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WASTE AND WASTEWATER MANAGEMENT AS A POTENTIAL FOR REDUCTION OF GHG EMISSIONS

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ABSTRACT – The main goal of this paper is to describe potential for GHG emission reduction in waste sector in the Republic of Serbia until 2050. Waste and wastewater sector covers emissions from the treatment and disposal of municipal solid waste (MSW) and wastewater treatment. During 2016 - 2021, the Republic of Serbia was developing a several national documents, which are currently in the draft form, to identify potentials for low-carbon economic development and to raise its reduction ambitions. Assessed GHG mitigation potential, based on comprehensive modeling through 4 mitigation scenarios, is result of analysis of technical, technological, and financial, as well as social and environmental conditions.

Keywords: Municipal Solid Waste, Wastewater, GHG, Emission, Scenarios.

INTRODUCTION

In previous years, Serbian climate change mitigation activities were shown in the national reporting documents (National Communications – NCs, Biennial update reports – BURs, National *Determined Contribution* - NDC) as sectoral actions presented through the GHG emission reduction [1-7]. The first climate change mitigation planning of the Republic of Serbia was conducted throughout development of a Low-Carbon Development Strategy (LCDS) and Action plan (AP), during the period 2016 – 2019, which is currently in the draft form [8]. The main goal of this document is to explore possibilities and identify potentials for low-carbon economic development, starting from possibilities for the GHG emission reduction until 2050. These possibilities were presented in the [3,5,8].

WASTE MANAGEMENT IN SERBIA

Approximately, 2.2-2.3 million tons of municipal waste are generated in Serbia every year, and a total of app. 2 million tons are collected and disposed. Of that amount, about 460,488 tons of waste, or 20% of the collected municipal waste, were disposed of at regional sanitary landfills in 2017 [9]. The average coverage of municipal waste collection is 82%. The municipal waste recycling rate is about 3%. There is no systematically organized separate collection, sorting, and recycling of municipal waste in the Republic of Serbia. Although the primary waste selection in Serbia has been set forth under the law which envisages which separation of paper, glass and metal in specially labelled

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containers, recycling is not functioning in practice even low amounts of recyclables are collected. Serbia does not have the necessary infrastructure to reduce the disposal of biodegradable waste. Currently, composting sites exist only in Subotica and partially in Sremska Mitrovica regions.

Wastewater mainly comes from households (67%), and much less from industry (19%) and 14% from other users. The total amount of wastewater in 2018 was lower by 1.3% compared to 2017, while the amount of wastewater discharged into public sewerage systems was lower by 0.5%. In 2018, 1.1% less wastewater was treated than in 2017. The percentage of residents connected to the public sewerage system in 2018 was 63.0% and of the population included into wastewater treatment 14.1%.

GHG EMISSION FROM WASTE SECTOR IN SERBIA

In 2018, emissions from the waste sector amounted to 2,928 Gg CO2 eq, or 4.6% of total GHG emissions. In the period 2010-2018, emissions have decreased by 3.5%. Figure 1 presents trends of GHG emissions from source categories within the waste sector.

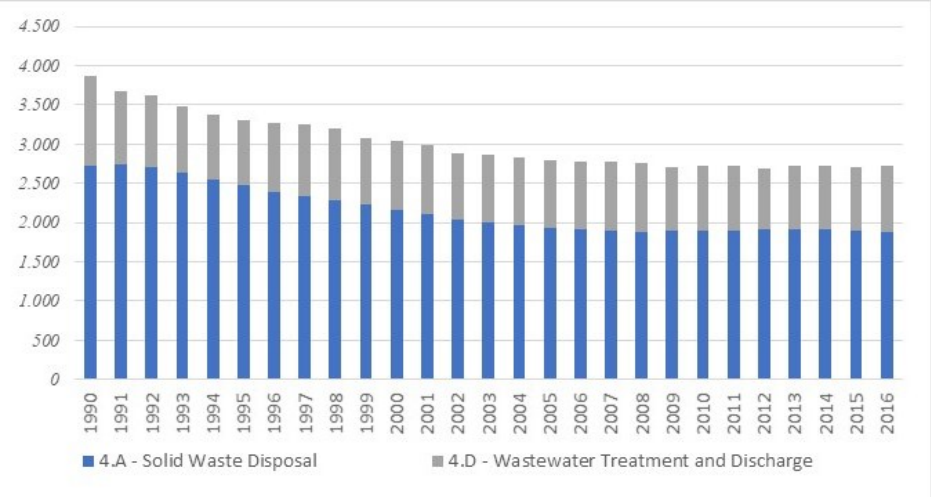

Figure 1 GHG emissions by categories in the waste sector, 1990-2018 (Gg CO2 eq)

Within the waste sector, 71.7% of total emissions in the year 2018 originated from solid waste disposal, and 28.3% from wastewater treatment. Despite improvements in waste and wastewater management practices in the recent period, the total number of waste management facilities and amounts of treated solid waste and wastewaters is still negligible and the share of GHG emissions from these categories have remained almost constant over the observed period.

MITIGATION SCENARIOS, DRIVERS, AND ASSUMPTIONS

Mitigation scenarios (up to 2050) developed for all sectors in LCDS [8] are:

- **Without Measures** (WOM), so-called Baseline (Business as usual, BaU) - Excludes all PAMs implemented, adopted and planned after the year 2015;

- **With Measures** (WEM) – Considers currently implemented, adopted, and planned PAMs (the whole EU 2030 acquis), assuming accession to the EU in 2025; and
- **With Additional Measures 1** (WAM1) - Considers a way of achieving the 2030 targets defined for the EU (-40% GHG emissions compared to 1990; 32% RES by 2030 and 32.5% enhanced energy efficiency) assuming accession to the EU in 2025.
- **With Additional Measures 2** (WAM 2) scenario - Serbia aiming to achieve 80% GHG cuts in 2050 compared to 1990 levels (the first EU target under the Paris Agreement).

Modelling has been conducted from 2015, while [2 and 4] the year 2010 is base year (for comparing GHG levels). For projecting the GHG emissions for the Waste sector, the IPCC 2006 Waste model was used [10].

As a most relevant scenario for all sectors (energy, IPPU, Agriculture, Forestry and Other Land Use, waste and wastewater) Scenario With Measures is chosen. In the waste and wastewater sector, this mitigation scenario is the same as the WOM/BaU scenario. In this scenario, the implementation of the relevant measures to achieve the goals is rescheduled.

MSW production is mainly driven by GDP and population. The emissions profile of the waste sector is, however, mostly determined by waste composition (organic vs non-organic) and waste treatment technology. Drivers for wastewater treatment are same as for MSW production. The emissions profile of the wastewater sector is, however, mostly determined by treatment technology. Wastewater treatment technology which considered tertiary treatment or treatment of sludge cause decreasing of emission.

Two key assumptions for the modelling of GHG emissions in the waste sector are the waste composition and the full implementation of the extensive agenda of EU approximation activities as a part of preparing of Serbia for the EU membership.

In order to develop a scenario, projected amount and composition of municipal waste in Serbia for period 2015 - 2050 was considered, assuming that the future characteristics of the waste by the end of 2050 will be changed in line with change of two key drivers, i.e. GDP and population growth/decrease. In other words, models for projection of the physical characteristics of the waste for the Republic of Serbia until 2050, were based on correlation between waste amount & composition with GDP and population. The amount of waste generated in Serbia in the period from 2015 to 2050, is projected to increase by 38.7%, which corresponds to approximately 1.1% per year. This means that the amount of municipal waste generated in the period from 2015 to 2050 will increase from 340.7 kg to 456.3 kg/capita/year.

The results related to the projected composition of municipal waste, shows that share of biodegradable categories consisting of garden and food waste, will be reduced by 21.9% in 2050.

The Republic of Serbia is preparing for the EU membership, which encompasses the transposition and implementation of EU environmental acquis, including requirements for waste management. Crucial legislative obligations include:

- Landfill Directive - 1999/31/EC,
- Directive on packaging and packaging waste - 1994/62/EC and
- Waste Framework Directive - 2008/98/EC.

Based on the estimation of the necessary time for each individual region to have a complete waste management system in compliance with EU requirements, it was projected how much the waste, by type, will be properly treated in relation to the time (table 1).

Table 1 Biodegradable waste treatment options and targets assumed in Scenario with measures

Relevant waste fractions for GHG emissions	Treatment option		Targets to be achieved			
			2025	2030	2040	2050
Food and garden waste	Landfilling		85%	75%	55%	35%
	Diversion	Composting	15%	25%	45%	65%
Paper and cardboard	Landfilling		85%	75%	55%	35%
	Diversion	Recycling	10%	15%	25%	45%
		Composting	5%	10%	10%	10%
		Incineration	5%	10%	10%	10%

GHG emission reduction is result of following measures:

- Construction of sanitary landfills – for 22 regions until 2025, and for four regions until 2030
- Introduction of source separation & Construction of Material Recovery Facilities - for 18 regions until 2025, and for eight regions until 2030.
- Construction of Biological Treatment Facilities (Composting Plants) – for one region until 2025, for 5 regions until 2030 and for rest 20 out of 26 after 2030.
- Construction of Thermal treatment (Incineration) Plant – only for Belgrade region until 2025.

In the field of wastewater collection and discharge systems, it is assumed that, by 2050, 95% of the major cities will have anaerobic digestion facilities installed. Facilities in the rest 5% of the cities would start with operation by 2062. The data are extrapolated without considering the industrial wastewater generation and discharge.

GHG EMISSIONS

Based on the results of modeling, it was concluded that for this scenario, GHG emissions in waste sector will increase 2% by 2020 compared to 2010 and decrease 7%, 17% and 39% by 2025, 2030 and 2050, respectively (table 2).

Table 2 CO_2eq emissions and emissions reductions for WEM scenario

Year	2010	2020	2025	2030	2050
CO2 eq, kt	1.920	1.960	1.791	1.585	1.167

The table below shows the dynamic of GHG emission in the wastewater sub-sector.

In last year (2050), CO_{2eq} emissions have been projected to be about 769 kt CO_{2eq} which represents 8,6% reduction compared to 2010 GHG emission levels.

Table 3 CO_2eq emissions from wastewater collection system for the chosen period 2010-2050 according to scenario WEM (kt CO_{2eq})

Year	2010	2015	2020	2025	2030	2040	2050
Emissions from wastewater	842	809	795	791	787	778	769
-of which from municipal wastewater	717	697	690	687	683	675	668

CONCLUSIONS

Described scenario represent the potential emissions pathway as a result of the transposition and implementation of the EU Acquis in Serbia, in a scenario of accession of Serbia to the EU in 2025.

Also, this scenario represents a minimum starting point for Serbia's low carbon transition process since implementation of all relevant EU legal framework is considered.

In order to achieve the stated objectives of the EU, it is not enough to build functional sanitary landfills, but there must be other elements of waste treatment, i.e. most important is to establish recycling of certain suitable fraction and treatment of biodegradable waste. Therefore, in addition to sanitary landfills, other modern treatment of municipal waste (recycling and biological/thermal treatment plants) need to be implemented.

In accordance with the current level of infrastructure and status of waste management regions development, for the implementation of this scenario, estimations are that Serbia need to invest almost 45 million € for project preparation and additional 986 million € for the investment, in next 10-15 years.

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