt, heavier than air and falls to the surface of the ground. Thus, it destroys flora and is very dangerous for fauna. For eliminating these gases, filters absorbing, and later depositing to a safe place can be installed. (Source: Doctoral thesis of the author of this study).

Economic aspects of wind power usage at bridges and overbridges: These are so far the newest trends in renewable energy usage for enlighting bridges, as well as for powering transport vechicles on the road. It is known that Serbia has 267 sunshining days per year, and that 1000 hours of sunshine per year belongs to every square meter of surface. In this paper the focus is only on some important features of our investigation.

Construction of wind power plants (used for enlighting by LED technique) and locating of solar

collectors: At ends of railroad and road brigdes, overbridges and suitable surrounding land, there are different winds which may used for wind generators to produce power to enlight them. The same power may be used to enlight billboards along a road, and, if any, additional power may be delivered to Serbian electro network, with appropriate, stimulative price. Also, additional power may be accumulated in sodium-sulphur batteries and used for its own needs. Direct current (DC) from battery is transformed into AC and it voltage increased to 220 V by using inverters, so that it can be commercially used. As for the bridge structural integrity, due to eventual wind turbulences, experts predict no problems. Namely, wind blows thru the wind power blades transforming kinetic energy into electricity. Also, all bridges are designed to support load up to two and more tousends of tons, and finally, additional supporting concrete columns may be built at a brigde ends, not connected to the bridge, which are used for wind power plant. On the other hand side, solar collectors are even more suitable. Namely, solar collector with, e.g., 6 kW of power, is amde of poliester material, which is very light.

Worldwide, there are more than 100,000 MW of wind power installed, including 60,000 MW in Europe. Estimate for 2012 are 160,000 MW, with China and India being dominant.

Our project is based on the following calculation:

There are two long bridges on which ends two wind power plants can be built. To produce electricity it is enough to have 5 m/s wind at 50 m height above road, i.e., valley or river below a bridge or overbridge.

Total wind potential in Serbia is 1,300 MW. At some locations, like Bela Crkva in Banat, it is possible to produce 100 MW, whereas in Indjija it would be 20 MW.

Also, on the same locations or the the center of a bridge, solar collectors may be positioned.

7.1 An Exmaple of Wind Power Plant and Solar Collector Construction on the Highway Beograd-Novi Sad, Close to Beške or at the Overbridges: Bridge on Ada Can Be Investigated in the Same Way

Figure 1 Bridges on Railroad Beograd-Bar

Figure 2 Computer Animation

Figure 3 Wind power plant 6 kW

Solar collectors produce electricity using PV plates (high-voltage photo plates) made of semi-conductors like silicon. Produces electricity is accumulated in batteries, where voltage is stabilized and then it can delivered to Serbian electro network or used directly in railroad electro network or to enlight bridges and roads. Calculation is following:

Bridge at Beška: (at both ends; the same case is with the bridge on Ada):

250 kW wind power x 4 (both bridges) = 1.000 kW

100 kW solar collector x 4 = 400 kW

250 working days for both wind and solar energy:

1.000 kW x 250 x 24 = 6.000.000 kWh x 9,5 euro cents = 570.000 EUR

400 kW x 250 x12 = 1.200.000 kWh x 23 euro cents = 276.000 EUR

Total: 846.000 EUR

1 W of power = 1 euro

Financial effects of these plants will be even better if "LED" system is used. Namely, this system can save up to 50% of energy.

8. Solar Energy as the Renewable Resource with Special Focus on Germany and USA Experience

In solar energy is used only for house heating, and to some extent, greenhouses. In this investigation is focused on developed countries, with financial potential enabling usage of solar energy to produce electricity, as well.

American experts have made an interesting calculation. Namely, the mankind needs today 16 TW of energy (1 TW = 10^{12} W). It is expected that by Year 2020 this amount will increase to 22 TW. Solar energy on the Earth land is 120,000 TW. This means that solar energy is unexhausted and unlimited.

8.1 Innovation in Production: Experts Are, Also, Just A Step Away from Finding A Solution to Exploit Such Enormous Light and Heat Potential of the Sun

Nowadays, research is well advanced on how to use solar light even when it is cloudy! Testing of systems for energy accumulation, like sodium-sulphur batteries, when it is cloudy are almost completed.

In Serbia there is potential to produce heat and electricity by using solar light. Namely, insolation in Serbia is 20-30% more than European average. Based on the fact that Serbia has 267 sunshine days per year, the average insolation per square meter per year is 1000 kWh. Having in mind Serbian economical power, solar plants for hotels and tourist complexes may be built. Otherwise, every house can have one collector of 20 square meters. There are 370,000 houses in Serbia, so a solar collector is installed on only half of them, several billions od kWh would be produced.

It is known that a photovoltaic solar module of 3 KW can produce 28.500 kWh of electricity Germany experience in production and usage of sun heat: Germany is the world leader in solar energy equipment production. Germany is so much advanced in this respect that nowadays 53% of total world PV energy is produced on solar panels located between Baltic sea and Schwartzwald.

There is a strong stimulation to produce solar, wind and hydro energy because so-called "feed-in" system guarantees 0.49 euro cents to be paid for any kWh of energy produced in this way, being three to four times more than the market price.

Germany will also invest 400 billion of Euros to built solar power plants in Sahara. In addition, experts from Siemens claim that by using high tech solutions they will solve a problem of large distance transport of energy because modern energy transmitters will have only 7% of loss. According to German experts and their calculations, solar mirror in Sahara, 360 × 360 km in size, can collect energy enough for the whole planet.

9. Energy Produced Out of Biomaterial

Public experts were informed about this research project in December 2009 at the conference. Here there are basic parameters of high efficiency by using biomaterial for electric power production.

Each farm of 22 ha can produce energy necessary for its functioning. 12kW installation can provide around 32,500 kWh of electric power.

Likewise, it is very important to note the fact that 1ha of agricultural soil can provide around 3 tons of waste biomaterial which equals 1 ton of light coal per year, namely 1 ton of oil (Energetics Secretary Office, Vojvodina Zezek-Dragutinovic).

Also, by calculating soil and number of people involved in agricultural production, it may be concluded that areas providing raw material for biodiesel and bioethanol can provide work for 20,000 people, and whole Serbia can provide work for 100,000 people, because production will be steady, marketing certain, and raw material will be dispatched to main factories by logistics, and that will also provide work for many people. Ultimately, also the villages will be renewed.

"Wheat oil" (bio-diesel) is motor ecology fuel produced by process of fermentation of crude organic matter, wheat, sugar beet and corn, for now. It is consisted of 85% ethanol and 15% fuel, which, in motor exhaust gases, reduce quantity of carbon dioxide, by 80%. It is direct replacement for fossil fuel, and the largest car companies, like Volvo, Ford and SAAB, are already producing so-called "flexifuel" cars with motors driven by this fuel (National Geographic from Serbia 2009).

Bioethanol is pure fuel used in combustion engines, instead of gas and oil, and it is considered as energy imperative of 21st century. EU has provisions for non-fossil fuels to constitute at least 2% of its market in 2010, and this part will be increased over years by 0.75 points until it reaches 5.75 points in 2013.

According to our research, if upgrade of blowpipe only in thermal plants in most of Serbian towns was performed, it would provide savings of around 0.8-1 million tons of oil, surely, along with using biomaterial as a renewable source and savings of around $800 million.

10. Measures Undertaken in Countries for Encouraging Production Out of Renewable Sources of Energy

Policy of encouragement will guarantee redemption prices for all quantities of electric power produced in small hydroelectric power plants, biomaterial plants, wind power plants, solar and biogas plants, dump and drainage gas, and it will last within 12 years since beginning of production in these plants. Calculations currently show that country encouragement for energy production out of renewable sources is acceptable.

Serbia has Strategy of Development of Energetic Complex.

Depending on power utilization of renewable source plants, our calculations show that the most payable would be investments in small hydroelectric power plants of 2MW, within 7-9 years, while the period to be paid off is the longest regarding solar energy and wind power plants, estimated 10-15 years. Of course, this was calculated according to prices in Serbia and if it become member of EU in that time, then the period for investment to be payable in some power plants is reduced by 1-3 years.

It is planned that, by 2012, at least 45MW be installed in small hydroelectric power plants, as well as 45MW of plants using wind power. Solar power plants should be constructed with power of 5MW, as well as biogas power plants, and 2MW for biomaterial plants. Anticipated assets for investing in different sources of energy would amount to €9 billion until 2015 (Energetics Secretary Office, Vojvodina (Zezek-Dragutinovic)).

It is interesting to note that the first biomaterial power plant will be put into operation in Dragacica village, near Cacak, which is already finished and it is expected that it will be put into operation and connected to electric grid of Serbia next year.

11. Other Renewable Sources for Power Production

Serbia stands great chance for power production out of renewable sources of energy and out of geothermal waters and biogas, namely liquid gas.

Geothermal energy: First research of hydrothermal bores was carried out in Vojvodina. Average productiveness of 9.51/s was determined on these 75 bores, and average temperature was 48.8°C. Total thermal potential of the bores is 54MW, and around 19MW or 26% of available potential is used. Utilization of energy, especially out of these sources, could be used in hotels and tourist facilities (Energetics Secretary Office, Vojvodina (Zezek-Dragutinovic)).

12. Concluding Statements

(1) Serbia has signed documents regulating issues of electric power production out of renewable sources (Website of Ministry of Mining and Energetics of Serbia). It is also a member of International Renewable Energy Agency (IRENA). Documents from this conference are legally binding.

(2) Serbia has also ratified Kyoto protocol legally binding countries signees to reduce global heating due to environmental protection. It is also the obligation of Serbia to reduce fossil fuel consumption until 2020, and replace it by renewable sources of energy.

(3) Out of renewable sources of energy, Serbia would be able to produce around 5,000MW of electric power in due time. If €2 billion was invested in renewable sources of energy, Serbia would not need to import electric power to 30% compared to hitherto import, and it could reduce fossil fuel import by 25%.

(4) Total balance of waste biomaterial is one third of total biomaterial, and calculating by kg/J, it is around 1 million ton of oil annually.

(5) Biomaterial and biofuels (1.0 + 800,000 t biodiesel and bioethanol) in total equivalent annually could replace around 1.8 million tons of oil.

(6) Measures for country encouragement, the way they are stipulated, are stimulating and enable guarantee of purchase of produced electric power for 12 years, since the moment of production beginning.

(7) Comparing encouragement given by developed west countries, Germany in particular, our encouragement is low, and everything needs to be monitored and adapted. Level of encouragement and its adjusting will also depend on the origin of produced energy sources.

(8) Due to big delays in issuing location and civil permits, strict control of delays in issuing those permits must be performed. It would be justified because currently spatial plan of Serbia is being is being ratified.

(9) Serbia, especially Vojvodina, has the conditions for electric power and thermal power production on farms, by using biogas as a basic starting point. Experts from Energetic Secretary Office in Vojvodina have calculated that small co-generative biogas plants for thermal/electric power production can provide 8,000 kWh of thermal energy and 16,450 kWh of electric power. Thermal power would be produced from thermal part of biogas co-generative plant, and electric power from part of biogas co-generative plant.

(10) Total financial effect of connecting these potentials to Serbian electric grid would provide very high amount of foreign exchange assets to the country, at least €1 billion per year. Moreover, if solar energy was used and quantities were made available for export, financial amounts would be very high, at least €2-3 billion. Thus, lack of electric power would be resolved, and also of energy used in industrial production and thermal power production for households and heating spaces, in general.

(11) Serbia will, by 2020, invest around $9 billion in construction of power plants. It would be favorable that this money is invested in renewable sources of energy.

(12) Energy efficiency in Serbia compared to Europe is 40% lower. Therefore, there are several questions

about standard implementation, for example civil engineering in building houses and apartments, business facilities, factory workshops, etc. It also implies the possibility of hiring managers of energetic who will professionally indicate unreasonable consumption of power in the companies.

(13) Finally, investing in renewable sources of energy can be achieved also by respective credit lines. Interest rate, according to our calculation, should not exceed 4% per year. Therefore, the ones who invest in these sources would have a long-term stable source of income, and, practically, ensured existence of households for at least 30 years.