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CO_2 and the energy balances of different treatment processes for biowaste

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Agenda

- Introduction
- Concepts for biowaste treatment
- Life-cycle analysis
  - Energy balance
  - CO_2-balance
- Conclusions

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Treatment concepts investigated

Concept 1 Composting

Concept 2 Biological drying for the production of biomass fuel fractions

Concept 3 Anaerobic digestion including maturation of the solid digestate

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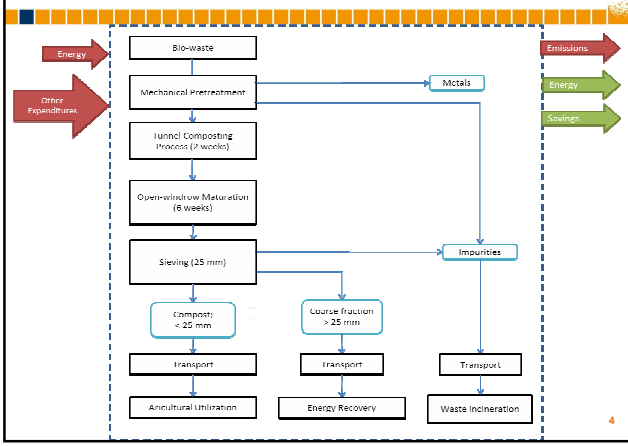
Concept 1: composting



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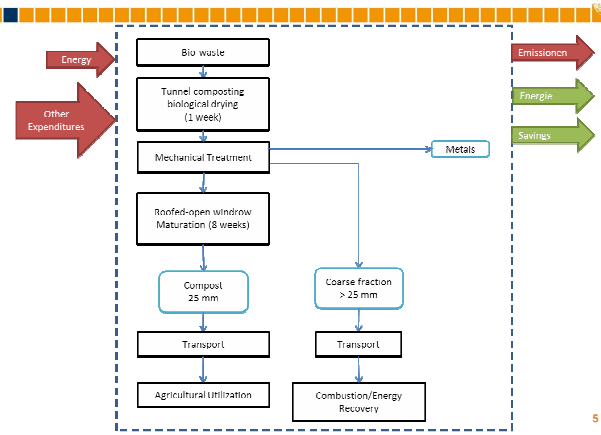
Concept 2: Fuel production



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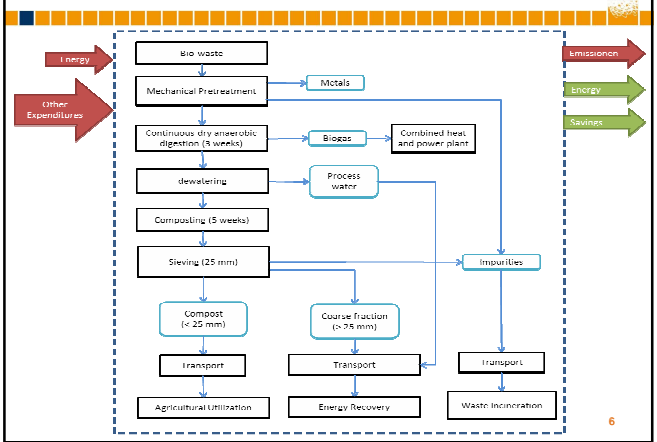
Concept 3: Anaerobic digestion



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[P07-en] CO2 and the energy balances of different treatment processes for biowaste

Dr. W. Müller, University of Innsbruck, AT

Mass balances

	Concept 1: Composting Fresh matter (t/a)	Concept 2: Biological drying Fresh matter (t/a)	Concept 3: Anaerobic digestion Fresh matter (t/a)
Input			
Bio-waste	25.000	25.000	25.000
Green waste	5.000	5.000	5.000
Total	**30.000**	**30.000**	**30.000**
Products			
Impurities	800	0	800
Fe-Metals	30	30	30
Biomass fuel	2.300	7.200	2.500
Compost	8.200	6.500	4.300
Process water			14.700
Biogas			3.600
Total	11.300	13.700	25.900

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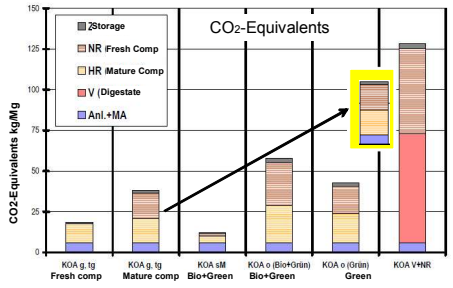
Exhaust air emissions from different treatment concepts



KOA	**Compost plant**
KOA g	In vessel compost plant
KOA tg	Compost plant partly enclosed
KOA sM	Compost plant with semipermeable membrane
KOA o	Open windrow compost plant
KOA V (VS)	Compost plant with dry digestion (full flow) and post decomposition
KOA V (TS)	Compost plant with dry digestion (partial flow)+ post decomposition

Anl.	Delivery
MA	Mechanical treatment
IR	Intensive decomposition, active aeration
ER	Extensive decomposition, passive aeration
HR	Main decomposition, active aeration; product: fresh compost
NR	Post decomposition, active or passive aeration, product: mature compost

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[Cuhls 2008]

Transports of products

Biomass to combustion facility: 120 km

Contraries to waste incineration plant: 120 km

Compost to field: 15 km

Process water to fiel: 15 km

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Efficiency of Energy production from products

	Utilisation plant	Electrical efficiency (%)	Heat efficiency (%)
Biogas	Combined heat and power	38 %	45 %
Woody biomass	Biomass combustion	27 %	35 %
Contraries	Waste incineration	10 %	30 %

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Credits

electricity production

•Electricity mix Austria : 253 g $CO_{2\text{-eq}}$/kWh

•Electricity mix Germany: : 550 g $CO_{2\text{-eq}}$/kWh

•Rate of renewable energy in the electricity mix:

Austria: 66 % (2011)

Germany: 16,5 % (2012)

•Substitution method (reduced emission through energy from renewable resources)

biogas gas engine: 698 g $CO_{2\text{-eq}}$/kWh

biomass combustion: 790 g $CO_{2\text{-eq}}$/kWh

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Credits

Utilisation of compost

•**Nutirents**: nitrogen, phosphorus, potassium

•**Humus** (soil improver);
no satisfying direct method available
current approaches to account for humus benefits

→Substitution of straw: compost replaces straw which can be used for energy production

→Production of intercrops: expenditures and emissions

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Energy consumption and produc tion

Energy balance	Concept 1: Composting	Concept 2: Biological Drying	Concept 3: Anaerobic Digestion
Diesel consumption for transportation (l/t Bio-waste)	1,1	1,6	1,6
Consumption of Energy for the operation of the facilites			
Energy consumption (KWh/t)	60	45	78
Diesel consumption (l/t)	2	2	2
Heat for the fermenter (KWh/t)	0	0	140
Production of electrictiy			
Biogas (KWh/t)	0	0	234
Biomass fuel (KWh/t)	42	205	43
Combustion of impurities (KWh/t)	7	0	7
Production of heat			
Biogas (KWh/t)	0	0	278
Biomass fuel (KWh/t)	55	266	55
Combustion of impurities (KWh/t)	21	0	21
Energy balance			
Diesel (l/t)	3,1	3,6	3,6
Electricity surplus (KWh/t)	-11	160	206
Heat surplus (KWh/t)	75	266	214

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Greenhouse gases; CO_2-equivalents

Greenhouse gases

Kg CO_2-equivalents; according to IPCC (2007):

Carbon dioxide (CO_2) = 1

Methane (CH_4) = 25

Di-nitrous oxide (N_2O) = 298

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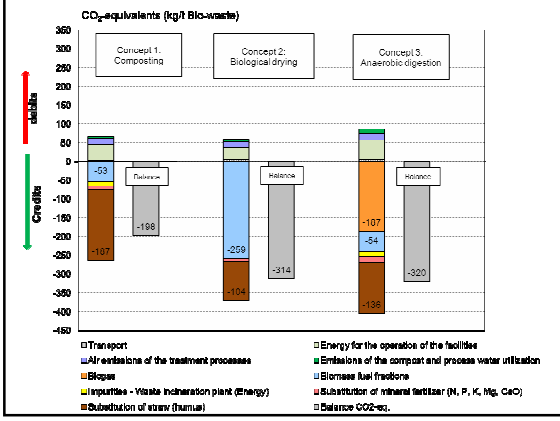
Greenhouse gases; CO_2-equivalents



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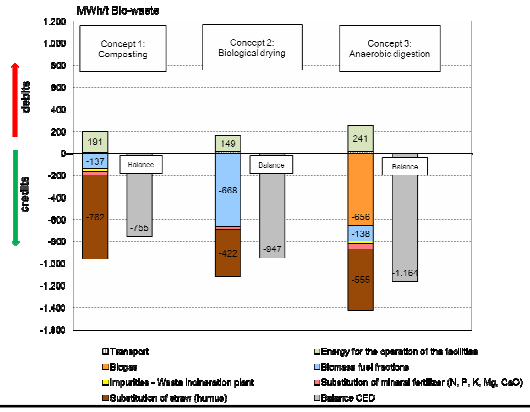
Cummulated Energy Demand (CED)



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conclusions

- The results show that all three concepts contribute to a reduction of greenhouse gas (GHG) emissions and show a positive balance for cumulated energy demand (CED).
- The benefits of compost as a soil improver play a significant role in the overall evaluation of any biowaste treatment concept.
- As a result of accounting for the soil improving properties of compost the advantage of anaerobic digestion compared to composting is smaller than shown in other studies.
- This means that composting is still playing a relevant role in the treatment of bio-waste.
- Due to it´s higher technical complexity Anaerobic digestion is associated with higher costs. Obviously the overall economics heavily depends on the revenues achieved from the utilisation of the biogas. As the feed-in tariffs are quite different in different countries the overall economics have to be assessed specific to each project.

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Thank you for your attention

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