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

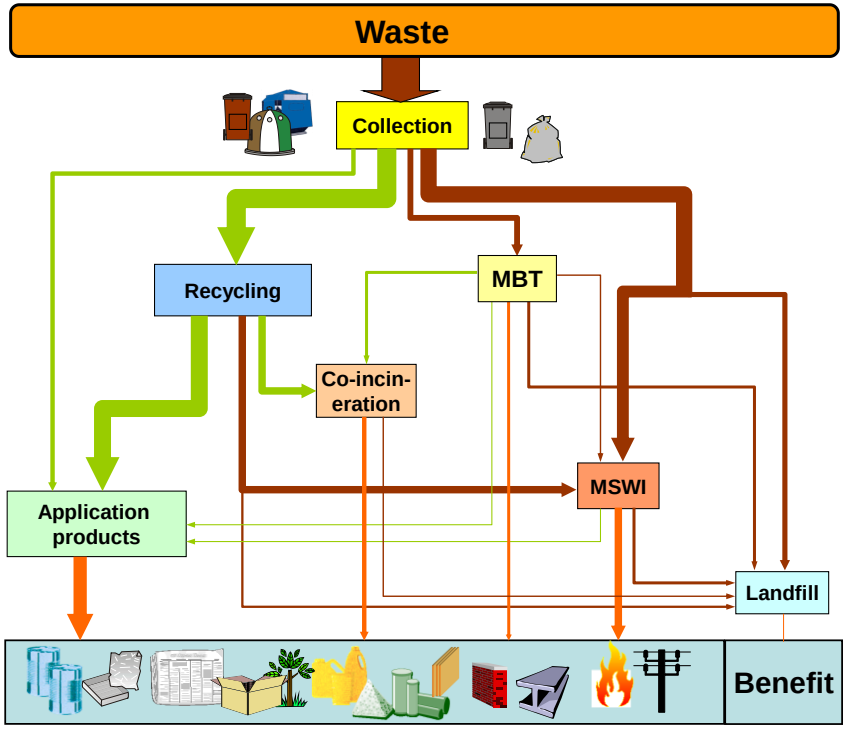
Studies

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

- Prognos et al. (2008)
  Resource savings and CO_2 reduction potential in waste management in Europe and the possible contribution to the CO_2 reduction target in 2020. prognos/INFU/IFEU, sponsored by European Coalition of Waste Management Organisations, Oct. 2008
- UBA (2010)
  Climate Protection Potential in the Waste Management Sector. Examples: Municipal Waste and Waste Wood.
  FKZ 3708 31 302, UBA-Texte 61/2010, Umweltbundesamt (Federal Environment Agency), Dec 2010
- EEA (2011)
  Projections of Municipal Waste Management and Greenhouse Gases. ETC/SCP working paper 4/2011. European Environment Agency, Aug 2011
- OECD (2012)
  Greenhouse Gas Emissions and the Potential for Mitigation from Materials Management within OECD Countries.
  Working Group on Waste Prevention and Recycling.
  ENV/EPOC/WGWPR(2010)1/Final. Environment Directorate, Environment Policy Committee, March 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

	Prognos (2008)	UBA (2010)	EEA (2011)	OECD (2012)
Geographical scope	EU 27	EU 27	EU 27 +NO+CH	OECD excl. EE, IT, SI
Time scope	2006 [extrapol. from 2004] scenarios 2020	2007 scenarios 2020	time series 1990-2020	2030 [extrapol. from 2005] scenarios 2030
Waste type	all waste material flows in EU incl. MSW	MSW	MSW	MSW
MSW volume	constant for 2020	constant for 2020	varying through time series	extrapol. to 2030

- 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 ($CF_{CH4,fossil}$=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

Material	Prognos (2008)	UBA (2010)	EEA (2011)	OECD (2012)
Food waste	X	X	X	X
Garden waste		X		X
Paper/cardboard	X	X	X	X
Wood	X	X	X	X
Glass	X	X	X	X
Plastics	X	X	X	X
Fe-metals (steel)	X	X	X	X
NF-metals	X	X		X
Textiles	X	--	X	X
Rubber/leather	mainly tyres	--	X	X
Solid fuel waste	X	output MBT	--	--
Residual waste	to incin./ to landfill	to incin./ MBT/ landfill	--	--

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

	Prognos (2008)	UBA (2010)	EEA (2011)	OECD (2012)
Electricity	EU average, 541 g/kWh	demand: DE grid, 598 g/kWh avoided: EU marginal, 749 g/kWh	country spec. grid, ELCD-database	demand: av. Europe 380 g/kWh avoided: marginal 770 g/kWh
Wood	47% recycling, 53% CHP	Prognos (2008) + saved wood for CHP in EU	100% material recycling	100% material recycling
Paper	primary fibre: pulp/mech.pulp, phys. SF=1	primary fibre: pulp/mech. pulp phys. SF=0.95; + saved wood for CHP in SE	primary fibre: pulp/mech. pulp/cardboard	Prognos (2008)
Glass	raw materials, energy, market-mix SF=30%;	raw materials, energy, phys. SF=1;	glass bottles (with 71% cullets)	Prognos (2008)
Plastic	PE/PP, PET, PS, PVC: recycling, mixed: co-incin.	PE/PP, PET, PS: recycling, 20% sorting residues MSWI	PO, PE, PS, wood/concrete palis., methanol	Prognos (2008), 100% recycling, arithmet. average

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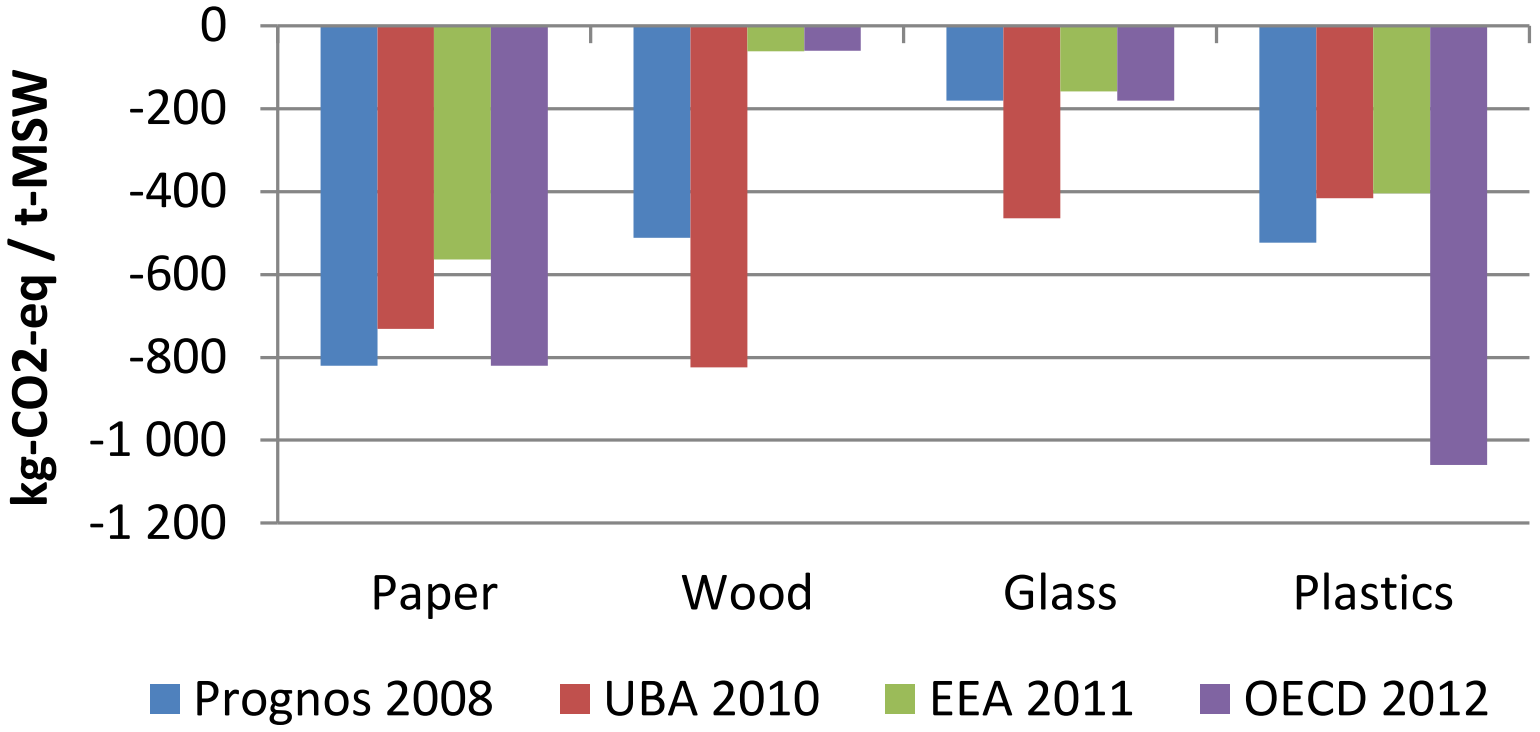
Emission factors – Material recycling, examples

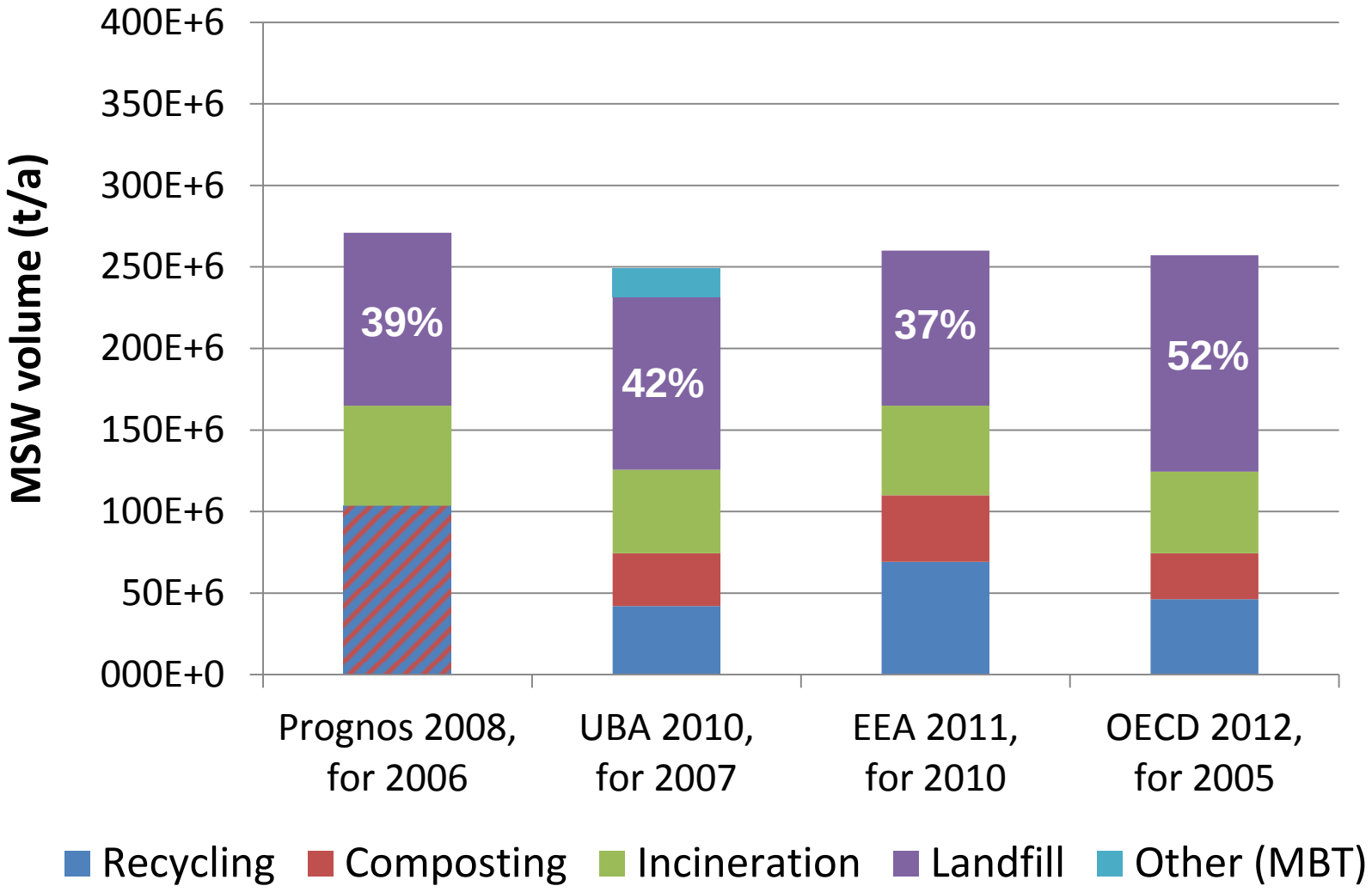


Emission factors – Incineration and Landfill

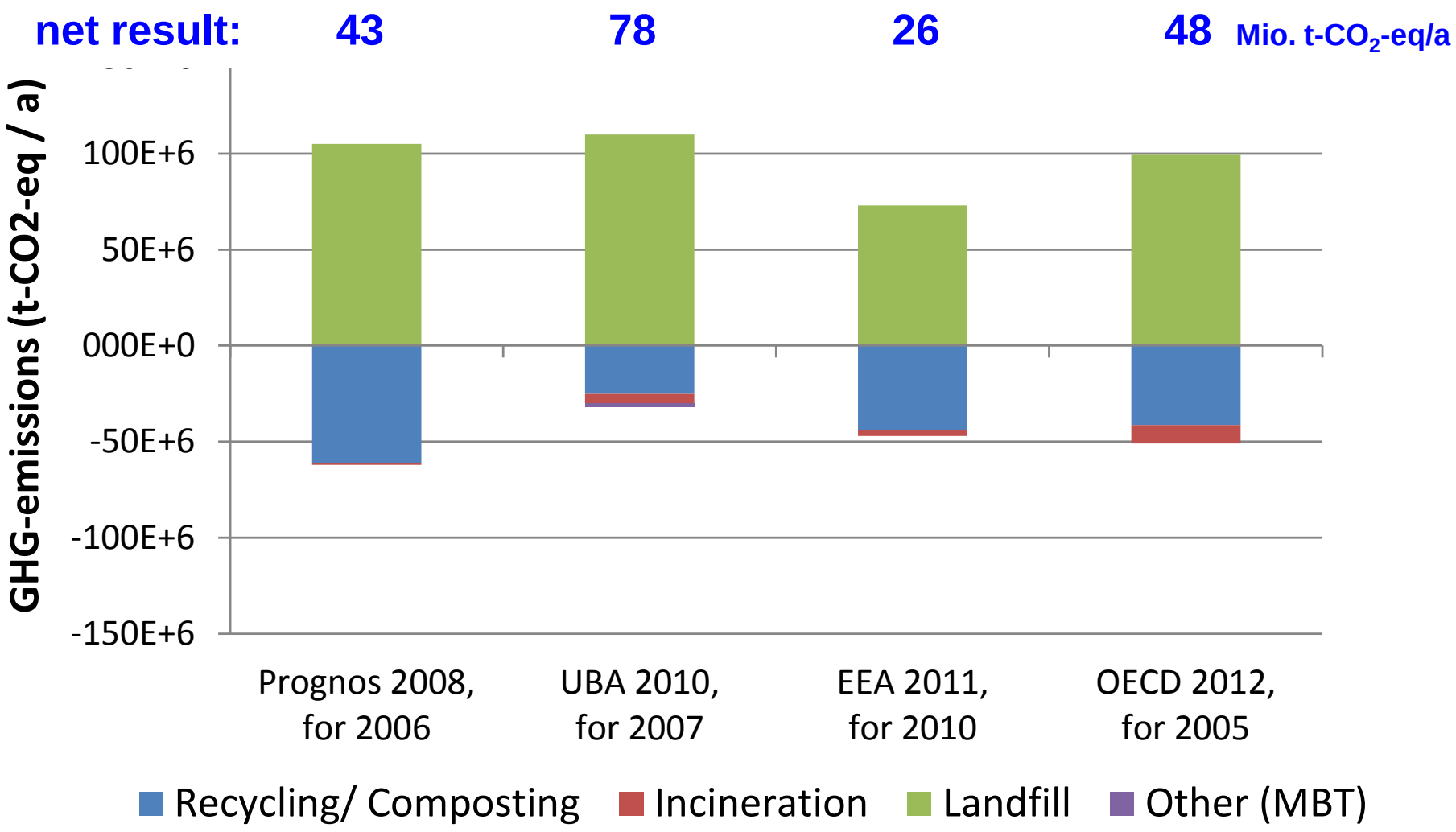
- Relevant waste characteristics: LHV, carbon content (DOC, C-fossil)

	Prognos (2008)	UBA (2010)	EEA (2011)	OECD (2012)
Incineration				
Electrical efficiency	10%	10%	33%	10%
Thermal efficiency	30%	30%	56%	30%
Landfill	Total emis. per t waste	Total emis. per t waste	FOD	Total emis. per t waste
Gas capture rate	20%	20%	NIR, capped at 45%	75%
Gas utilization rate	0%	0%	100%	40%
Electrical efficiency	---	---	33%	25%
Thermal efficiency	---	---	0%	0%

Municipal solid waste volumes - current



GHG-emissions (overall results) - current



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!