# WASTE TREATMENT TECHNOLOGIES: APPROACH TO GHG EMISSION AND COST

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## Abstract
Municipal solid waste may have a negative impact on the environment, causing pollution and greenhouse gas emissions (GHG) that contribute to climate change, if it is not treated. Treatment of waste is a key for sustainable development. Composting, anaerobic digestion and incineration are proven technologies for treatment of municipal solid waste. Selection of waste treatment depend on many factors, mainly cost, local conditions. Aim of this paper is to analyze different scenarios for waste treatment and their impact on environment and their cost.

## Introduction
The municipal waste management landscape in EU accession countries will change, due to legal obligation regarding waste management. [1,2,3]. Serbia is a candidate country for European Union membership (EU), must transpose and implement the total body of EU legislation, including chapter 22 Environment.
In developing countries, and Serbia as well, main deficiencies in waste management are weak and inefficient law enforcement mechanism, lack or weak capacity or motivation of staff, lack of finances for investments, lack of incentives for both local community and for the citizens. High share of biodegradable municipal waste going to landfill, like in South Eastern Europe countries [4,5,6]. Almost all packaging waste from the household which is sent to recycling is collected by an informal sector. Separate collection is not established.
In EU Member States where the disposal of waste is not high, and where there are no fees and charges for waste disposal, diversification of waste, particularly biodegradable waste from landfills and implementation of waste treatment technologies has been more slowly, unlike in countries where fee for waste disposal was introduced and gradually started to build the necessary infrastructure for waste management [6]. In addition, new member states e.g. Poland, Bulgaria, Romania, Croatia, still depend on landfilling, and treatment options are rarely in place. Therefore, still a large amount of waste is disposed of in landfills
The transposition and implementation of the Directive provisions legislation will be an extremely challenging task for the country. The aim of this paper is Aim of this paper is to analyze different scenarios for waste treatment and their impact on environment and cost, in Novi Sad Waste Management Centre.

## Experimental
The input for the analysis is morphological composition of MSW in NSWMR and generated MSW waste. In 2009. total amount of generated waste was 189.000 tones [7]. Out of this, 44% is biodegradable waste (see Figure 1).

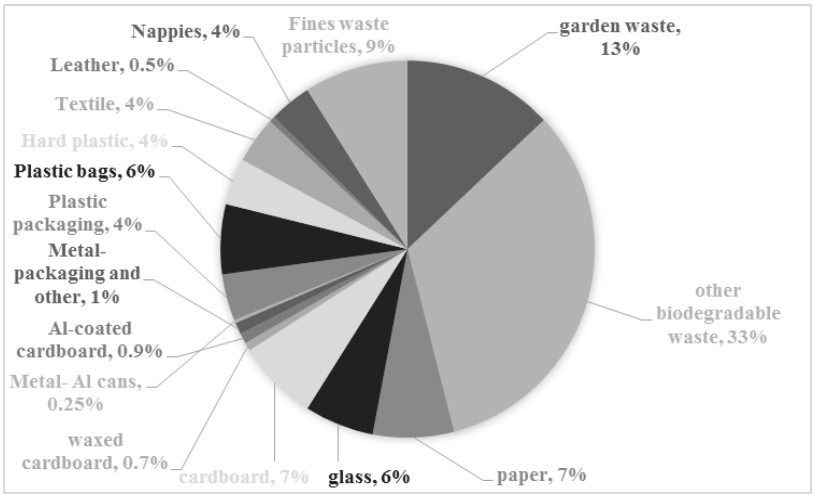


**Figure 4:** Morphological composition of MWS in the region [6]

For the projected waste generation growth rate we have used GDP in Serbia, which was around 2% [8].

Analysed technologies in are composting and incineration with CHP. Composting is used for the treatment of the biodegradable fraction. Composting considers open-air process in a box, which include composting and the stage of maturation and main products are compost, wastewater and residues are produced during the process. Incinerator, with energy recovery, produces electricity and heat from the waste treated; bottom ash, fly ash and filter cake are exported for disposal and reduces the amount of waste sent to landfill.

In this paper we have analysed two scenarios. Scenario 1 is treatment of only biodegradable waste, to reduce the emission of GHG from landfill, and Scenario 2 is treatment of biodegradable waste and treatment of residual waste in incinerator, to reduce the amount of waste which is landfilled. Parameters used environmental and cost analysis for Scenario 1 and Scenario 2 are given in Table 1. Environmental analysis includes the potential saving in term of CO2 emission from selected treatment plants. Cost analysis include investment and operational cost for treatment plant, based on amount of treated waste.

**Table 1**: Analyzed technologies for the MSW treatment [10,11,12]

| Technology | Investment and operating cost | | GHG emission (t $CO_2$ eq) |
|---|---|---|---|
| Composting | $y=2000\ (x)^{0.8}$ | $y=2000(x)^{-0.5}$ | 0.012 |
| Incineration CHP | $y=5000\ (x)^{0.8}$ | $y=700\ (x)^{-0.3}$ | 0.378 |

**Results and discussion**

In 2035. total amount of generated municipal waste will be 322,769 tones with 2% increased rate. In order to reach the EU biodegradable waste goals, it will be necessary to treat 97.509 tons of biodegradable waste in composting plant. Furthermore, to reduce the GHG emission, and protect the environment, 161.398 tons of residual waste should be treated. Also, 64.977 of packaging waste, must be recycled to reach the EU recycling goals [1] Cost of the analyzed technologies are given in Table 2. Incineration costs, investment and operating, are higher compared to composting, eight and ten times, respectively. Also, incineration is superior compared to composting, in terms of GHG emission.

**Table 2: Environmental and cost analysis of waste treatment**

| | Investment cost (€) | Operating cost (€) | GHG emission (t $CO_{2\ eq}$) |
|---|---|---|---|
| Composting | 19,439,281 | 11,838,866 | 20,095 |
| Incineration | 73,326,217 | 73,326,215 | 974,487 |

In Table 3, are given costs for Scenario 1 and Scenario 2. Incineration plant, increase the cost, but also increase the savings in terms of GHG emission. Treatment of biodegradable waste will reduce only biodegradable waste for landfill, while residual waste will increase. Selection of incineration, will reduce the amount of waste sent to landfill as well, but will increase the cost of by-products treatment (fly ash and bottom ash). However, scenario 2 has a better GHG "balance" than scenario 1, thus contribute to reduction of GHG emission. Selection of waste treatment plant (scenario) will depend on many factors. One of the important factors will be the investment cost of the plant and economic sustainability of the plant. However, any of scenarios for waste treatment must be tailored to local conditions, because many proven technologies have fallen due to difficulties to adapt waste treatment to local conditions.

**Table 3: Cost and GHG emission of analyzed scenarios**

| | Investment cost (€) | Operating cost (€) | GHG emission (t $CO_{2\ eq}$) |
|---|---|---|---|
| Scenario1 | 19,439,281 | 11,838,866 | 20,095 |
| Scenario 2 | 92,765,498 | 85,165,081 | 994,582 |

## Conclusion

Both analyzed technologies are proven waste treatment. Implementation of those technologies will be challenging task for the Novi Sad region. Decision makers will have to implement and introduce different mechanisms e.g. landfill ban, landfill taxes in order to divert the waste to treatment and reduce the GHG emission from landfill.

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