# ASSESSING THE PRESENT AND FUTURE LANDFLL EMISSIONS IN GREEK CITIES UNDER THE IMPLEMENTATION OF CIRCULAR ECONOMY TARGETS

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## Extended abstract

The sustainable management of MSW in Greece has been an issue and the goals that are set by the framework of circular economy are challenging. Specifically, it is assessed that Greece is in danger of not achieving the European Union target for municipal waste recycling by 2035, and primarily not achieving the target for reduced landfilling. Landfilling, which is the main treatment practice for the country's municipal solid waste, is also responsible for emitting greenhouse gases in the form of mainly carbon dioxide and methane. Thus, there is a necessity to minimize landfilling. Waste-to-energy is a widely applied technology in many European countries, even in countries with very high recycling rates, and can be an effective choice for reducing landfilling and -as a result - the GHG from MSW management. In this study, the GHG emissions from the landfilling practices in three urban centers in Greece (Athens, Thessaloniki, and Larissa) were studied over time. The purpose of this work is to investigate whether the use of waste-to-energy is a preferable choice in order to achieve the reduction of GHG emissions in comparison to landfilling.

For the collection of data on the quantitative and qualitative characteristics of MSW for the cities of Athens, Thessaloniki and Larissa, we used data that were available on the official websites of Regions and the Municipalities. More specifically, for Athens, quantitative data of MSW were taken from the reports of the years 2015-2018 (FOSDA Attica & EDSNA). For Thessaloniki, the quantitative data were taken from the reported values which were available per month in the open data portal of the Municipality of Thessaloniki. For the best study they were grouped in 12 depending on the year, added and then their average was taken for the years 2015-2018. For Larissa, data were taken from the local decentralized waste management plan (2015-2020), which present quantitative data for the years 1998-2014. The quality composition of the MSW was used

with percentages according to the new ECHR 2015 as given by the local waste management plan for Thessaloniki (Local decentralized waste management plan of the Municipality of Thessaloniki 2016). Finally, for Larissa, data were obtained that are available in the local decentralized waste management plan (203.2 15-2020).

Analysis tools: The modeling of the landfill emissions for each case were performed with the software LandGEM, which is calculating emission rates for total FLG (Landfill gas), methane, carbon dioxide, non-methane organic compounds (NMOCs) and individual air pollutants from MSW landfills. LandGEM uses site-specific data, and the modeling has been adjusted for the local conditions. For the needs of the modeling, the elemental composition and the chemical type of the waste were calculated. A calculation tool developed at the Energy Management Laboratory of the University of the Aegean was used to calculate the chemical composition by accounting the concentration of each material in MSW. Each material (e.g., paper) has a characteristic chemical formula. The chemical formula for plastics has been created from a mixture of the most common plastics in a ratio corresponding to that found in MSW. Finally, the Circular Economy calculator of CEWEP was used in order to estimate the volume changes between recycling / composting, landfill and WtE under the implementation of the Circular Economy targets. The calculation of future recycling shares is based on the objectives of the EU circular economy package with a current recycling share of 55% by 2025, 60% by in 2030 and 65% by 2035, respectively.

The amount of upper and lower calorific value for the three regions was calculated using three scenarios for the three different study regions:

- For the burning of 25% MSW
- For the burning of 40% of MSW
- For the burning of 55% of MSW

Also, a scenario was created for Athens for k = 0.05 year ^ -1 where the GWP results and the results from the scenarios for the production of carbon dioxide were used. Then three hypotheses were created based on the MSW combustion calculation scenarios (25 % MSA combustion, 40% MSW combustion and 55% MSW combustion). Three scenarios were created where 75%, 60% and 45% of CO2 and CH4 emissions from the landfill were calculated and then combined with the 25%, 40 % and 55% burn MSW until the total of the two fractions is 100%.

The purpose of this scenario was to present the relationship between combustion gases and landfills in a time frame up to 2135. Finally, the total emissions for the years 1995-2135 from landfills and incineration were calculated and compared.

Under the guideline of Circular Economy landfilling will be gradually reduced and the materials that will be disposed in landfills will be practically inert. The simulations show peak emissions between 2057 and 2075, which shows the long-lasting effects from landfilling. A model wass implemented for the case of Athens and for a projection for the years 1995 – 2135 and the accumulated emissions from the application of 100% landfilling, 100% WtE and three mixed scenarios. For reference, and assuming the composition of the MSW in Athens, the GHG emissions, have a ratio of 1.7: 1 by switching from landfilling to WtE.

In respect to micropollutants that are usually connected to WtE, like dioxins and furans, the following should be noted: The uncontrolled fire in the landfill of Tagarades (Thessaloniki) in the summer of 2006 created 3g of toxic dioxins per day. In contrast, US-based 88 WtE plants, which burn more than 30 million tons of waste, release less than 10g of dioxins over a full year. A major nuance of this present study is that the exact composition of MSW has been accounted in the calculations. The 20-year projections, i.e., 1995 – 2015, returned similar results to the longer projections (1995 -2135) in respect to the ratio of emissions from WtE and landfilling and shows that WtE have 60% the quantity of emissions that would be emitted from landfilling.