



Biowaste Management from an Environmental Perspective

Ecological Assessment of the entire System
“separate Collection and Composting of Biowaste”

Andreas Detzel, Florian Knappe, Regine Vogt, Bernd Franke
Institut für Energie- und Umweltforschung – ifeu Heidelberg
(Institute for Energy and Environmental Research)

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Contents



- Background
- The concept of „the entire system“
- Ecological Assessment: some Basics
- Results
- Conclusions

Legal Background



- According to the „Commercial and Industrial Waste Management Act“ (KrW-/AbfG) priority has to be given to recycling systems
 - a) that are „more compatible with the environment“
 - b) that results in secondary products of a „high value“
- The environmental relevance of a recycling option is not limited to an individual treatment plant, but environmental impacts of the complete recycling route need to be analysed, beginning from the source of generation of the biogenic waste until its final application or usage as secondary product
- Consequently, the selection of a particular waste management option requires the proof that is more environmentally friendly than other existing alternatives = a ranking from an ecological perspective is needed

Political Background



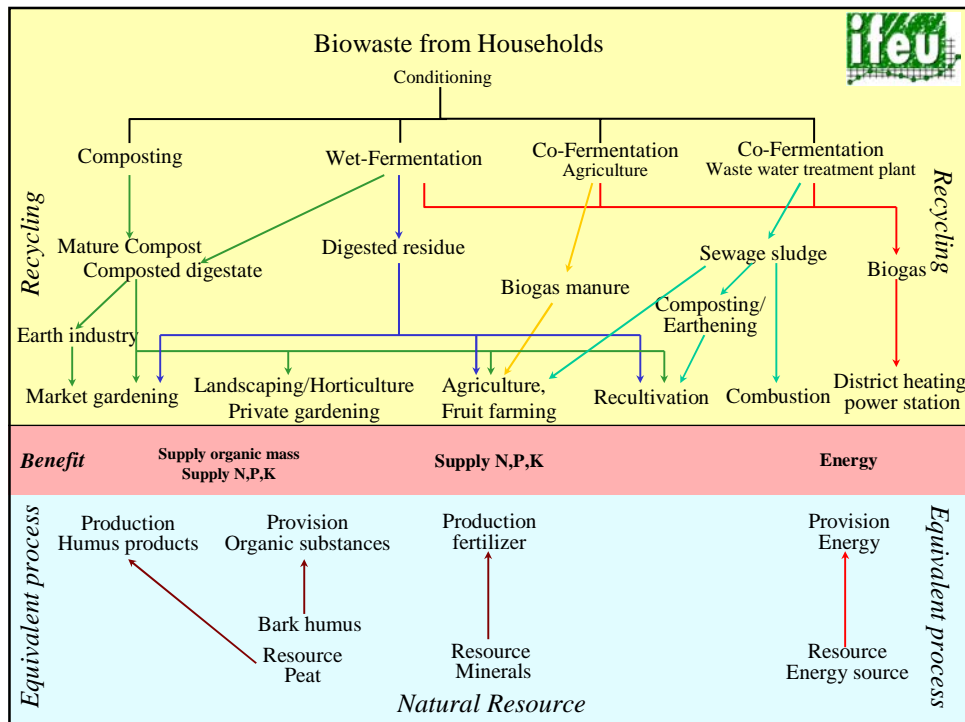
- Focus program on biowaste by the German Environmental Fund:
 - a) Development of technologies and applications for biowaste handling
 - b) Evaluation of environmental benefit of individual solutions
- On-going debates on environmental advantages and disadvantages of source separated collection and recovery of biowastes



Key issues for decision makers

- Is recycling of source separated biowastes from households preferable to incineration of biowaste collected with mixed municipal solid waste from an environmental point of view?
- If yes: what would be the best way to deal with this typ of biowaste?

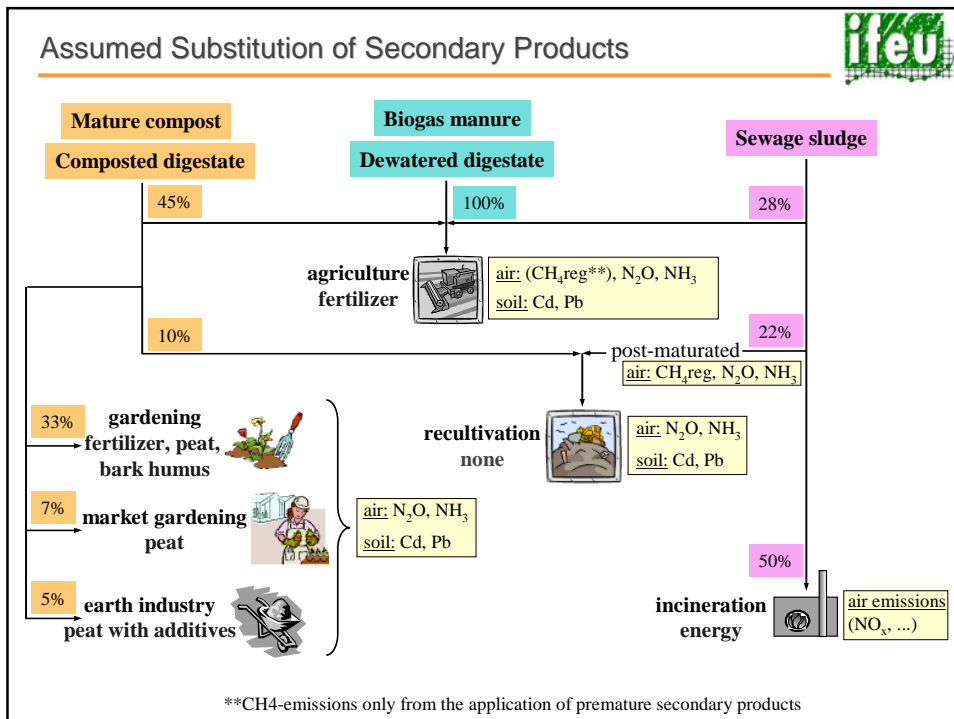
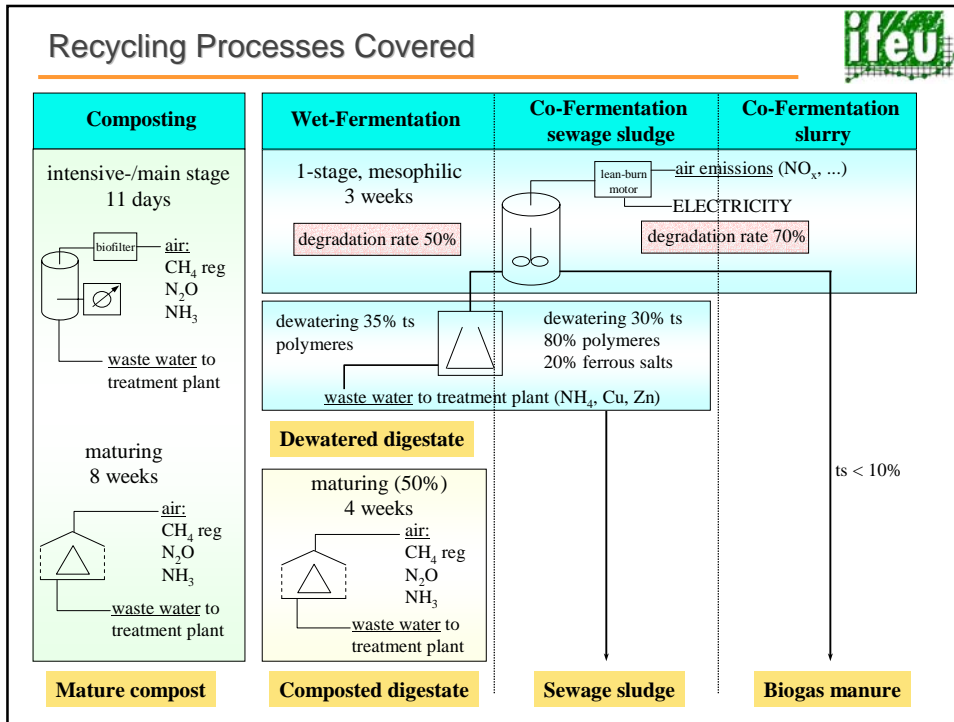
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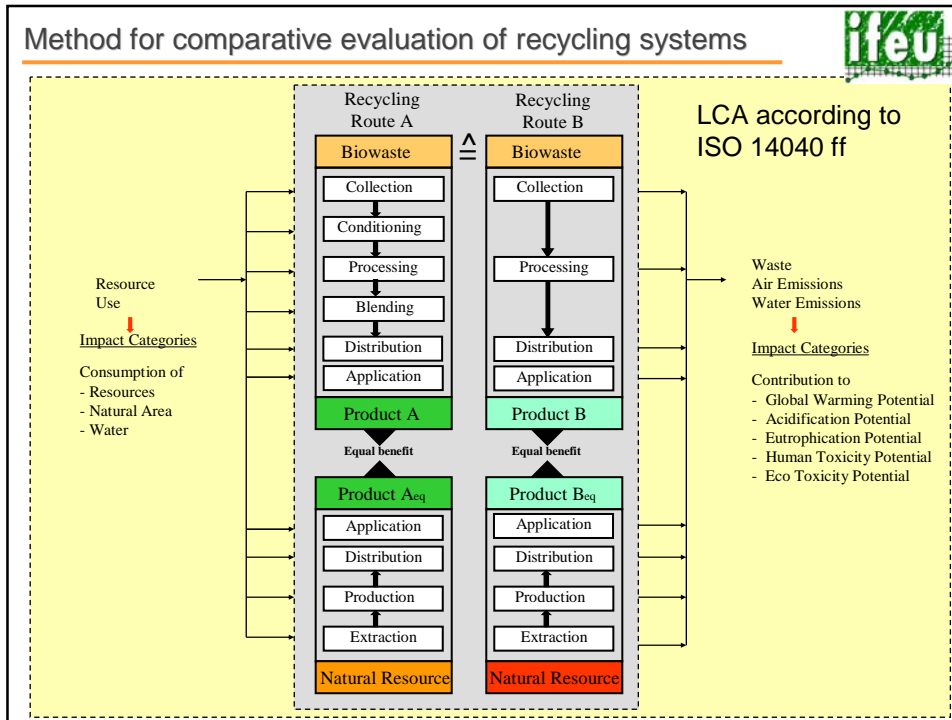
Scenarios Examined

- **Scenarios for Composting of Biowaste**
 1. Private Composting at Homes („PrivComp“)
 2. Open Composting – Fresh Compost Application („OpenComp_1“)
 3. Open Composting – Open Maturing - Mature Compost Application („OpenComp_2“)
 4. Closed Composting – Fresh Compost Application („ClosedComp_1“)
 5. Closed Composting – Closed Maturing - Mature Compost Application („ClosedComp_2“)
- **Scenarios for Digestion of Biowaste**
 1. Dry Fermentation – Fresh Digest Application („FermDry_1“)
 2. Dry Fermentation – Open Maturing of Digest („FermDry_2“)
 3. Wet Fermentation – Fresh Digest Application („WetDry_1“)
 4. Wet Fermentation – Open Maturing of Digest („WetDry_2“)
 5. Co-Fermentation with Slurry – Fresh Digest Application („CoFermSlurry“)
 6. Co-Fermentation with Sludge – Fresh Digest Application („CoFermSludge“)
- **Final Disposal of Biowaste**
 1. Municipal Solid Waste Incineration („Incineration“)

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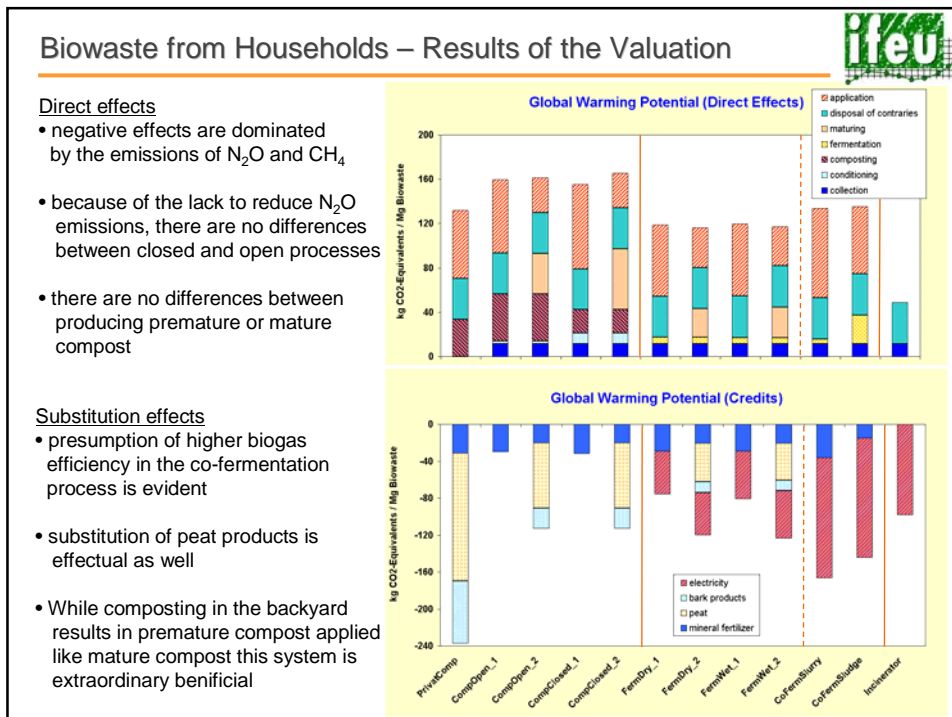
Assessed Impact Categories, Indicators and Parameters

Impact Category	Indicators	Parameters in the Life Cycle Inventory (LCI)
Global Warming Potential	CO ₂ -equivalents	CO ₂ fossil, CH ₄ , N ₂ O
Photochemical Ozone Creation Potential	Ethylene-equivalents	NO _x , CH ₄ , NMVOC, BTX _e , Formaldehyde
Eutrophication Potential	PO ₄ -equivalents	Air: NH ₃ , NO _x Water: N, P, CSB, NH ₄ ⁺ , NO ₂
Acidification Potential	SO ₂ -equivalents	SO ₂ , NO _x , NH ₃ , HCl, HF, H ₂ S
Resource Use	Crude oil-equivalents single parameter	mineral oil, natural gas, brown/hard coal phosphate ore
Human Toxicity (Carcinogenic risk)	Arsenic-equivalents	As, Cd, Cr(VI), Ni, Hg, BaP, dioxin/furan, diesel particulate
Eco Toxicity	single-parameters	Water: Cu, Zn
Entry in Soils	single-parameters	Pb, Cd

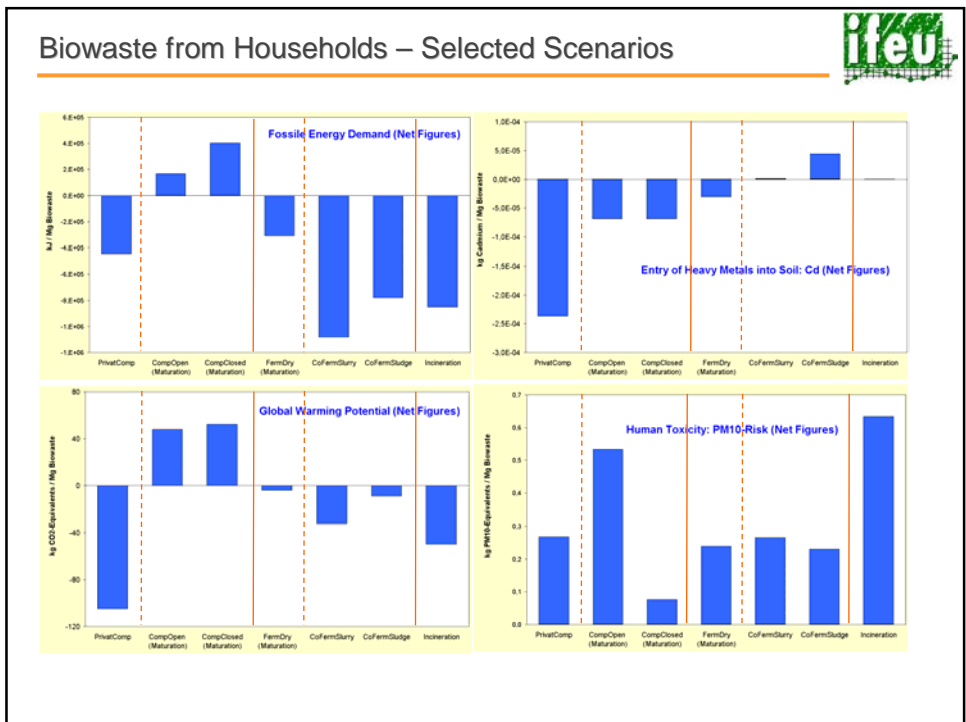
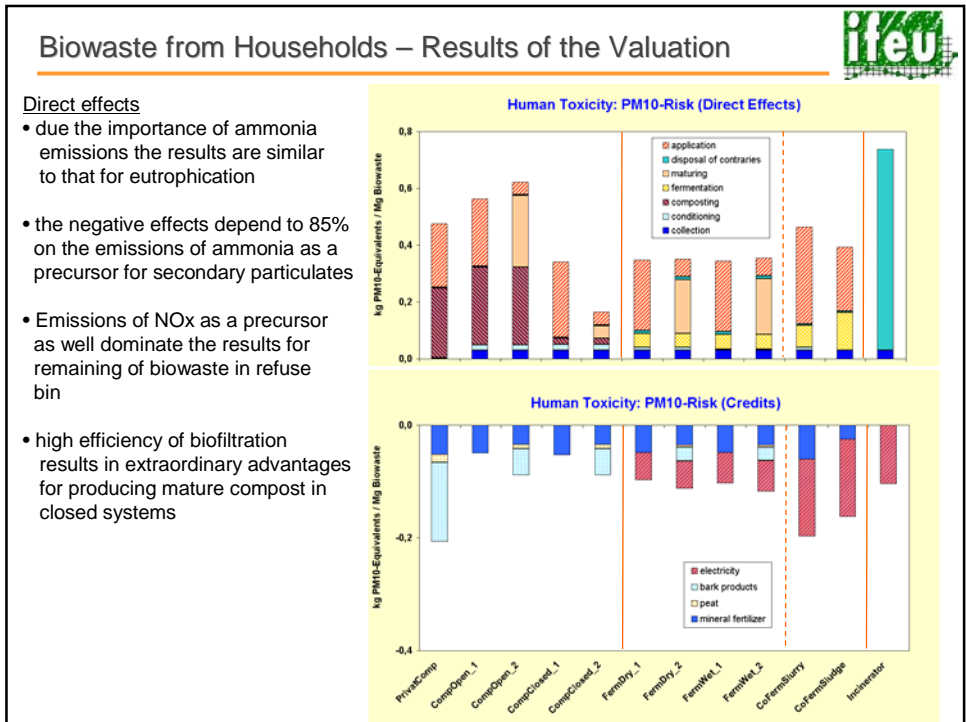
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Composition of Biowaste from Households 

Parameter	“Average” Value	Maximum Values	Unit
Moisture	60		[% of fM]
Organic Matter	50		[% of dM]
Nutrients			
C/N	16	25	[% of dM]
Total Nitrogen	1,65	2,7	[% of dM]
Total Phosphorus	0,39	0,61	[% of dM]
Total Potassium	0,87	1,33	[% of dM]
Total Magnesium	0,75	1,2	[% of dM]
Total Carbon	51,9		[% of dM]
NH ₄ , soluble	7		[% of dM]
Pollutants			
Cadmium	0,1	0,3	[mg/kg dM]
Mercury	0,04	0,15	[mg/kg dM]
Zinc	30,6	155	[mg/kg dM]
Copper	9,2	56,1	[mg/kg dM]
Chromium	1,8	7,7	[mg/kg dM]
Nickel	1,3	7,9	[mg/kg dM]
Lead	2,6	9,2	[mg/kg dM]



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Conclusions



- All recycling options are likely to provide an overall environmental benefit
- Individual recycling options achieve different scores according to the environmental impact category examined
- The result of each biowaste treatment option is strongly influenced by the quality of its outlet and the related substitution effects
- High quality outlets produced under „low-emission“ conditions are a prerequisite for favourable scores against incineration:
 - ⇒ Composting: Mature composts replacing organic matter (peat, bark); Closed plants
 - ⇒ Digestion: Matured digestates replacing organic matter; State-of-Art digesters
- Composting versus Digestion in general lines shows:
 - ⇒ Advantages for digestion related to fossile energy demand and global warming
 - ⇒ Advantages for closed composting for standard air emissions
 - ⇒ Disadvantages for open composting
- Best scores across all impact categories were found for:
 - ⇒ Home composting / Closed composting and maturing / Co-fermentation with slurry