GHG-Emissions from MSW treatment
- Comparison of four studies -

Workshop “Methods to calculate GHG mitigation potentials in Solid Waste Management”
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Agenda

• Studies compared
• Qualitative comparison
  - Scope and general aspects
  - Waste fractions and composition
  - Treatment and substituted processes
• Quantitative comparison
  - Emission factors
  - Waste volumes
  - GHG-emissions (overall results)
• Conclusion and questions for discussion
Studies

Four recent important studies on MSW-management and GHG-emissions in the European context:

• Prognos et al. (2008)

• UBA (2010)

• EEA (2011)

• OECD (2012)
Scope & general aspects

- All studies follow LCA-approach of the waste management sector
  - cradle (waste generation) to grave (secondary product/ final disposal)
    - burdens of MSW-treatment
    - benefit of avoided production (credits for energy, materials)
## Scope & general aspects

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<tr>
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</thead>
<tbody>
<tr>
<td><strong>Geographical scope</strong></td>
<td>EU 27</td>
<td>EU 27</td>
<td>EU 27 +NO+CH</td>
<td>OECD excl. EE, IT, SI</td>
</tr>
<tr>
<td><strong>Waste type</strong></td>
<td>all waste material flows in EU incl. MSW</td>
<td>MSW</td>
<td>MSW</td>
<td>MSW</td>
</tr>
<tr>
<td><strong>MSW volume</strong></td>
<td>constant for 2020</td>
<td>constant for 2020</td>
<td>varying through time series</td>
<td>extrapol. to 2030</td>
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</table>

- **For this comparison**
  - Prognos (2008) only MSW
  - OECD (2012) only OECD-Europe
Scope & general aspects

- Characterisation factors from IPCC (2007) for GWP 100a
  - Prognos (2008) and UBA (2010) additionally consider CH$_4$ oxidation in atmosphere ($CF_{CH_4,fossil}=27.75$)
- Biogenic carbon climate neutral
- No carbon sinks considered
  - Prognos (2008) and UBA (2010) consider C-sink in landfill and from compost use in sensitivity analyses
- Carbon intensity of national electricity generation assumed constant
- Management options
  - Landfill
  - Incineration
  - Recycling / composting
    - partly also MBT and anaerobic digestion (esp. UBA 2010)
## Waste fractions

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<tr>
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<tbody>
<tr>
<td>Food waste</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Garden waste</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Paper/cardboard</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Wood</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Glass</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Plastics</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fe-metals (steel)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>NF-metals</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Textiles</td>
<td>X</td>
<td>--</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rubber/leather</td>
<td>mainly tyres</td>
<td>--</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Solid fuel waste</td>
<td>X</td>
<td>output MBT</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Residual waste</td>
<td>to incin./ to landfill</td>
<td>to incin./ MBT/ landfill</td>
<td>--</td>
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</tbody>
</table>
Waste composition

- Prognos et al. (2008)
  - no specific composition of residual waste (average characteristics)
  - share of recyclables based on statistical information from Eurostat
- UBA (2010)
  - composition of residual waste based on Kern (2001)
  - share of recyclables based on European Atlas of Secondary Raw Materials (Prognos)
- EEA (2011)
  - composition of landfilled and incinerated waste mainly from NIR
  - share of recyclables based on empirical values (country-specific or default average from values for AT, BE, DK, SE, UK)
- OECD (2012)
  - total MSW split according to regional compositions for Europe from IPCC (2006)
  - material specific recycling rates adapted from Prognos (2008)
## Treatment & substituted processes - examples

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<tbody>
<tr>
<td><strong>Electricity</strong></td>
<td>EU average, 541 g/kWh</td>
<td>demand: DE grid, 598 g/kWh avoided: EU marginal, 749 g/kWh</td>
<td>country spec. grid, ELCD-database</td>
<td>demand: av. Europe 380 g/kWh avoided: marginal 770 g/kWh</td>
</tr>
<tr>
<td><strong>Wood</strong></td>
<td>47% recycling, 53% CHP</td>
<td>Prognos (2008) + saved wood for CHP in EU</td>
<td>100% material recycling</td>
<td>100% material recycling</td>
</tr>
<tr>
<td><strong>Paper</strong></td>
<td>primary fibre: pulp/mech. pulp, phys. SF=1</td>
<td>primary fibre: pulp/mech. pulp phys. SF=0.95; + saved wood for CHP in SE</td>
<td>primary fibre: pulp/mech. pulp/cardboard</td>
<td>Prognos (2008)</td>
</tr>
<tr>
<td><strong>Glass</strong></td>
<td>raw materials, energy, market-mix SF=30%;</td>
<td>raw materials, energy, phys. SF=1;</td>
<td>glass bottles (with 71% cullets)</td>
<td>Prognos (2008)</td>
</tr>
<tr>
<td><strong>Plastic</strong></td>
<td>PE/PP, PET, PS, PVC: recycling, mixed: co-incin.</td>
<td>PE/PP, PET, PS: recycling, 20% sorting residues MSWI</td>
<td>PO, PE, PS, wood/concrete palis., methanol</td>
<td>Prognos (2008), 100% recycling, arithmet. average</td>
</tr>
</tbody>
</table>
Agenda

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• Quantitative comparison
  ▪ Emission factors
  ▪ Waste volumes
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• Conclusion and questions for discussion
Emission factors – Material recycling, examples

Emission factors for recycling
- Comparison of different studies -
Emission factors – Incineration and Landfill

- Relevant waste characteristics: LHV, carbon content (DOC, C-fossil)

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<tbody>
<tr>
<td><strong>Incineration</strong></td>
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<tr>
<td>Electrical efficiency</td>
<td>10%</td>
<td>10%</td>
<td>33%</td>
<td>10%</td>
</tr>
<tr>
<td>Thermal efficiency</td>
<td>30%</td>
<td>30%</td>
<td>56%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Landfill</strong></td>
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<tr>
<td>Gas capture rate</td>
<td>20%</td>
<td>20%</td>
<td>NIR, capped at 45%</td>
<td>75%</td>
</tr>
<tr>
<td>Gas utilization rate</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>40%</td>
</tr>
<tr>
<td>Electrical efficiency</td>
<td>---</td>
<td>---</td>
<td>33%</td>
<td>25%</td>
</tr>
<tr>
<td>Thermal efficiency</td>
<td>---</td>
<td>---</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Municipal solid waste volumes - current

Results of different studies:
- Prognos 2008, for 2006: 39%
- UBA 2010, for 2007: 42%
- EEA 2011, for 2010: 37%
- OECD 2012, for 2005: 52%

Recycling: 39%
Composting: 42%
Incineration: 37%
Landfill: 52%
Other (MBT):
GHG-emissions (overall results) - current

Prognos 2008, for 2006
UBA 2010, for 2007
EEA 2011, for 2010
OECD 2012, for 2005

Recycling/Composting  Incineration  Landfill  Other (MBT)
Conclusion and Questions

- **Waste volume**
  - Account for variation in future scenarios?
    - do both, constant waste volume like UBA, Prognos for base year and future scenario, and prediction of change like OECD with system comparison for future scenarios?
  - Consider effects due to changes in waste volume only qualitatively?

- **GHG emissions from landfill**
  - In case yearly emissions are of interest, also additionally calculate total emissions related to total amount landfilled?
  - how to assure reliability of data that are hard to measure like landfill gas recovery rate? – certificates, verification of special technical equipment, or in general conservative approach and sensitivity analysis?
Conclusion and Questions

- **Substitution potential / avoided processes**
  - E.g. glass: physical or market share? Physical when potential shall be considered, real market share e.g. for LCA of products or CDM projects?
  - Assessment of wood and paper material recycling in fossil based economies (energetic use yields higher credits)? Account for alternative use of saved wood for energy production?

- **Data**
  - Definition of standardized emission factors - possible? Or documentation in a special (standardized?) way?
  - Identification of waste composition and waste characteristics: obligatory (national) sorting analysis for MSW from households? sensitivity analysis?
  - GWP characterisation factors: IPCC (2007), 100a? IFEU approach for fossil methane (incl. oxidation in the atmosphere)?
Thank you very much for your attention!