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# WASTE AS RENEWABLE AND SUSTAINABLE ENERGY SOURCE IN THE REPUBLIC OF SERBIA

**Abstract:** The Government of Serbia considered a proper policy on waste materials as one of its primary tasks in the area of environmental protection. In May 2009, a Law on Waste Management was adopted by National Assembly, together with some other Environment Protection Laws and by-laws. Also, a new Waste Management Strategy for period 2010–2019 is adopted in April 2010. One of the objectives of this Strategy is that waste which cannot be reused, recycled and recovered, must be incinerated and the energy recovered. The Law on Waste Management stipulates applying waste streams for producing energy (biogas, biodiesel), and building plants for utilizing landfill gas. Ministry of Environment and Spatial Planning are adopted or prepared a lot of by-laws which are treated waste as renewable energy source.

**Key words:** *waste, renewable energy sources*

## INTRODUCTION

Environmental protection together with waste management in the Republic of Serbia is facing a period of rapid and radical change, following political changes in 2000. The Government of Serbia considers a proper policy on waste materials as one of its priorities in this area. Also, it encourages the use of renewable energies for electricity production.

First strategic document adopted after political changes was National Waste Management Strategy for period 2003–2008. Energy Sector Development Strategy, which is adopted in 2005, proposes policies for incentives for financial investments in energy facilities using renewable energy sources, incentives for increasing energy efficiency, and methods for ensuring environmental protection. Program for the Implementation of the Energy Sector Development Strategy is also adopted, which sets among main priorities the utilization of the renewable energy sources and the implementation of clean technologies. Also, the Republic of Serbia signed South-

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East European Energy Community Treaty in 2006. By ratifying it, Serbia committed to increase use of renewable sources.

National Sustainable Development Strategy adopted in 2008, and corresponding Action Plan adopted in 2009 as key priority established Protection and improvement of environment and rational use of natural resources. Cleaner Production Strategy which is adopted in 2009 set to implement part of the national sustainable development strategy. National Environment Protection Program is approved in January 2010.

In May 2009, set of Environment Protection Laws were adopted by the National Assembly, which are in accordance with EU directives. Among those are the *Law on Waste Management* and the *Law on Packaging and Packaging Waste*. Following that, appropriate by-laws were also adopted (totally over 50 new laws and by-laws).

As the National Waste Management Strategy was not implemented by desirable dynamics despite significant measures undertaken in setting waste management system during last years, a new Strategy for period 2010–2019 was adopted in April 2010.

## BACKGROUND

The Republic of Serbia covers the area of 88,361 km$^2$, total population is 9.5 million (estimation for 2010), with GDP per capita $6,811 (estimation for 2008). Around 58 per cent is urban population (2003). Estimation is that average annual waste generation is 290 kg per capita. Households generate about 63% of the municipal waste and businesses about 20%. About 60–70% of municipal solid waste (2.2 million tons annually) is collected.

Generally, solid waste is collected only in urban centers. There is no organized waste collection and treatment in rural areas, as part of the generated waste is directly burned in backyards. Landfills are the primary waste disposal method. Municipal waste, including hazardous waste generated by households, is usually disposed directly to landfills, which mainly do not meet EU standards. Recycling and separating communal waste into its component parts is organized only in small pilot areas.

Serbia is one of the last European countries that does not have market for municipal waste. Also, Serbia does not have waste incineration plants, and municipal waste is not used as an alternative fuel. In this moment production of electricity from renewable resources is not present in Serbia, at least not in the industrial or economic way.

Because of that, today's share of renewable energy in final energy supply is small (about 11% in 2009, including the large hydro power plants), and it is predicted that it will not change significantly until 2015 (to raise up for 1.5–2%). Energy production from renewable sources in Serbia is in its initial phase, and waste is not significantly applied as energy source. There is high potential for waste recycling, as well as for obtaining energy (both heat and electricity) from waste.

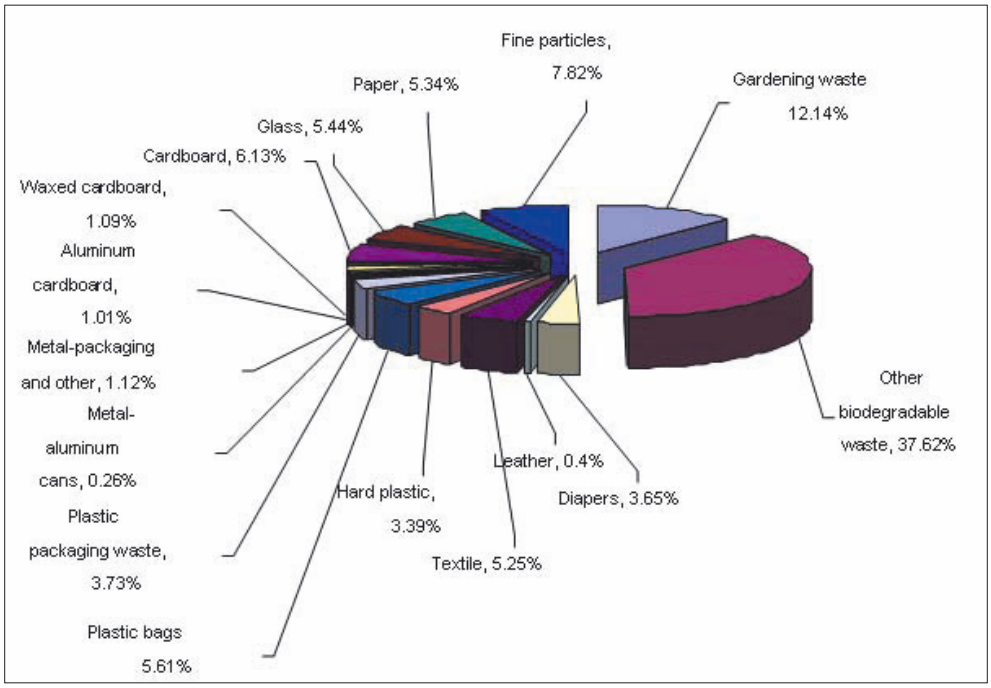


Figure 1. Municipal Waste Composition

## NATIONAL WASTE MANAGEMENT STRATEGY

The objectives of the new (and also previous) Waste Management Strategy are:

– To minimise the amount of waste being produced at source and thereafter increase the percentage of waste that can be reused, recycled and recovered.

– The disposal and incineration of waste which can be reused shall be forbidden.

– Waste that cannot be recovered must be incinerated and the energy recovered.

Waste Management Options according to the Strategy are:

– Waste reduction at source;
– Reuse;
– Recycling;
– Composting;
– *Anaerobic digestion;*
– *Waste Incineration;*
– Other methods for treatment of waste;
– Waste disposal.

Among medium-term goals of waste management strategy (2010–2014) are:

– To achieve reuse, recovery, recycling rate of waste oils;
– To achieve reuse, recovery, recycling rate of waste tires;
– To introduce composting of organic waste;

– Efforts would be made to maximize energy recovery from waste.

Besides hydroelectric power plants and thermal power plants, the generation of electricity will include production in combined heat and power (CHP) plants and renewable energy or waste electric power plants. Strategy anticipated opening of regional landfills in the Republic of Serbia, and multi-material facilities for sorting and processing waste, opposite to over 180 officially registered dumpsites which are not satisfying EU standards and where the waste is deposited without any management or treatment. The future regional landfill will cover an area with a population of around 400,000. There will be considerable amounts of waste which could be suitable for both recycling and energy use.

The utilization of waste as energy source should be conducted in such a way that does not have an impact on environment. Municipal Solid Waste (MSW) can be converted into energy by direct combustion, or by natural anaerobic digestion in the landfill. The existing plants should be renovated and new plant built for anaerobic digestion–production of biogas as well as plants for composting.

The procedures for treating waste oils for their re-use purposes (regeneration and re-refinement) are advantageous with respect to use for energy or other appropriate treatment procedures. Waste tires must be treated, and recycling has an advantage over burning.

## LEGAL FRAMEWORK CONNECTED WITH MESP

*1) Law on Planning and Construction:*

– Define the urban planning requirements for the construction of facilities that use renewable Energy Sources (RES);

– Shortens the time for issuing building permits of projects and studies.

*2) Environmental Protection Law*

– established Environmental Protection Agency;

– established Environmental Protection Fund.

*3) Law on Environmental Impact Assessment*

– Asses impact on the environment from the facilities which are applying RES

*4) Law on Integrated Pollution Prevention and Control*

– Defines the IPPC permit for facilities that are using waste, biomass or other alternative resource-Directive 96/61/EEC on Integrated Pollution Prevention and Control;

– Introduces best available techniques (BAT) in facilities which are using RES.

*5) Law on Waste Management*

– Stipulates the use of waste streams for energy production (waste, biomass…);

– Stipulates construction of facilities for the use of landfill gas.

*6) Kyoto protocol (ratified in October 2007)*

– Designated National Authority-DNA was established in 2008, which enabled participation in Clean Development Mechanism and projects in this area;

– Strategy for Implementation of CDM Projects is adopted

## LAW ON WASTE MANAGEMENT

One of the aims of the *Law on Waste Management* is to provide and ensure conditions for the re-use and recycling of waste, separating secondary raw materials from waste and *using waste as fuel.* This Law stipulates applying waste streams for producing energy (biogas, biodiesel), and building plants for utilizing landfill gas, as according the Article 38 of this Law, waste can be used for energy recovery, that is, the use of waste value through its biodegradation or incineration with energy recovery. According to the same Article, waste incineration as thermal treatment, shall be performed with recovery of energy generated through combustion only if it is economically justifiable, and additional energy not used for waste incineration but for initial ignition only, or if waste is used as fuel, that is additional fuel for co-incineration.

Thermal treatment of waste is performed in accordance with the *treatment permit,* issued from the Ministry of Environment on the basis of this Law. Prior to waste incineration, the hazardous waste holder ensures that the testing of hazardous waste characteristics is performed during the first delivery of waste into the facility, while the facility operator shall ensure control over waste delivered for incineration.

## INCENTIVE MEASURES

Besides the *Law on Waste Management* and other environment protection Laws, the following regulations on special waste streams are adopted or prepared by the Ministry of Environment and Spatial Planning, which enable treating of waste as renewable energy source:

*– Rulebook about incentive measures for reuse and utilization of waste as secondary raw material, or for derivation of energy;*

*– Rulebook on conditions and methods of collection, transport, storage and treatment of waste which is used as secondary raw materials or for derivation of energy;*

*– Rulebook on condition, method and procedure of thermal treatment of waste;*

*– Decree on Waste Oil Management;*

*– Rulebook on conditions, methods and procedures of managements of waste oils;*

*– Rulebook on the methods and procedures of managements of waste tyres;*

*– Rulebook on amending and updates of Rulebook on the methods and procedures of managements of waste tyres.*

Ministry of Mining and Energy also adopted some important by-laws, which are encouraging measures for electricity generation using renewable energy resources:

*– Decree on incentive measures for electricity generation using renewable energy sources and for combined heat and power (CHP) generation (Feed-in Tariff);*

*– Decree on the requirements for obtaining the status of the privileged electric power producer and the criteria for assessing fulfillment of these requirements.*

Also, *Action Plan for Biomass* is adopted in August 2010.

Table 1. Feed-in Tariffs

| Type of Power Plant | Installed capacity (MW) | Feed-in Tariff Price (c€/kWh) | Prices in European countries (c€/kWh) |
|---|---|---|---|
| Biomass power plants | up to 0.5 MW | 13.6 | 8–16 |
| | from 0.5 MW to 5 MW | 13.845–0.489*P | |
| | from 5 MW to 10 MW | 11.4 | |
| Biogas power plants | up to 0.2 MW | 16.0 | 8–17 |
| | from 0.2 MW to 2 MW | 16.444–2.222*P | |
| | over 2 MW | 12.0 | |
| Landfill and sewage gas power plants | | 6,7 | 4–7,7 |
| CHP plants using renewable energy sources, fossil fuels or fossil fuels combined with RES | up to 0.2 MW | 10.4 | |
| | from 0.2 MW to 2 MW | 10.667–1.333*P | |
| | from$^2$ MW to 10 MW | 8.2 | |
| Waste fired power plants | up to 1 MW | 9.2 | |
| | from 1 MW to 10 MW | 8.5 | |

where P is the capacity installed (P), stated in MW

Last two by-laws established the Feed-in Tariffs and legal regulation for obtaining the status of privileged producer (producer of renewable energy resources). Buying price in c€/kWh is guaranteed at agreed level for 12 years. Rate of buying price is formed in a way to allow each investor to recoup investment and operational costs within 12 year period.

All previous by-laws encourage measures for electricity generation or for combined heat and power generation using waste. Aim is to start construction of small-scale CHP or power plants with installed capacities up to 10 MW using separated biodegradable fraction of communal waste or biomass, and plants with other renewable energy sources like biomass, biogas, synthetic gas, landfill gas, gas from waste water treatment plants as well as uncontaminated waste water from the food and wood-processing industries…

## USING OF ALTERNATIVE FUELS IN CEMENT INDUSTRY IN SERBIA

It is estimated that 50,000 tones of waste motor oils and 10,000 tones of edible oils are generated in the Republic of Serbia each year. Also is estimated that existing quantity of waste tires is 50,000 tones, and that 18,000 tones is generated each year. In final disposal of both waste streams, recycling has an advantage over burning.

Co-incineration is the use of alternative fuels as a primary or additional fuel in different types of kiln (cement or thermal power plants). Due to by-laws, in the Republic of Serbia cement plants perform organized legal collecting and final disposal of waste tyres for energy purposes (co-incineration for producing cement clinker), and have permit for use of maximum 15,000 t/year. HOLCIN from$^2$006 collects,

transports and co-processes waste tyres. The future plan is to co-process different types of industrial waste, municipal and packaging waste. LAFARGE performs co-incineration of waste tyres from 2008, and are preparing for using agricultural biomass as additional fuel. Also, in LAFARGE is co-processing waste oil. Only TITAN is not applying waste oils or tyres as alternative fuels.

The burning of tyres in the Republic of Serbia as a fuel in cement kilns has been increasing. Target is that in 2010 recycling of waste tyres will cover 70%, and its use as energy source will cover 30% of the total quantity of collected waste tires, while in 2011 this ratio will be 80:20.

**BIOGAS**

Disposal of waste to dump sites is the only way of organized handling with waste in the Republic of Serbia. Landfill gas is formed as a result of anaerobic microbiological action from the biodegradable part of municipal solid wastes, which is disposed within a landfill. It is a mixture comprising mainly of methane and carbon dioxide (approximately 50: 50%). It can be collected from the stored material and scrubbed and cleaned before feeding into internal combustion engines or gas turbines to generate heat and power

Although the most efficient and effective way to convert municipal waste to energy is to use landfills created for this purpose, in the Republic of Serbia there is no controlled capture of landfill gas and using or selling to utilities as energy source. Specific problems in applying gas from landfills and dumpsites are:

– Lack of monitoring of methane emission from landfills and dumpsites;

– Lack of reliable assessment of biogas quantity generated in landfills and dumpsites;

– Lack of development of measures for collection and utilization of biogas generated in landfills and dumpsites;

– Lack of feasibility studies for utilization of methane from landfills.

**FUTURE PROJECTS**

Although there are no installed waste-to-energy facilities in the Republic of Serbia, some projects are finished or in preparatory phase:

– One project consists of installing the gas extraction system on Novi Sad landfill, and flaring of landfill gas in the 1 st phase. The second phase will include the energy generation from landfill gas and the generated electricity will be fed into the grid.

– First facility for energy generation from MSW will be build in town of Chachak up to 2016. The proposed operation of the plant will be fueled by biogas produced in anaerobic digesters from MSW and other biomass material. In this moment, feasibility study is finished.

– In 2007 Serbia got factory for serial biodiesel production, "Victoria Oil" in Shid. It was constructed for production of around 25,000 t of biodiesel in the first year.

– Plant which uses the waste from the yeast factory as a raw material is also built in Senta in 2009. This waste is converted into biogas, which is used to power the new co-generation plant (combined heat and power generation).

## MESP ACTIVITIES IN AREA OF RES

MESP performs the following activities in the area of application of Renewable and Alternative Energy Sources (RAES):

– Participation in the elaboration of projects and studies related to the implementation of renewable and alternative sources of energy (*gas at dumping areas, waste-energy, biomass, biogas,* and others like wind energy, water, sun, geothermal energy).

– Analysis of the implementation of renewable and alternative energy sources.

– Participation in the preparation of expert foundations for the elaboration of rules in this field, within cooperation among sectors.

– Participation in international cooperation in this field.

– Proposing measures for the realization of aims of the clean energy.

– Environmental Protection Fund finances projects connected with use of Renewable Energy Sources (RES), as well as in the field of energy efficiency.

– In 2010 the Fund is focused on projects for promotion of waste management and exploitation of valuable properties of waste, as well as promotion of applying of renewable energy sources (solar, wind, biomass, geothermal energy, etc.).

## MAIN BARRIERS IN APPLICATION OF WASTE

The main barriers in application of waste and other renewable energy sources are:

– Very high investment costs.

– The price of public services (waste, water and sewage) is far below economic costs, which results that renewable energy sources projects remain constrain by low prices.

– The low prices of electricity, which results in many homes using electrical heaters for space heating.

– The environmental protection, although identified as one of the strategic aims and important topic, was never supported with significant budget resources.

– The absence of long term contracts with producers of green energy.

– The absence of adequate support measures, especially the lack of favorable credit lines.

– Clean Development Mechanism (CDM) is not operational. CDM projects are still in the initial phase and so far there is not a single project that has passed the whole CDM approval procedure.

– The Serbian government needs to promote the use of biomass waste for energy production in residential and industry sectors.

## CONCLUSION

Waste-to-energy facilities produce clean, renewable energy, reduce environmental impacts of municipal solid waste management and reduce greenhouse gas emissions. The Republic of Serbia is in the beginning of process trying to find via-

ble solutions to manage solid waste. The first priority is to establish a modern sanitary landfill system and avoid using the open dumps located in inferior geologic locations without liners and mitigate methane issues. In accordance with the Kyoto Protocol, EU directives, and based on taking on the obligation of increasing the share of renewable energy in total energy production, the Republic of Serbia promotes the utilization of waste as source of energy, besides other RES. It is expected that the application of adopted laws and by-laws, as well as the adoption of some new laws, will increase the energy recovery from waste, and thus increase the share of renewable energy in the total energy supply. MESP, in an effort to expand waste-to-energy application, will consider further enacting legislation of renewable energy in the Republic of Serbia.

## LITERATURE

[1] Waste Management Strategy for period 2003–2008.
[2] Waste Management Strategy for period 2010–2019.
[3] Law on Waste Management.
[4] Decree on incentive measures for electricity generation using renewable energy sources and for combined heat and power (CHP) generation (Feed-in Tariff).
[5] Decree on the requirements for obtaining the status of the privileged electric power producer and the criteria for assessing fulfillment of these requirements.