Greenhouse Gas Emissions from Municipal Waste Management: The Situation in Greece

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Climate change framework

1992: United Nations Framework Convention on Climate Change (UNFCCC)

Aim: Hold global warming below 2°C

1997: Kyoto Protocol

<table>
<thead>
<tr>
<th>Year</th>
<th>GHG reduction targets compared to 1990 levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UNFCCC Parties</td>
</tr>
<tr>
<td>2008-2012</td>
<td>5%</td>
</tr>
<tr>
<td>2013-2020</td>
<td>18%</td>
</tr>
<tr>
<td>2030</td>
<td>-</td>
</tr>
<tr>
<td>2050</td>
<td>-</td>
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</tbody>
</table>
Global Greenhouse Gas Emissions by Gas

Source: IPCC (2007) based on global emissions from 2004
Global Greenhouse Gas Emissions by Source

IPCC (2007); based on global emissions from 2004

- Energy supply: 26%
- Residential & Commercial buildings: 8%
- Industry: 19%
- Agriculture: 14%
- Forestry: 17%
- Transport: 13%
- Waste and wastewater: 3%
7. Gases-generation and contribution
## Anthropogenic emissions of the main GHG in the EU, 1994

<table>
<thead>
<tr>
<th>Direct GHG</th>
<th>Emissions (Mt)</th>
<th>GWP [2] (over 100 years)</th>
<th>Global Warming Equivalence of all emissions Mt equiv CO$_2$ (% from solid waste disposal)</th>
<th>Global warming equivalence emissions from waste disposal Mt equiv CO$_2$ (% of total waste management component for each gas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO$_2$ fossil</td>
<td>3.215</td>
<td>1</td>
<td>3,215 (&lt;0.5 %)</td>
<td>15 (9 %)</td>
</tr>
<tr>
<td>CH$_4$</td>
<td>22</td>
<td>21</td>
<td>460 (33 %)</td>
<td>152 (89 %)</td>
</tr>
<tr>
<td>N$_2$O</td>
<td>1.05</td>
<td>310</td>
<td>325 (1 %)</td>
<td>3 (2 %)</td>
</tr>
</tbody>
</table>
Estimated share of the three waste disposal operations in GHG emissions (2011)

Source: EEA Greenhouse gas data viewer, March 2014
GWP values and lifetimes for a time horizon of 100yrs (IPCC)

<table>
<thead>
<tr>
<th>GHG</th>
<th>Lifetimes (years)</th>
<th>2001</th>
<th>2007</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CH₄</td>
<td>12,4</td>
<td>23</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>N₂O</td>
<td>121</td>
<td>296</td>
<td>298</td>
<td>298</td>
</tr>
</tbody>
</table>
GHG emissions from landfills

**Simplified Landfill Methane Mass Balance**

Methane (CH$_4$) produced (mass/time) = $\Sigma$(CH$_4$ recovered + CH$_4$ emitted + CH$_4$ oxidized)
Solid waste landfilling technologies

- **Dump**
  The dump refers to a landfill where many different kinds of waste are disposed of with little or no benefit of an engineering plant. The waste is not compacted, no measures exist to prevent gas and leachate emissions to the environment, and the waste is not covered.

- **Conventional landfill**
  A conventional landfill, as typically defined, is a landfill that implements technical measures to collect and manage the leachate and gas generated (as also foreseen in the Landfill Directive).

- **Engineered landfills with energy recovery**
  In addition to the technical measures implemented in conventional landfills, these technologies adopt active measures to enhance the waste degradation process, in order to make it faster and more efficient.

- **Engineered landfills for low organic waste**
  These landfills are destined for the disposal of residual waste. Similar to engineered landfills, these landfills adopt technical measures to collect and treat the generated leachate.
MSW generation in the EU (2013)
in kg per capita
Waste management in the EU-28 (2013)

- **Prevention**: All measures taken before a substance, material or product has become waste
- **Prepare for re-use**: Any operation by which products or components that are not waste are used again for the same purpose
- **Recycling**: Any recovery operation by which waste materials are reprocessed into products, materials or substances (excl. energy recovery)
- **Other recovery**: Includes energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations
- **Disposal**: Any operation which is not recovery (e.g. landfilling)
Average net GHG emissions from different types of waste management methods
MSW management facilities in Greece

- 29 Material Recovery Facilities
- 4 Mechanical Biological Treatment Plants
- 79 Sanitary landfills (75 in operation)
- 39 Dumps in operation
National Waste Management Plan in Greece

The National Waste Management Plan (NWMP) sets a number of ambitious targets for waste management by 2020:

- Preparing for re-use and recycling with separate collection of recyclable and biowaste of at least 50% w/w of MSW
- Reduction of BMW going to landfills to 35% w/w (compared to 1997 levels)
- Reduction of total waste disposal of MSW to <30% w/w
- Separate collection of 40% w/w of BMW
- Preparing for re-use and recycling of 65% w/w of at least paper, glass, metal and plastic
- Recovery of 60% and recycling 55-80% w/w of packaging waste
GHG emissions for different landfill scenarios

- 4.565,000 tonnes of MSW (2011)
- 1.528,685 tonnes of low organic MSW (2020)
Concluding remarks

- Although landfill disposal of MSW is considered the least preferred option, there is great potential for reducing its carbon footprint.
- Landfilling is unavoidable, as with any other waste management option, there will always be an amount of residual waste that will need to be disposed of.
- Waste, even when disposed of in landfills, holds a significant value that may still be exploited.
- The amount of biodegradable waste disposed of in landfills must be reduced to avoid methane generation in landfills.
- In all cases, standards must be followed for reducing landfill methane emissions by capture and combustion of landfill gas with or - if this is not possible - without energy recovery.
- Achieving the targets set in the National Waste Management Plan for 2020, is expected to substantially reduce landfill emissions in Greece.
Thank you for your time and your attention!!