RENEWABLE ENERGY SOURCES TOWARDS SOCIAL CHALLENGES IN SUSTAINABLE DEVELOPMENT AND LOW CARBON ECONOMY

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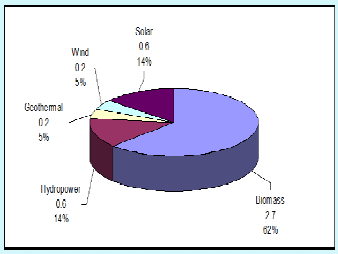
Abstract: ***Low carbon economy, sustainable and holistic development is a challenge for all society. The imperative is to alleviate carbon emission, global warming effects and minimize cross-border environmental pollution. Developing countries follow the global policy and protocols by preparing their technically feasible renewable energy potential for investment and world emission trading market. This paper presents the current state of different renewable energy sources in Serbia, as well as opportunities for incorporating the world and European legislation, technology, knowledge, and investments in the energy sector of this Balkan country. Several case studies of initial investments in renewable energy sources are reported.***

Keywords: *renewable energy sources, low carbon economy, sustainable development, feed-in tariffs, carbon credit benefits.*

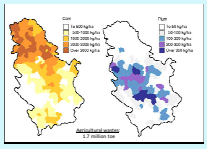
INTRODUCTION: Utilization of renewable energy sources (RES) has proven to reduce dependence on imported fossil fuels, introduce new technologies and reinforce local industry capabilities, create new jobs, and significantly decrease greenhouse gas emissions. Therefore, utilization of RES in Serbia has become a critical segment of the country's environmental policy and energy law. Particular attention is paid to fundamentals, legislative framework, and feasibility of RES utilization in Serbia, a developing country that is geographically so close to a highly developed region of EU. The selection of the objectives, priorities, and legislative instruments is primarily based on a broad political consent to adjust the whole energy system of the country to its recent economic development, especially its anticipated integration into the European Union.

Location Map of Serbia

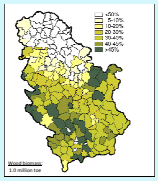


Technically Feasible RES Potential of Serbia in Million Toe

BIOMASS: Serbia has a considerable biomass potential. The territory of Serbia covers 88,360 km^2, of which about 30 percent is covered with forests, while about 55 percent of the territory is arable land. This is a very unique setting compared to many European countries. The northern part of Serbia, the province of Vojvodina together with territories along the rivers Sava and Danube, is flat and fertile. This region is the main source of agricultural products and biomass waste, especially waste from crop farming.



Average Agricultural Yields and Forests in Serbia



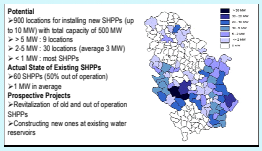
Oil Crop	Average Yield (tons/ha)	Seed/Oil Content (%)	Biodiesel Production	
			(kg/ha)	(litres/ha)
Sunflower	1.79	40	716	816
Soybean	2.25	18	405	460
Rapeseed	1.60	36	608	690

Potential Annual Biodiesel Production from Oil Crops

Percentage of Rapeseed by Crop Type	Potential Biodiesel Production (metric ton)
100 % Rapeseed	212,800
70 % Rapeseed + 30 % Sunflower	224,140
50 % Rapeseed + 50 % Sunflower	235,700
30 % Rapeseed + 70 % Sunflower	239,260
100 % Sunflower	250,600
100 % Soybean	141,750

Potential Annual Biodiesel Production for Different Crop Types

SMALL HYDROPOWER PLANTS: According to the Energy Law, the term "small hydropower plant" (SHPP) denotes a hydropower facility of up to 10 MW installed capacity. The total hydropower potential of waterways in Serbia, including the most suitable locations for the installation of SHPPs, is identified in the National Cadastre of SHPPs. SSHPPs could ultimately generate about 5 percent of the total production of electrical energy in Serbia (34,400 GWh/year in 2006), or about 15 percent of the total hydropower production (10,900 GWh/year).



SHPP BRODAREVO CASE STUDY: Reservoir Capital Corporation (RCC), a Canadian public company focused on renewable energy, has recently established its operations in Serbia with a mandate to acquire and develop natural resource opportunities in Southeast Europe. In early 2009, RCC was granted the Brodarevo energy license to develop a 48 MW run-of-river hydroelectric facility on the River Lim in southwest Serbia.

Run-of-river (ROR) hydro power is a renewable energy source generated by the natural flow of water. Unlike traditional hydroelectric facilities, which flood large areas of land, ROR projects do not require large capacities of dammed water. Instead, water is diverted from a river, or held for short periods of time, and sent through turbines that generate electricity. The water leaves the generating station and is returned to the river without significantly altering the existing flow or water level. The benefits of this project are:

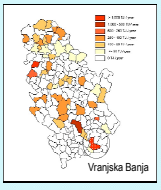
1. Environmental Impact
- ➢Energy produced by renewable source
- ➢No carbon emissions
- ➢No pollutants or waste
- ➢Minimal disruption of surrounding environments and habitats, as flow through remains unchanged
- ➢Small environmental footprint, with low visual impact

2. Cost and Reliability
- ➢No fuel dependency
- ➢Low technology risk, turbine and dam structures known well
- ➢Long-life cash flow generated by projects
- ➢Reliable energy source which provides consistency for cash flow
- ➢Although capital costs may be relatively high, operating costs are low

3. Social and Economic
- ➢Fosters economic growth in developing countries
- ➢Provides long-term and stable job opportunities for surrounding communities
- ➢Secure and available, not dependant on imports or market prices

GEOTHERMAL ENERGY: Serbia is relatively small in size (about 80,000 km^2), but its geological and tectonic structures are very complex. As a consequence, its geothermal characteristics are unique. On two-thirds of the Serbian territory, values of the heat flow density are greater than those for the continental part of Europe.

The total thermal power that could be obtained from all geothermal sources in Serbia is estimated at 220 MW, with an annual thermal energy production of 7,650 TJ (TJ = terajoules = 10^{12} joules), which would replace about 180,000 toe/year.



VRANJSKA BANJA CASE STUDY: Vranjska Banja in southern Serbia is one of the best known geothermal localities. Its natural geothermal resources have temperatures between 80 and 92°C (176-198°F) with a yield of about 80 litre/s. The current use of geothermal energy at this location is of the cascaded type, such that the water can first be utilized for heating several hotels, then medical spas for balneo therapy, schools, kindergartens, health centers, and poultry farms. Finally, it is used to heat two greenhouses. In January 2010, Southern European Exploration (SEE, a subsidiary of Canadian RCC) was granted an exploration permit for additional geothermal sources at Vranjska Banja.

This is the first permit of its kind to be issued to a private company in Serbia (SEE has also filed applications for three additional energy permits in the Vojvodina Province of northern Serbia). The Vranjska Banja exploration permit covers 17.5 km^2 of an area where two existing geothermal wells have confirmed a high temperature gradient. One well intercepts several hot water aquifers, the best of which measures 126°C (259°F) at a depth between 864 and 890 meters. Another well intercepts a zone containing three intervals with measured temperatures of 124°C (255°F), at a depth between 1,500 and 1,575 meters.

WIND ENERGY: Global wind energy potential of Serbia has been estimated at 1,300 MW [15]. This assessment was based on the wind measurement data (speed and direction) collected by the Republic Hydrometeorological Service of Serbia. The most promising locations for the installation of wind turbines are: Midžor Planina, Suva Planina, Vršački Breg, Stara Planina, Deli Jovan, Krepoljin, Tupižnica, Juhor, and Jastrebac. High resolution measurements (of wind speed and direction) are needed for a complete assessment of technically feasible wind power potential at the above locations. Some preliminary results of the tall-tower wind measurements (at a 50-meter height above ground) collected by the Serbian Energy Efficiency Agency (SEEA) are presented in the next table.

Location	Average Wind Speed at 50-meter Height (m/s)		Extrapolated Wind Speed at 80-meter Height (m/s)	
	6 months	12 months	6 months	12 months
Veliko Gradište	3.6	3.5	3.8	3.7
Negotin	5.2	5.8	5.6	6.1
Titel	4.7	4.7	5.0	5.0

BELO BLATO WIND FARM CASE STUDY: This project (300MW development plan) is one of the milestones for Serbia pertaining to RES as it will be the first wind farm development in the region, promoting the national initiative for increased energy creation from renewable resources.

SOLAR ENERGY: The average daily solar radiation intensity over Serbia's territory in winter ranges from 1.1kWh/m^2/day (kilowatt-hours per square meter per day) in the north to 1.7 kWh/m^2/day in the south. The above range is higher in summer, between 5.9 and 6.6 kWh/m^2/day. The annual average insolation over Serbia ranges from 1,200 kWh/m^2/year in the northwest to 1,550 kWh/m^2/year in the southeast. Since the solar energy utilization rate is directly proportional to solar panel efficiency (maximum 40%), technically feasible solar energy in the Republic of Serbia is about 550 kWh/m^2/year. According to the 2002 Census, Serbia has about 2.5 million households. If every fifth household put up a rooftop solar system with a minimum surface area of 4 m^2, this would provide a total annual solar energy production of 1,750 GWh/year. The majority of this amount would be used for electricity consumption, while a portion could replace fossil fuels utilized for sanitary water heating, resulting in decreased carbon emissions by 2.3 million tons per year.

ENVIRONMENTAL POLICY AND SUBSIDIES FOR RES IN SERBIA: The overall objective for 2020 of the Republic of Serbia is to enhance its power generation from RES by 7.4 percent or 735 million kWh compared to 2015. In this respect, the Ministry of Mining and Energy has prepared a set of changes and amendments to the National Implementation Program of Strategy for the Development of Energy Sector in Serbia, adopted a regulation on acquiring the status of privileged power producers in September 2009, and a decree on incentive measures (feed-in tariffs) regarding power generation from renewable sources and by means of combined heat and power (CHP) systems.

The privileged electric power producers are defined as those that:
1) use renewable energy sources or a separated fraction of the communal waste in the electric power generation process;
2) produce electric power in power plants regarded to be small power plants pursuant to the Energy Law; or
3) cogenerate electrical and thermal energy, provided that they met the criteria related to energy efficiency.

The privileged power producers are entitled to feed-in tariffs valid at the moment of submission of the request for status acquiring or renewal. Feed-in tariffs, or renewable energy payments, are a policy mechanism designed to encourage the adoption of RES and to help accelerate the move toward grid parity. They typically include three key provisions:
1) guaranteed grid access;
2) long-term contracts for the electricity produced; and
3) purchase prices that are methodologically based on the cost of renewable energy generation.

Under a feed-in tariff, an obligation is imposed on regional or national electric grid utilities to buy renewable electricity from all eligible participants. Feed-in tariffs (renewable energy payments) adopted in Serbia per kilowatt hour of electricity, generated from renewables or CHP, are as follows:
- ➢small hydropower plants (SHPPs) – between 7.8 and 9.7 Euro cents/kWh
- ➢biomass units – between 11.4 and 13.6 Euro cents/kWh
- ➢biogas – between 12 and 16 Euro cents/kWh
- ➢gas from waste water treatment plants and landfill gas – 6.7 Euro cents/kWh
- ➢wind farms – 9.5 Euro cents/kWh
- ➢solar power plants – 23 Euro cents/kWh
- ➢geothermal power plants – 7.5 Euro cents/kWh
- ➢cogeneration power plants – between 7.6 and 10.4 Euro cents/kWh
- ➢waste power plants – between 8.5 and 9.2 Euro cents/kWh

The above tariffs are guaranteed and fixed during a 12-year period. The level of a purchase price is set to provide invested capital returned in 12 years, covering all operating costs incurred during the same period. In case of power plants that had been in operation before the application of feed-in tariffs, proposed tariffs are valid for the shortened period of time. Feed-in tariffs for old power plants that have been out of commission for at least five years will be separately defined, in order to encourage their revitalization and re-entering into operation.

CONCLUSIONS AND RECOMMENDATIONS: The Republic of Serbia has extensive unused potential for greater energy efficiency and production from RES. In particular, it could profitably develop its hydro and biofuel capacity. With relatively little adjustment to the regulatory environment, Serbia could enable private enterprise to produce enough biofuels to meet local demand and even to export, while creating up to 24,000 new jobs by 2020. Projections suggest that with minor adjustments in the regulatory system, renewable energy could easily rise to one-third of Serbia's overall primary energy consumption, which now relies on fossil fuels for 93 percent of its supply. Currently, hydropower comprises almost all of the renewable energy sources employed in Serbia. With relatively little effort, the country could obtain more than 18 percent of current fossil fuel usage from biofuels, 5 percent from wind power, and 1 percent from solar power.

Serbia has an extensive body of laws addressing energy issues, including the 2004 Law on Energy and the 2005 Energy Development Strategy through 2015, the 2009 regulation on acquiring the status of privileged power producers, and the 2010 decree on incentive measures (feed-in tariffs) regarding power generation from RES and by combined heat and power systems. All these legislative instruments are in line with the European Union Directives and supported by international agreements, such as the Energy Community with Southeast Europe and the European Union, Copenhagen Accord, and Kyoto Protocol. Some obstacles still remain in the area of regulatory and institutional capacity, mainly the lack of sublegal documents - regulations, ordinances, rules, etc. - that make it possible to implement the above laws.

Moving forward, Serbia's policy makers should provide training to increase the number of energy experts, put to use the necessary regulations, and ensure that adopted prices (feed-in tariffs) for renewable send the right signals to investors. The Government needs to continue working on two-way education with the population on conservation and alternative energy.