MÉXICO-ALEMANIA
DIÁLOGOS POR UN FUTURO SUSTENTABLE | ENERGÍA DE RESIDUOS

FORO INTERNACIONAL 2015
VALORIZACIÓN ENERGÉTICA DE RESIDUOS URBANOS
Experiencias y estrategias globales

México, D.F. 7 de octubre del 2015

Waste Management in Germany and Global Trends

Prof. Dr. Ing. Klaus Fricke
Technische Universität Braunschweig (GER)

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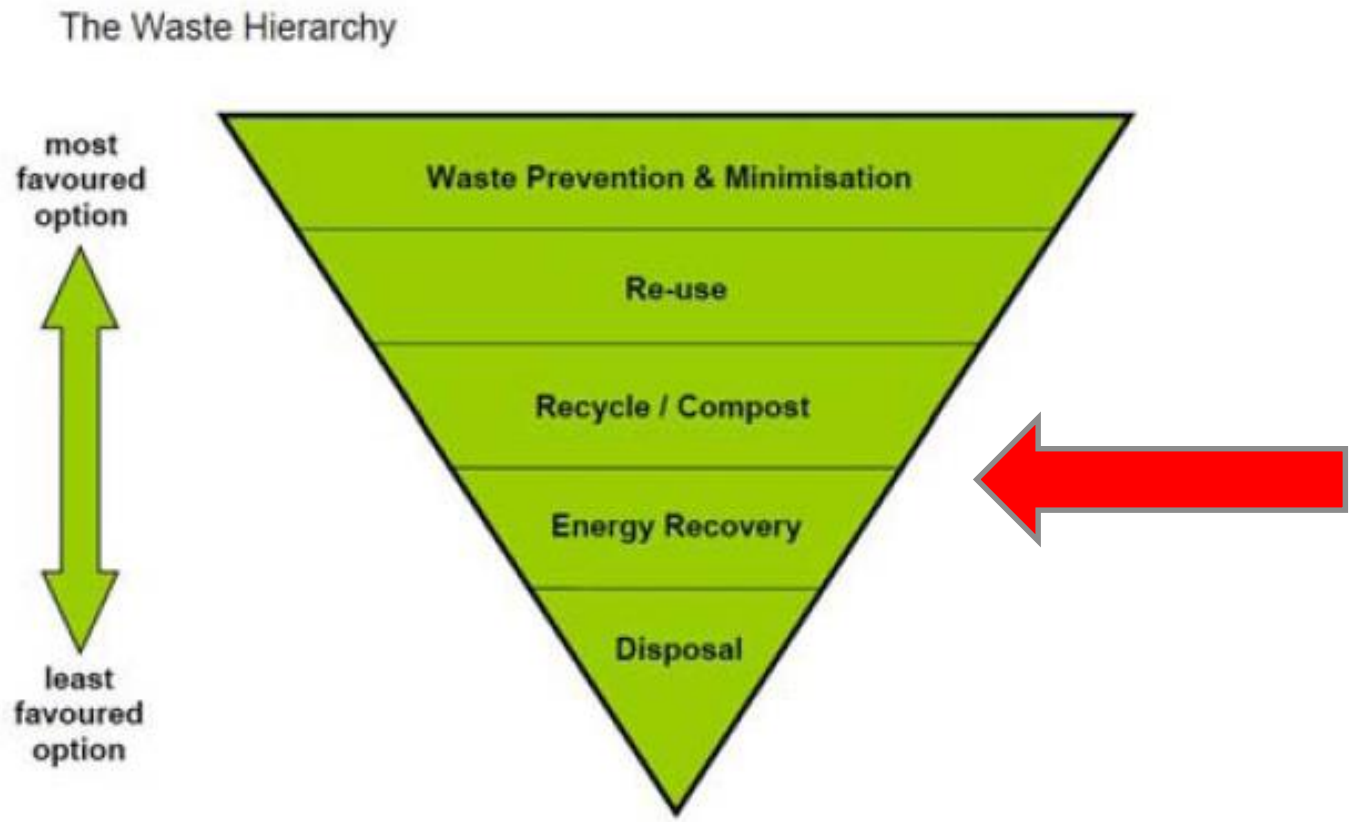
Trend setting influences

- Resource effiency
- Environmental protection e.g. climate change
- Economics and markets
- Waste composition

Waste Management Law in EU and Germany - Hierachy



What is the most sustainable strategy

- Material recycling or energy recovery or disposal?

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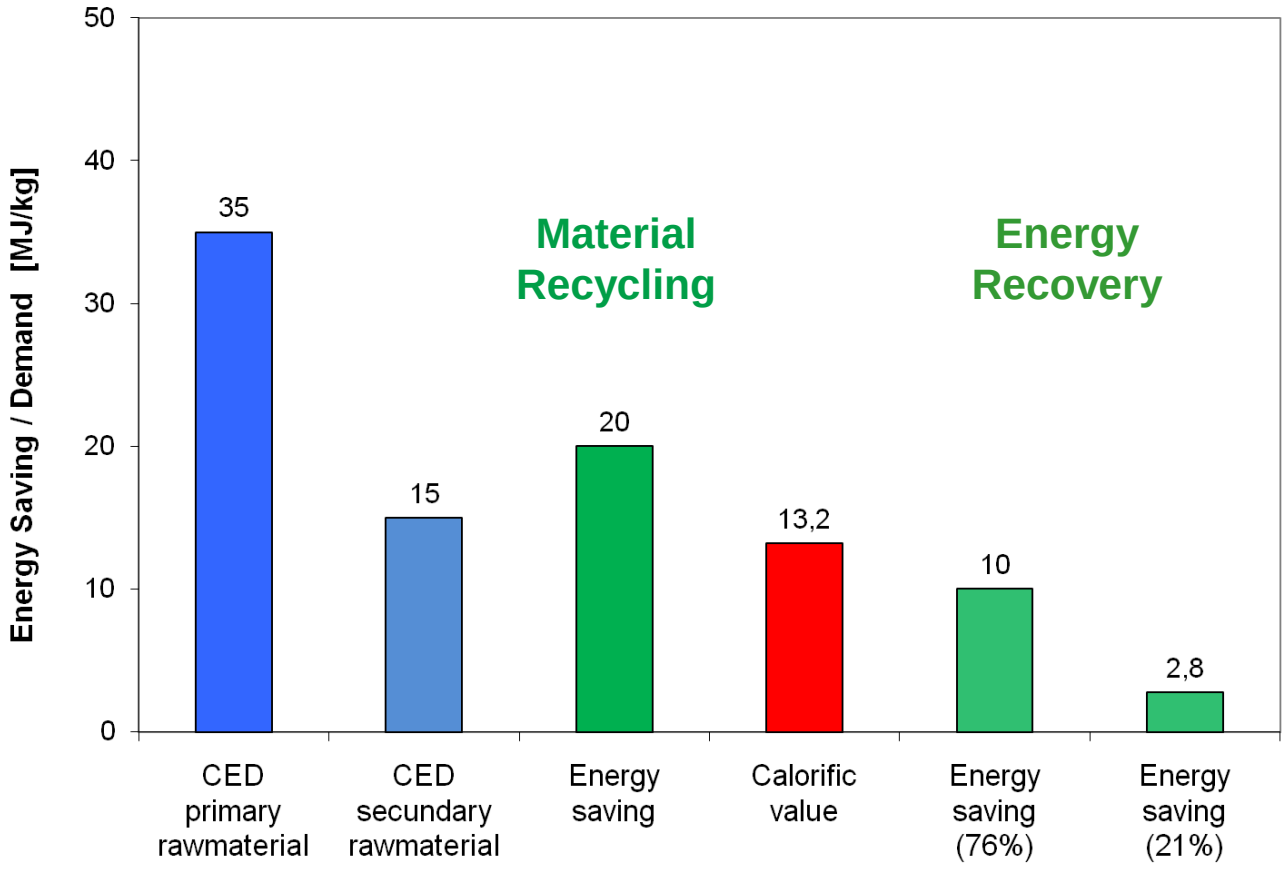
Energy Saving
- Material Recycling vs. Energy Recovery



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CED = cumulated energy demand

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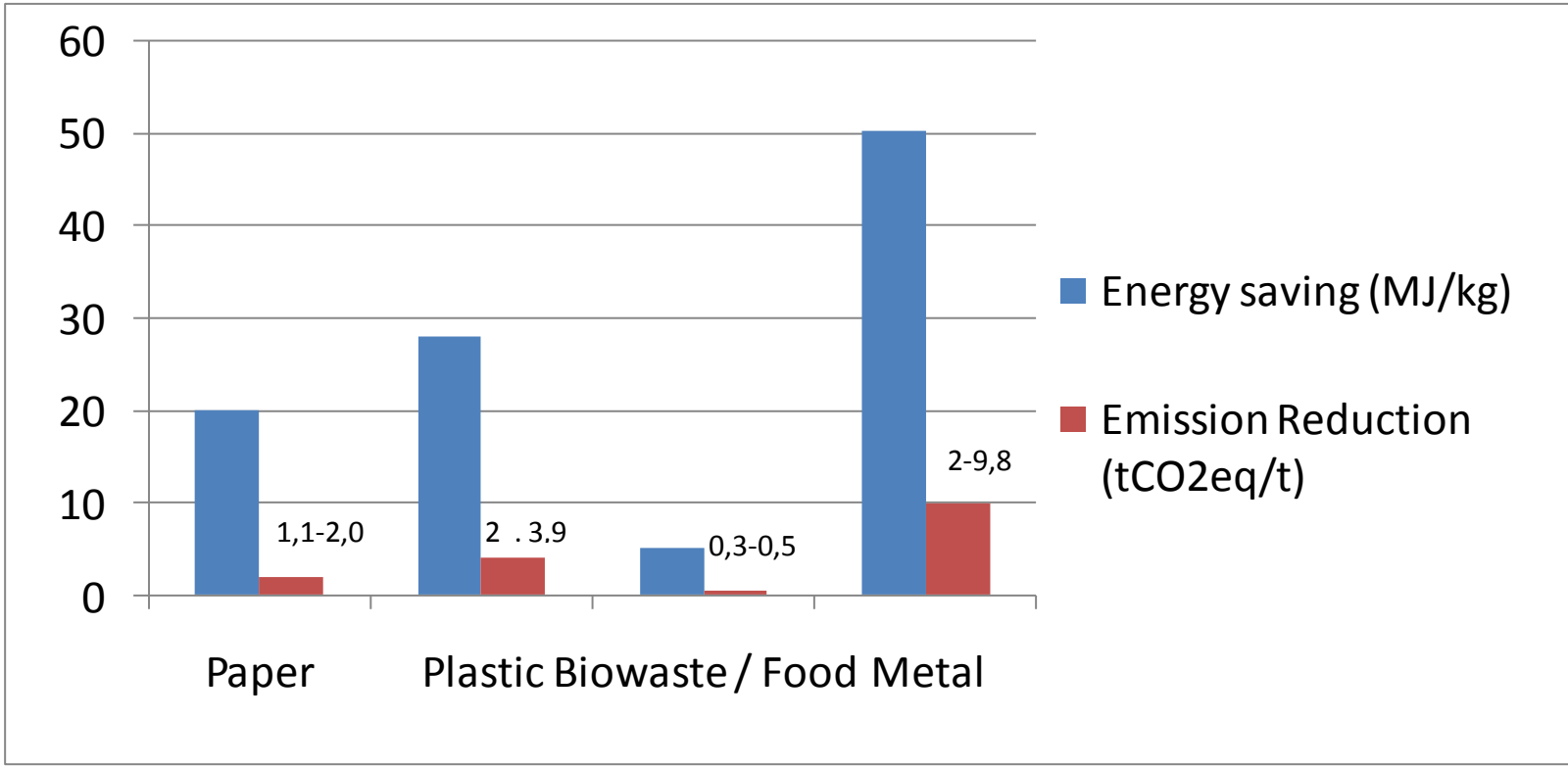
Energy Savings and GHG-Emission Mitigation by Means of Recycling



- Regarding resource efficiency, material recycling shows significant advantages compared to energy recovery (Paper, Plastics)
- Higher energy efficiency corresponds to lower climate effects (CO_2-Emissions)

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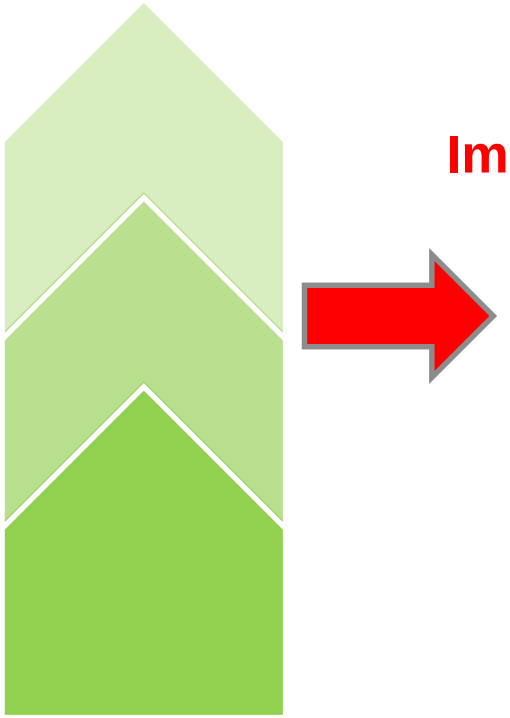
Trend Setting Influences – Results and Consequences

- Regarding resource efficiency, material recycling shows significant advantages compared to energy recovery and disposal (**Paper, Plastics**)
- Higher energy efficiency corresponds to **lower climate effects** (GHG)



Improve Material Recycling by means of

- **upgrading separate collecton and**
- **establishing assorting facilities**

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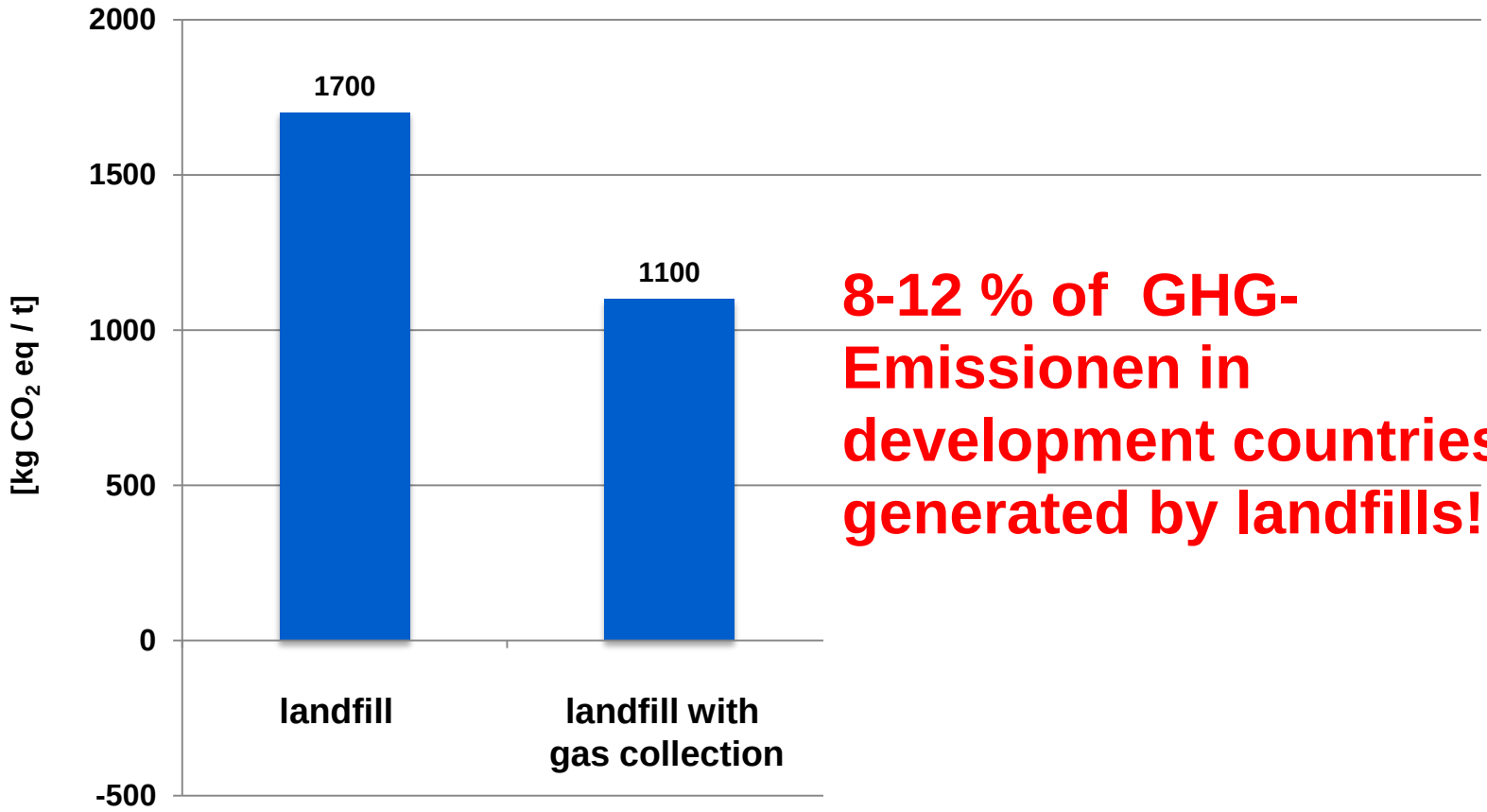
Trend setting influences

- **Environmental protection**
  - **climate change**
  - **marine litter**

GHG-Emission
- Low and Hight Standard Landfillls



8-12 % of GHG-Emissionen in development countries are generated by landfills!!!!

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Trend Setting Influences
- Consequences

- Landfill ban for untreated waste since 2005 in GER, CH and A - as from 2016 all over Europe

- **Recycling, treatment technologies for non recycables - MBT and energy recovery**

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G7 Summit in Germany

G7 Agreement on 2 degree target

UN-Climate Summit (COP 21), Paris, Frankreich 12-2015

Hope: New effective instruments for Climate Protection

Marine Litter

Trend Setting Influences
- Marine Litter

„Water comes in three qualities:

- **too much**
- **too little**
- **too dirty**

Heavy metals – Chlorides – Fluorides – Hydrocarbons – PCB, Pathogens ……

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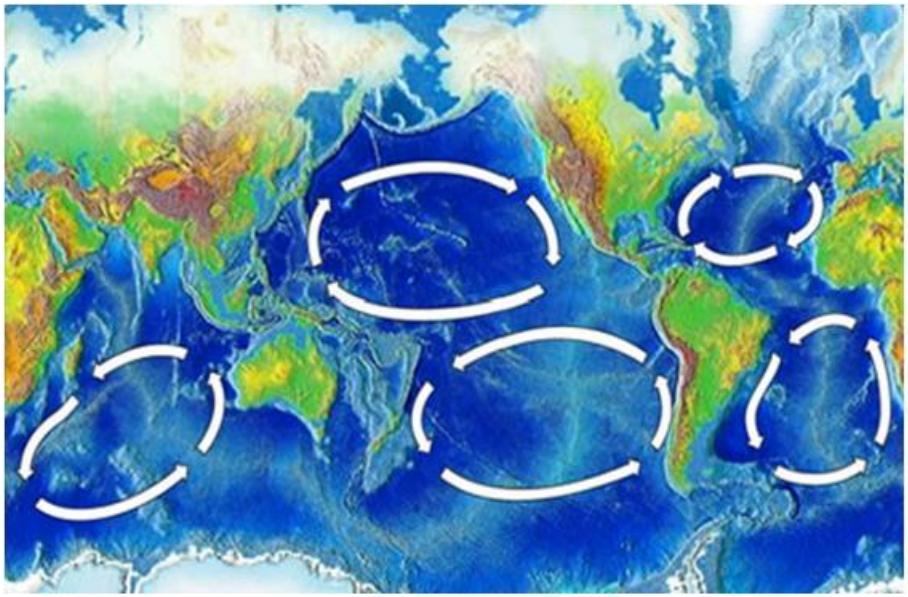
Trend Setting Influences
- Marine Litter



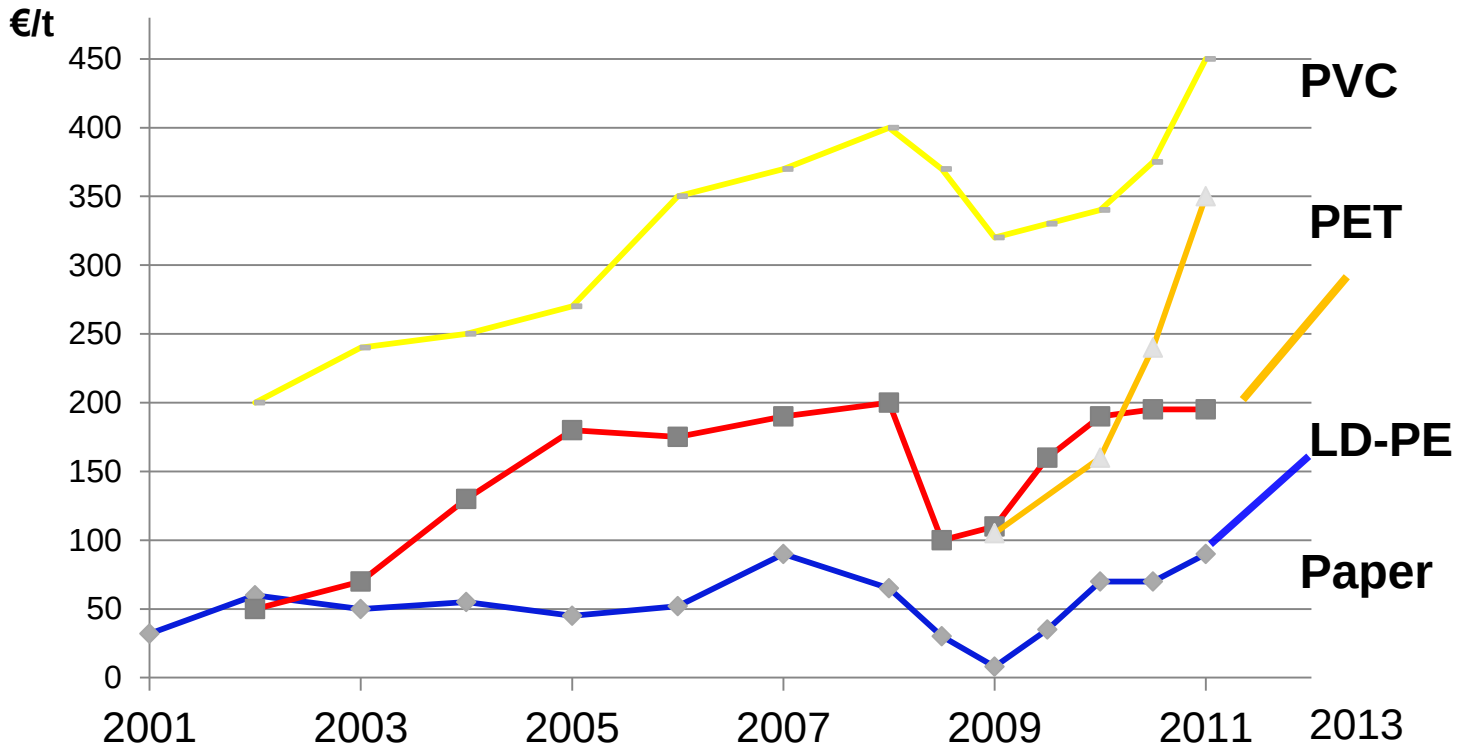
- 18.000 debris items per km^2
- 1 kg plancton comes 6 kg of plastic components
- 30% on the surface, 70% sediment onto the ground – e.g. 200 Mio t in the sediment of the Mediteran Sea

Trend setting influences

- **Economics and markets**

Trend Setting Influences
- Markets for Secundary Resources

Markets for Secondary Resources - Paper and Plastic



Medium and long term: Increasing

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(Quelle: EUWID: 02.2013)

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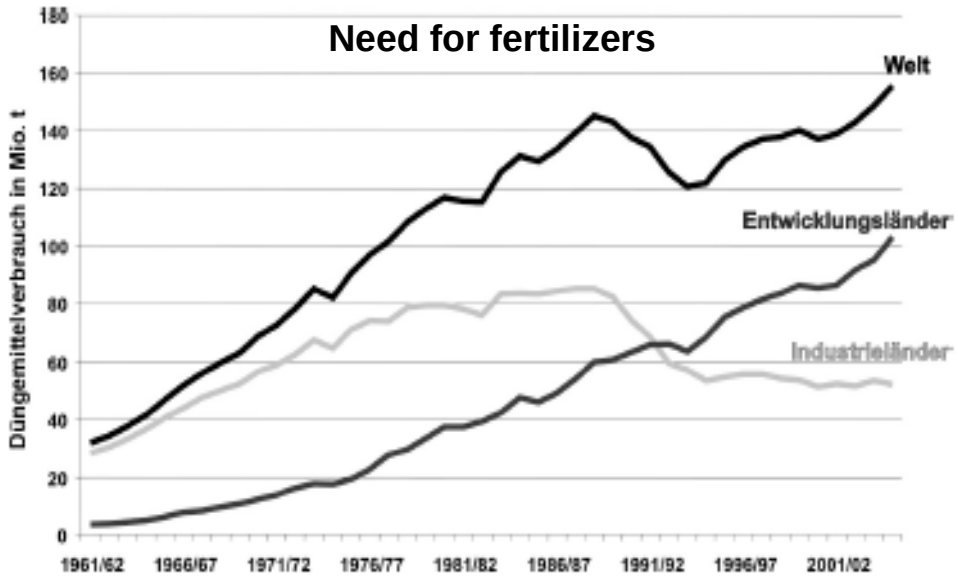
Markets for Secondary Products - Compost



- **Mexico City** **20 - 55 €/t**
- **GER** **up to 50 (avarage 6.-€/t)**
- **Brasil** **10 - 35 €/t**

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Markets for Secondary Products - Biogas Use

Financing the operating costs:

• Tax or fees	total amout in GER	
• Revenue from Compost	0 - 40 € / t FM	Compost
	0 - 13 € / t FM	Biowaste
• Revenue from Biogas (6 €cent/kWh)	6 - 7 € / t FM	fermenter-input
• Revenue from Biogas (+ financial funding by EEG up to 16 €cent/kWh)	15 – 28 € / t FM	fermenter-input
• Revenues CDM	1 – 2 € / Biowaste?	

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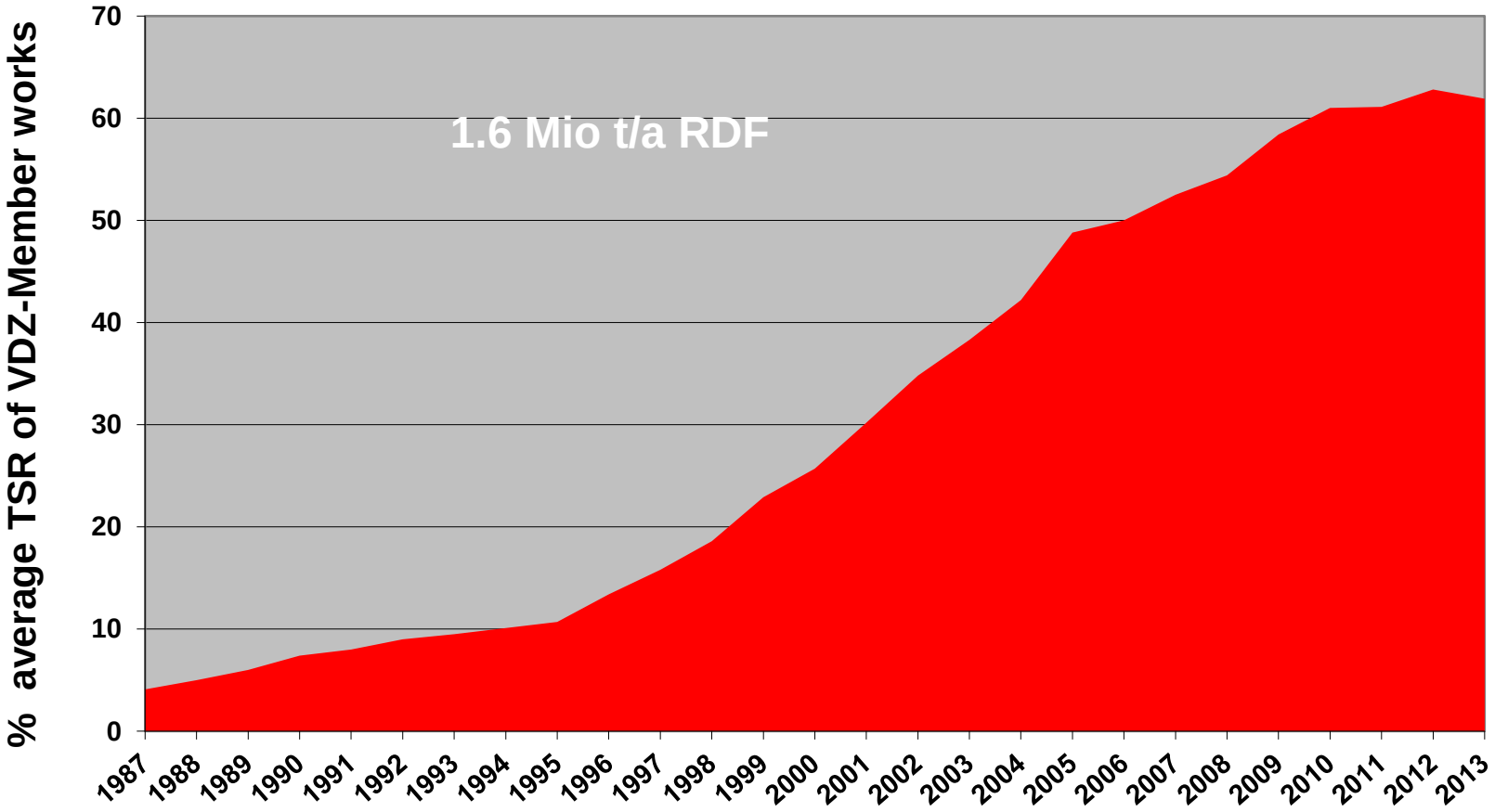
Average Thermal Substitution Rate (TSR) by Alternative Fuels /RDF) in the German Cement Industry



Revenues: - € 35 up to € 35.-/t
Production costs € 20 – 45.-/t

(Source: VDZ 2014)

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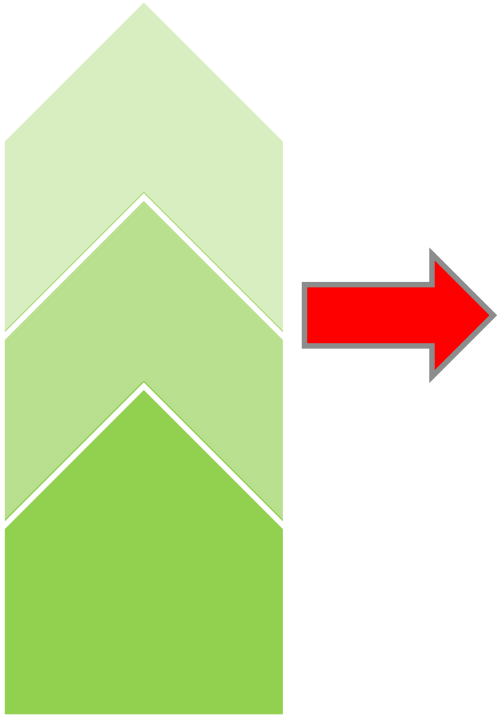
Trend Determining Influences
- Consequences



- Upgrading separate collecton
- Establishing assorting facilities
- RDF (and biogas???) production for energy recovery

Trend setting influences

- **Waste composition**

Waste Compositions

%	Germany Avarage (1989)	China	Brazil	Thailand	Mexico[1]
Paper / Cardboard	20	15,0	10.2	7.7	14
Glass	8	2.0	2.0	2.0	6
Organic	42	63,9	67.1	62.0	52
Plastic	9	16,9	8.7	12.0	12
Textiles	4.0	1,4			1
Metal	4	0,7	3.2	0.5	2
Rest	17	2,1	8.8	16	13
Water content					
Calorific V kJ/ kg					

Source: Semarnat, 2009

Waste Compositions

%	Germany Avarage (1989)	China	Brazil	Thailand	Mexico
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Textiles	4.0	1,4			1
Metal	4	0,7	3.2	0.5	2
Rest	17	2,1	8.8	16	13
Water content	35 - 45	42 - 60	46- 58	41 - 53	47 - 54
Calorific V kJ/ kg	8.500*	4 - 7.300	3 - 6.900	4 - 7.500	6. – 6.700

*today around 8.000

efficiently burning >> 6.000 kJ/kg

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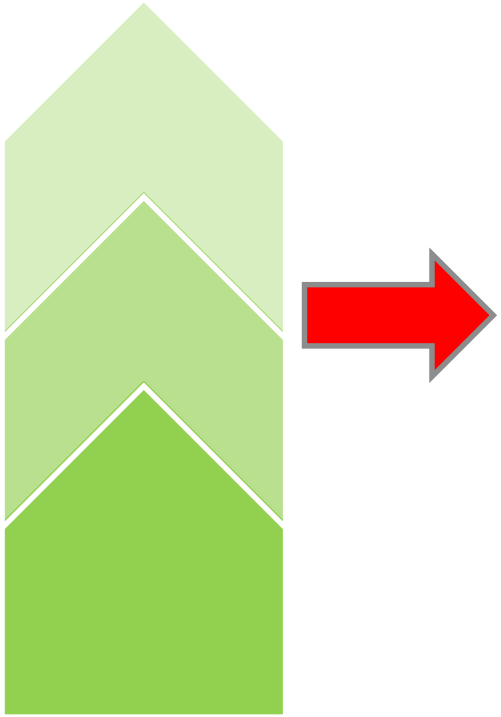
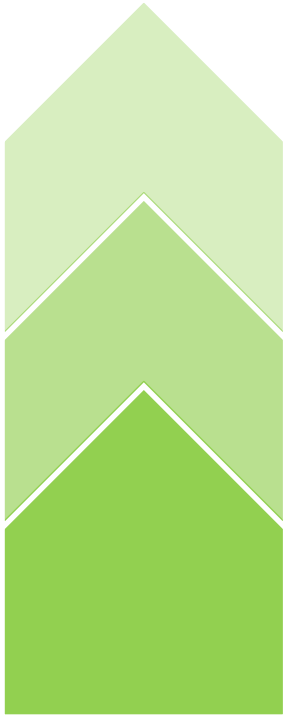
Tendencies Treatment Technologies
- Consequences



- **Increase**
  - **of separate collection and assorting facilities**
- **Decrease**
  - **of composting in favour of anaerobic digestion**
  - **of MBT bevor landfill in favour to produce RDF in MBT with drying process**
  - **Of conventional incineration in favour of RDF-use – e.g. cement?**

Waste Compositions
- Developments

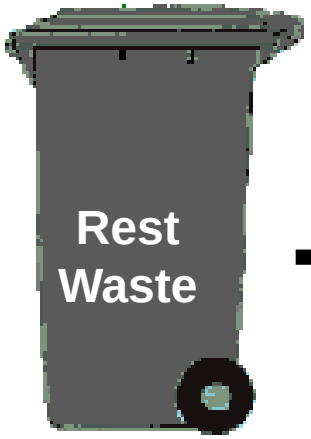


- **Reduction** of packagages production glas 3 - 4%/y, Fe-metals 1 - 3%/y

  Reduction of print media bei 5-7%/y in favor of cardboard in the same number
- **Increasing** of PET by >>8%/y
- **Reduction** of calorific value due to increasing material recycling of paper/cardboard and plastic
- and
- **Increasing** of calorific value due to increasing material recycling of biowaste

Separate Collection and Sorting and Recycling

Separate Collection Systems - (GER)



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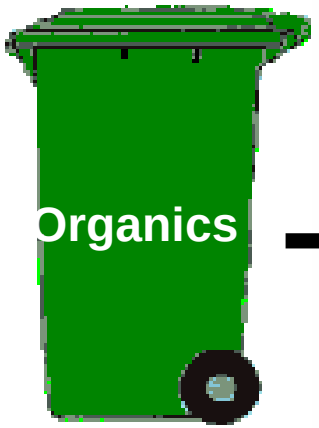

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MBT/RDF or Incineration

Anaerobic digestion / Composting Facility

Papermill

Sorting Facility

Glass Manufacturing

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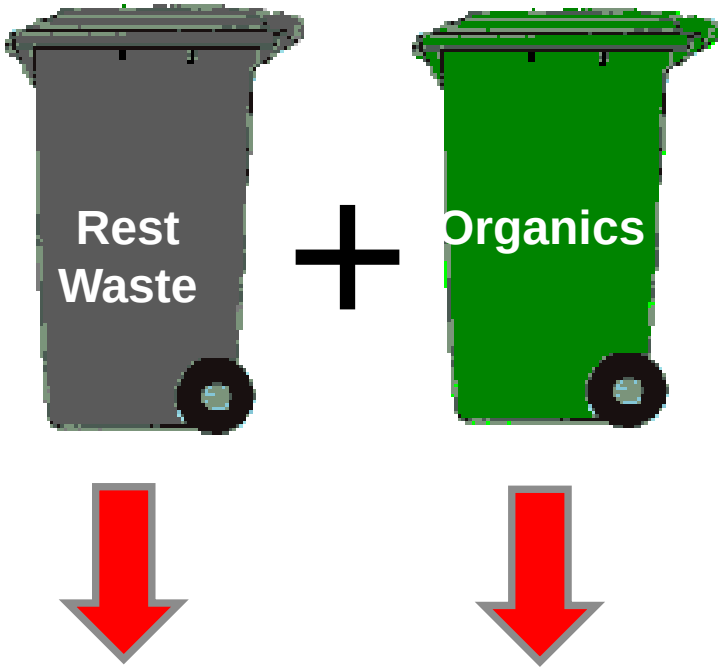
Separate Collection
- Biowaste and Rest Waste



MBT/RDF or Incineration Facilities

Fermentation, Composting Facility

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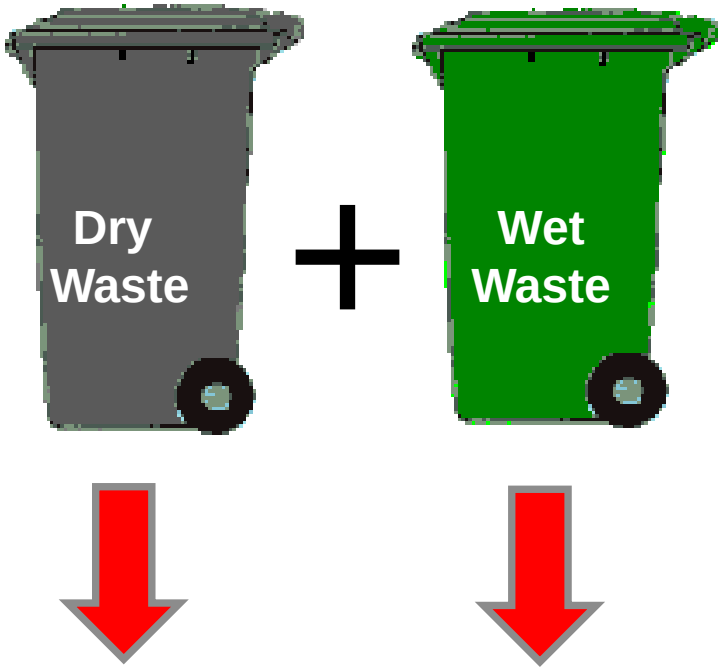
Separate Collection
- Biowaste and Rest Waste



Sorting, MBT/RDF Incineration Facilities

Fermentation, Composting Facilities

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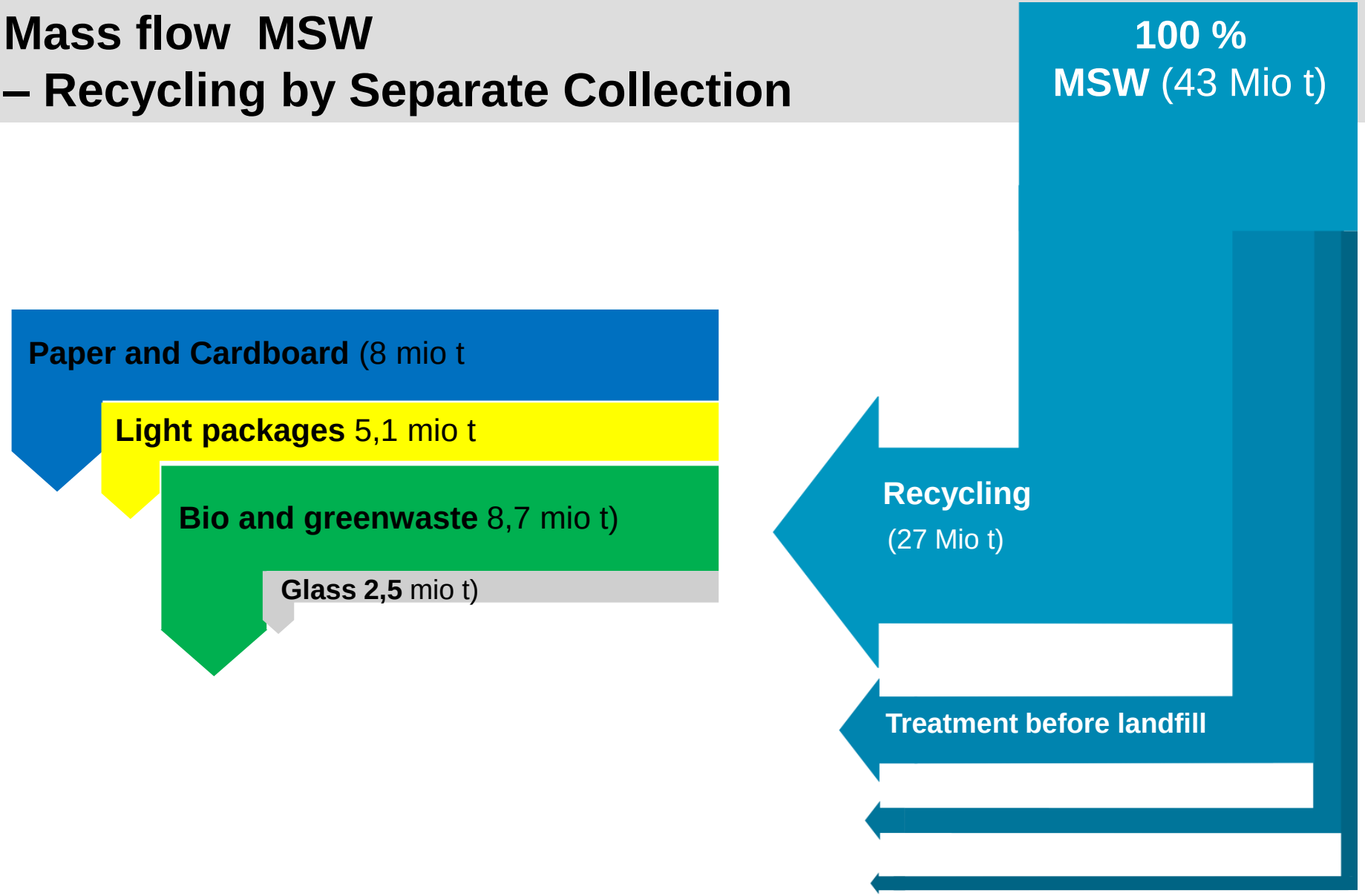
Mass flow MSW – Recycling by Separate Collection



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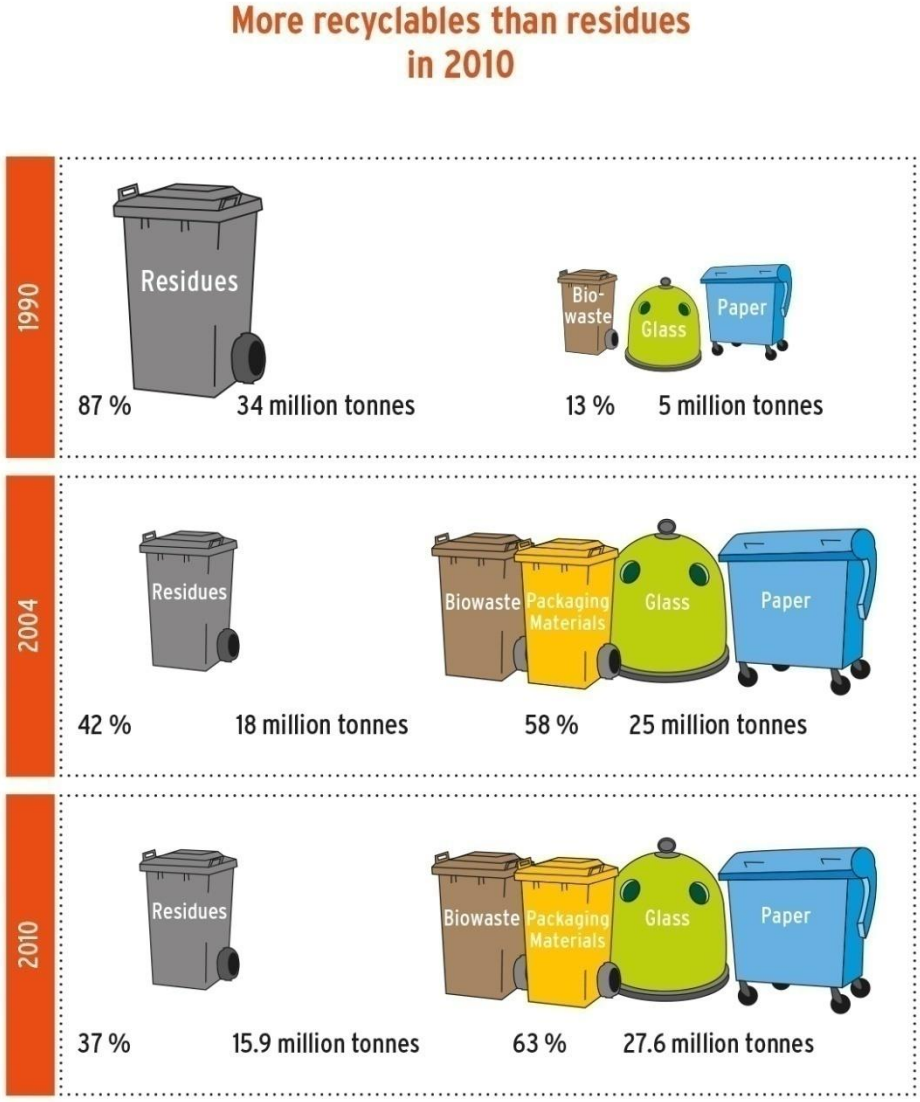
Material Recycling in Germany
- Development of Recycling Intensity



Source: Federal Statistical Office (Statistisches Bundesamt) 2012, own calculations

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But!!!!!

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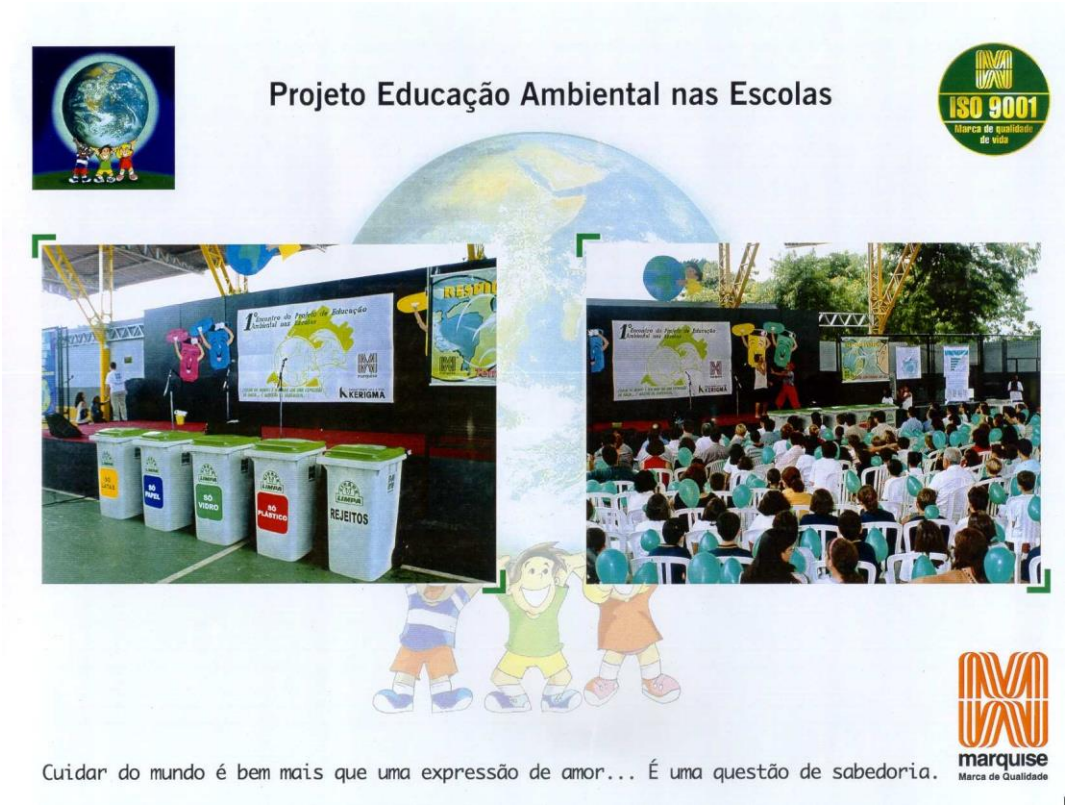
Education and PR-Work

Separate collection needs properly informed and prepared citizens!!!!



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Without well informed and motivated citizens, separate collection wouldn't work

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Informal Sector: waste picker / scavanger

- **e.g. India, Pune**

  10.000 adults and 2000 children-waste pickers collect
  15 kg/day and adult
  6 kg/day and child
  = 30 US$/month and person (Hüttner, GTZ)

- **e.g. Brasil**

  200.000 waste pickers on street earn up to
  400 US$/month (Source: Florisbela dos Santos, GTZ/CEMPRE)

Sorting Technologies – Low Tech

…with a high number of staff

working places!!!!

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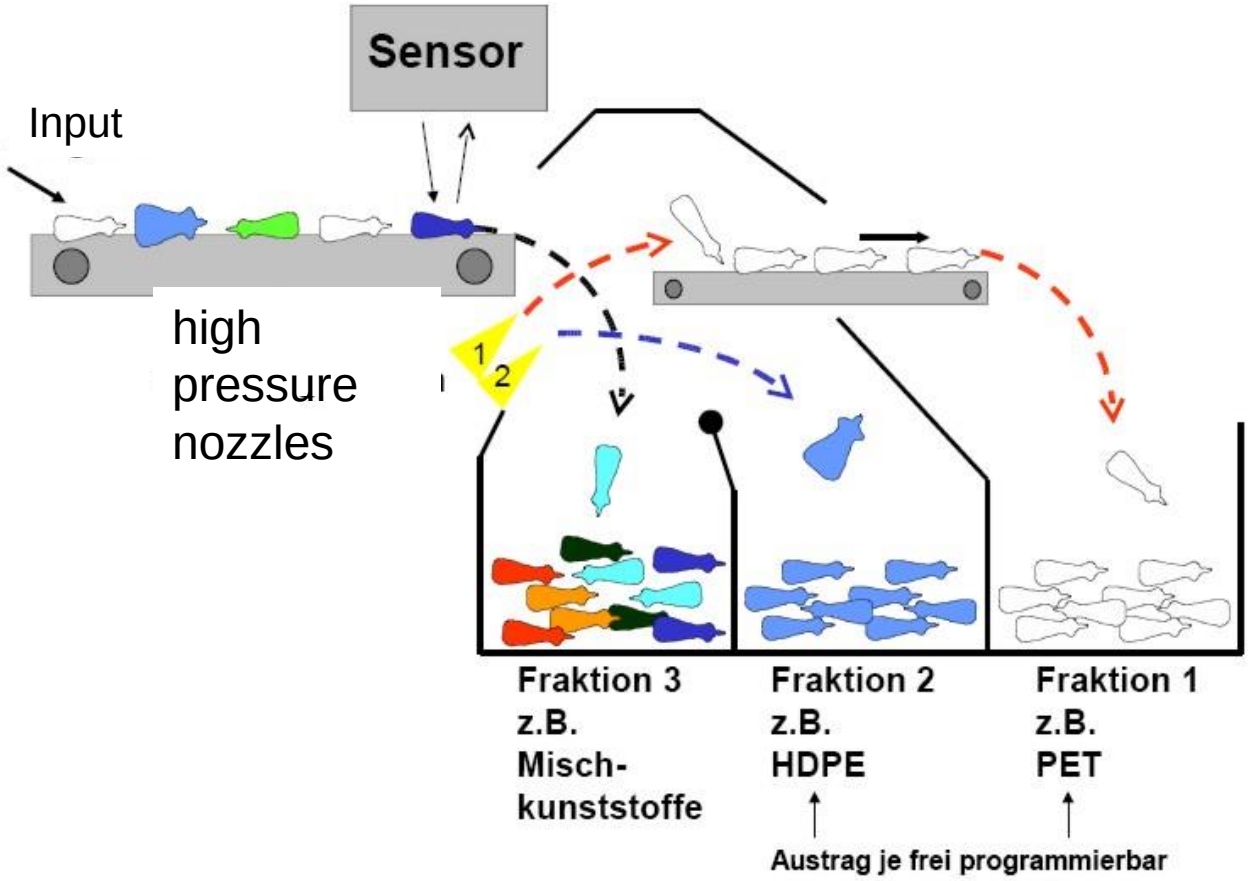
NIR Technology
- Basic Technology



Emission NIR-light

- IR-light activates molecules
- Reflected IR-light has lost a part of its energy (absorption)
- Analytic of reflected NIR-sectrum
- Reflected spectrum is characteristic for molecular structure

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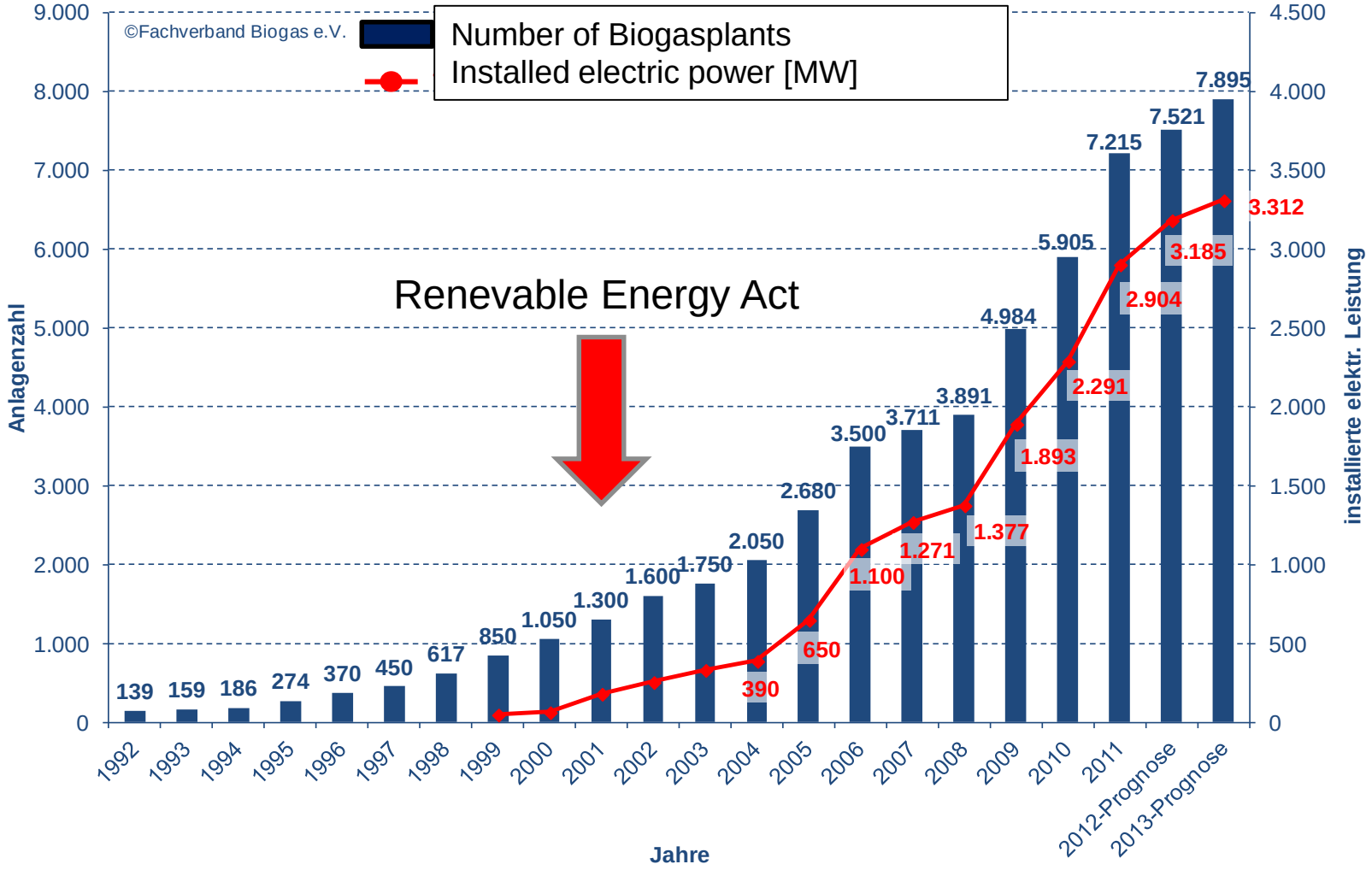
Fermentation and Composting

Development of Numbers and Installed Electric Power [MW]



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- 73 Bio waste — 1.400.000 t/y
- 170 Industrial waste — 750.000 t/y
- 12 MSW — 680.000 t/y

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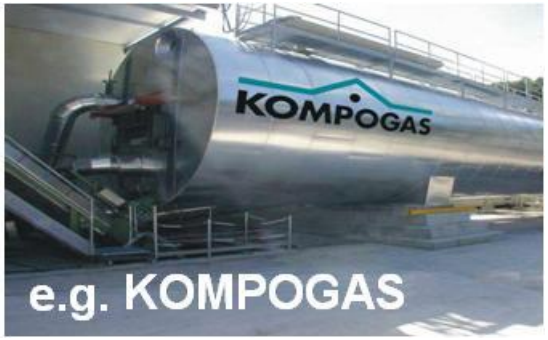
Technological Aspects
- Fermentation

Appropriate technologies are available

- **low and high tech**
- **low and high cost**

$C_6H_{12}O_6 \rightarrow 3CO_2 + 3CH$



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Biogas Production

Raw Material	Quantity [m^3 / t fermenter input]	CH_4 [vol.-%]
bio waste (mixture of kitchen and garden waste)	75 - 156	53 - 65
bio waste (kitchen waste)	123 - 178	53 - 68
org. MSW	100 - 178	n/a

Reactor-Input

- **100 Nm^3/t FM** reactor input FM.
- **CH_4-content in biogas app. 58%**
- Energy content **9,94 kWh / Nm^3 CH_4 = 576,5 kWh**
- **CHP degree of efficiency 40%** electr. and **55%** therm.
  - **231 $kWh_{electr.}$** and
  - **317 $kWh_{therm.}$** / t FM reactor input

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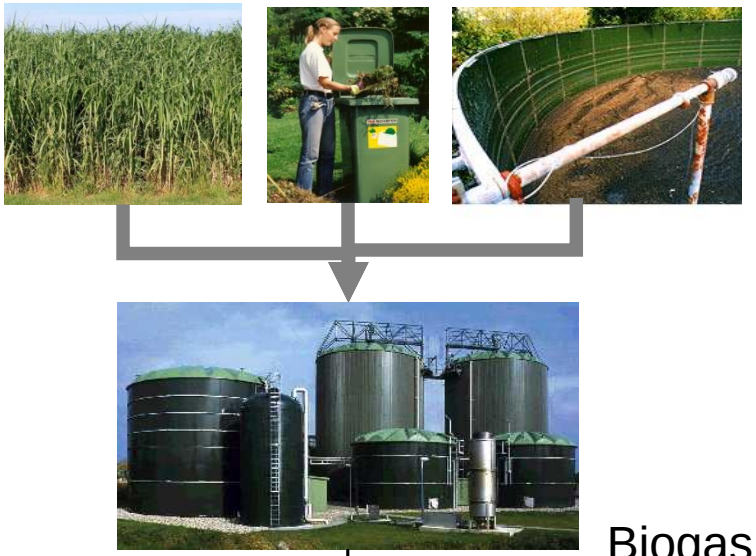
Anaerobic Digestion
- Gas Utilisation

Suitable organic substrates



Biogas

Desulfurization

Conditioning

Refining

Compression

Pressurized storage

Gas heating boiler

CHP

Fuel cell

Heat

Electricity

Motor fuel

Technological Aspects
- Composting

Appropriate technologies are available
- low and high tech
- low and high cost

Need for Compost

e.g.: Water saving due to Increase of waterholding capacity in arid zones by using compost

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Heavy metal concentration in compost from separated organic waste and from mixed waste - mg/kg d.m.

	SPAIN MIXED WASTE / MBT (DATA: SCT 2013)	FRANCE MIXED WASTE / MBT (DATA2007)		FRANCE BIOWASTE COMPOST (DATA 2009)	AUSTRIA BIOWASTE COMPOST (DATA 2010)	GERMANY BIOWASTE COMPOST (DATA 2013)
	Avarage	75%ile N=97	95%ile N=97	Range of mean value	Avarage	Avarage
Cd	1,4	1.4	1.7	0.3 - 0.4	0.6	0.4
Cr	111	54	70	17 - 28	32	41
Cu	158	152	179	58 - 65	62	39
Hg	0,3	0.6	0.9	0.1 - 0.3	0,2	0.2
Ni	29	31	41	9 - 18	23	13
Pb	97	138	162	32 - 32	31	31
Zn	351	476	566	128 -192	204	165

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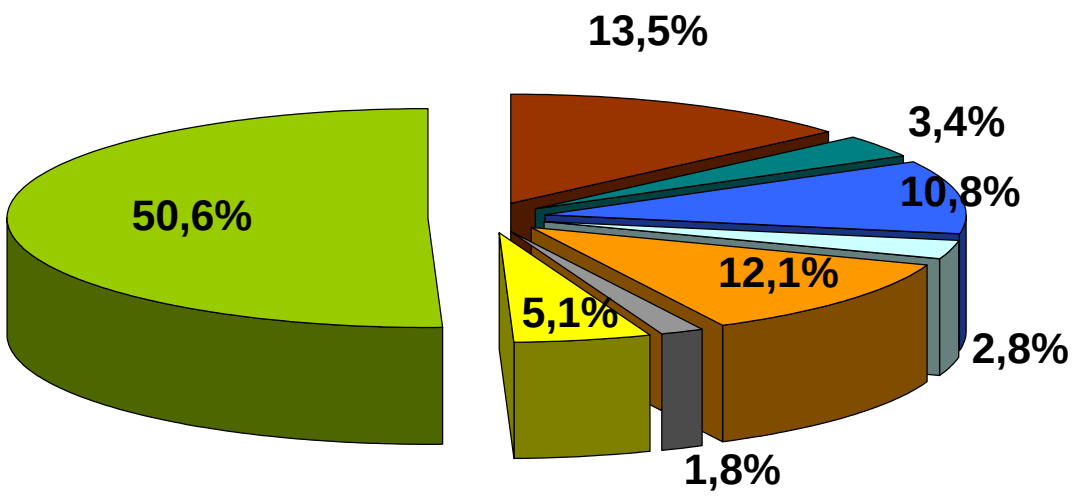
Compost Application (e.g.GER)



- Substrate industry
- Market gardening
- Hobby gardening
- Municipalities
- Landscaping
- Divers
- Special cropping systems
- Agriculture

Source: BGK 2010

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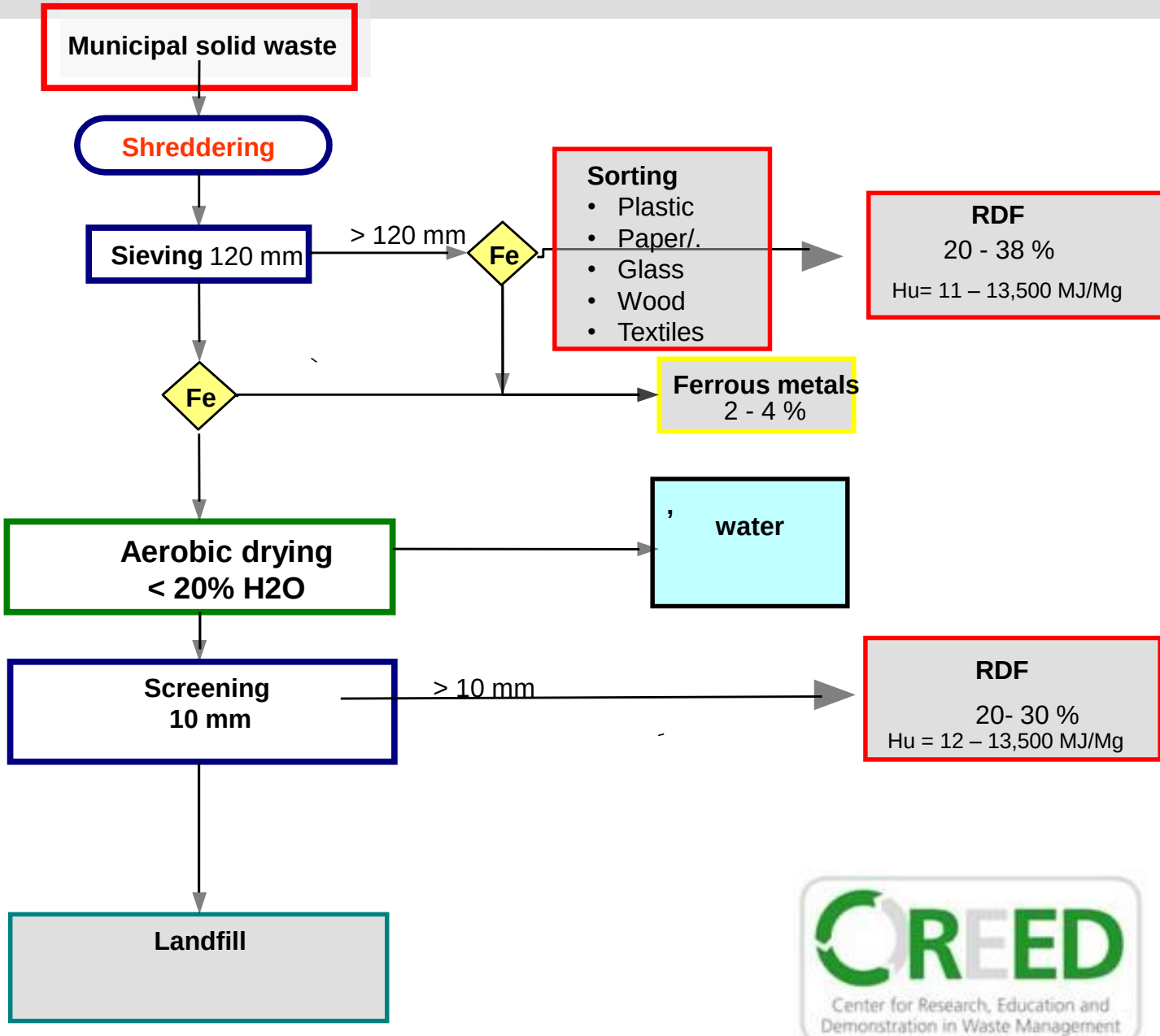
Energy Recovery

MBT Mass Flow (GER)



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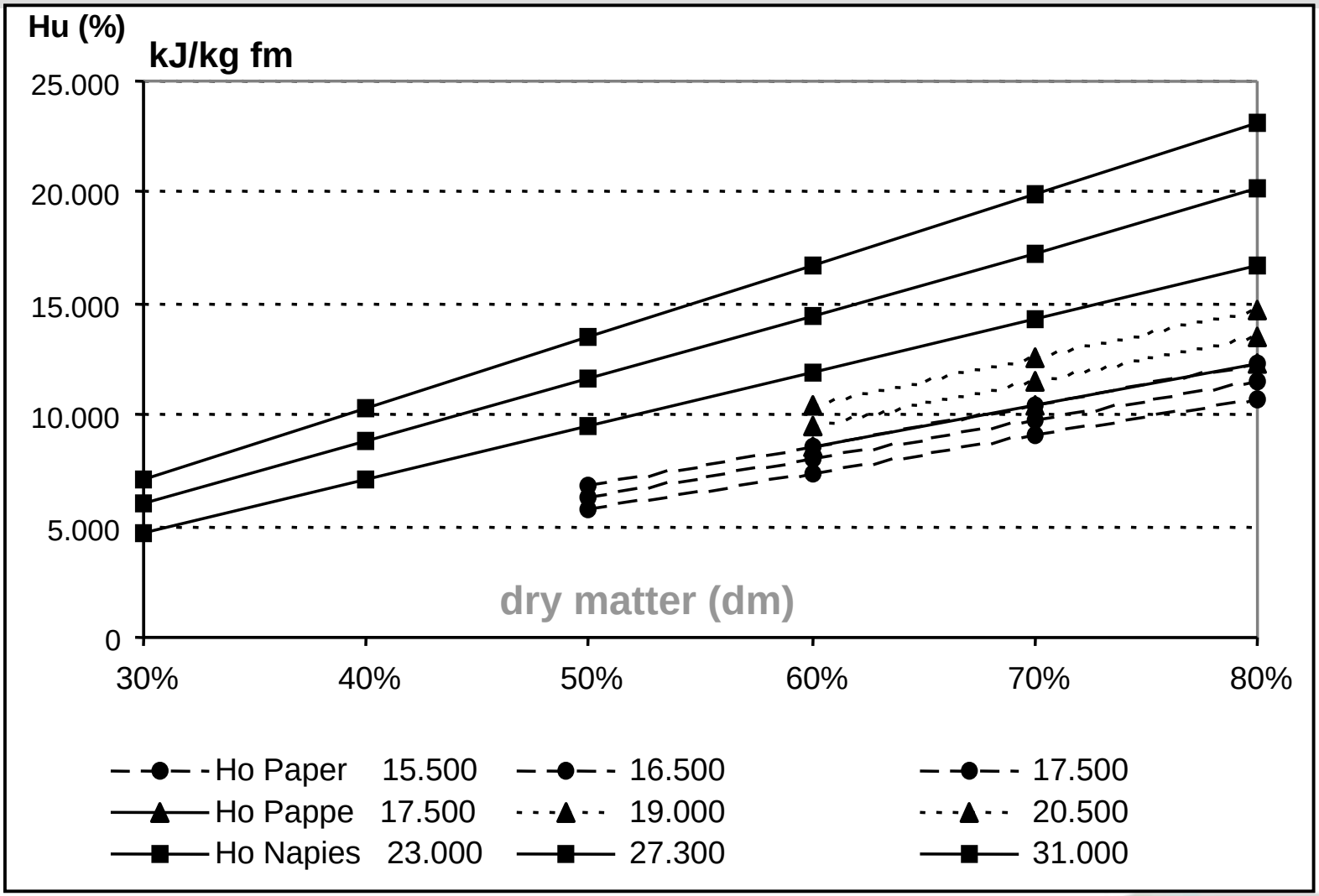
Drying of Waste



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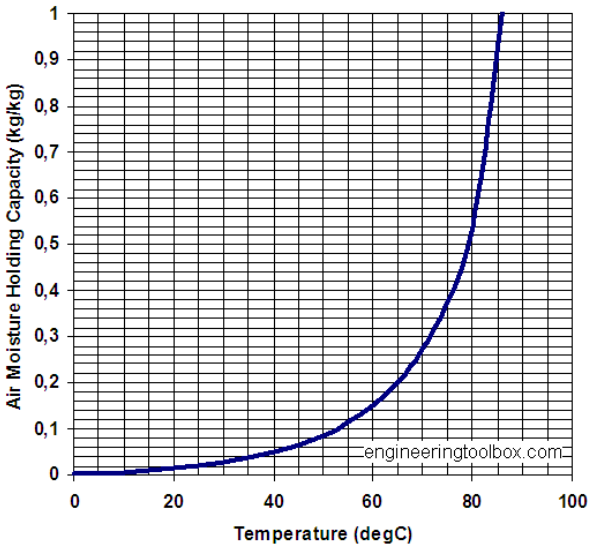
Green Waste or MSW
- Aerobic Drying

Air temperature 50°C
82,3 g H_2O/m^3 air



Air temperature 30°C
30,4 g H_2O/m^3 air

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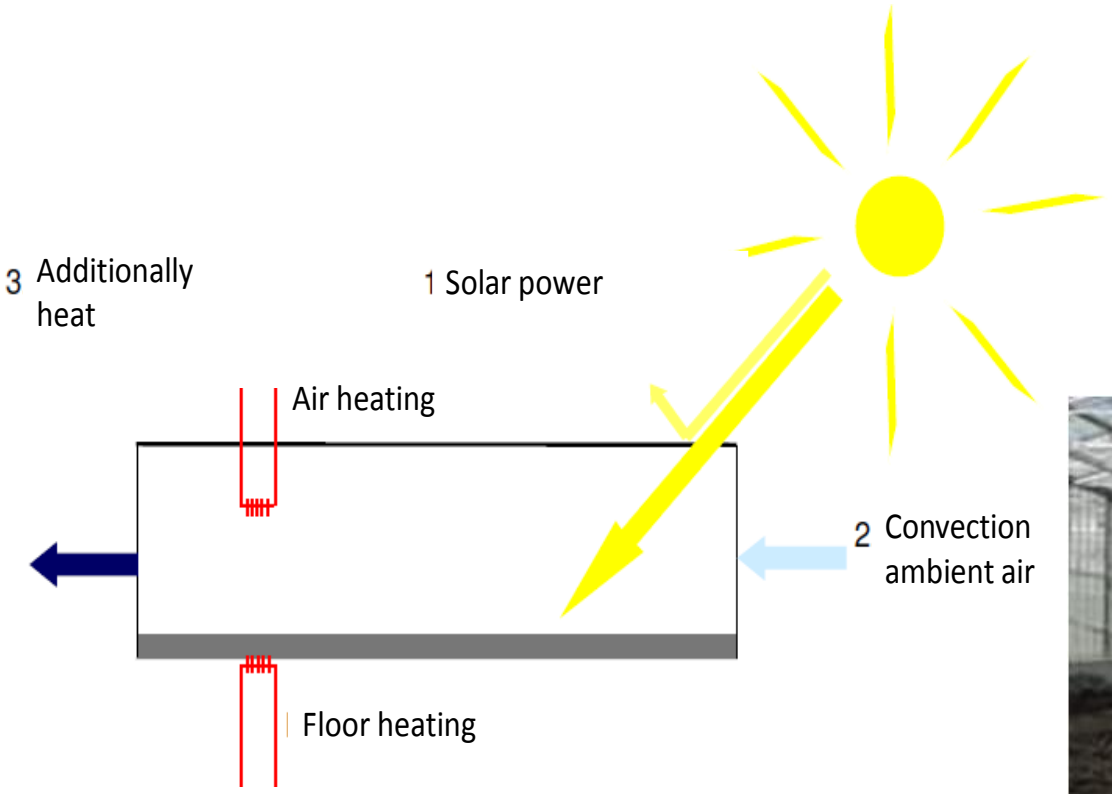
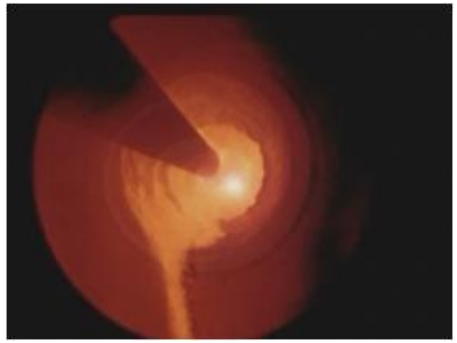
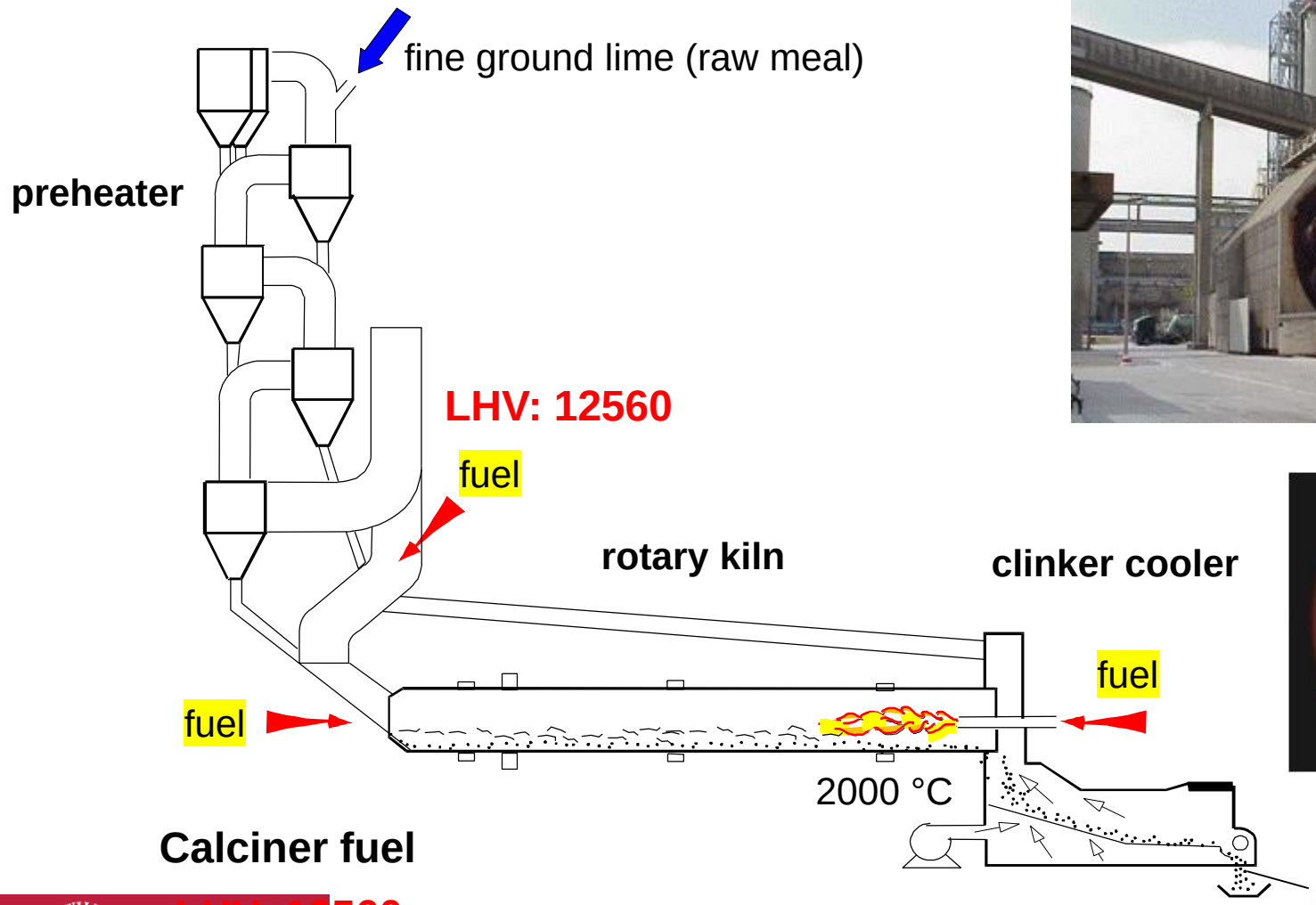
Energy Recovering
- Solar Drying for Digestates and Sludges



Source: Thermo Systems GmbH

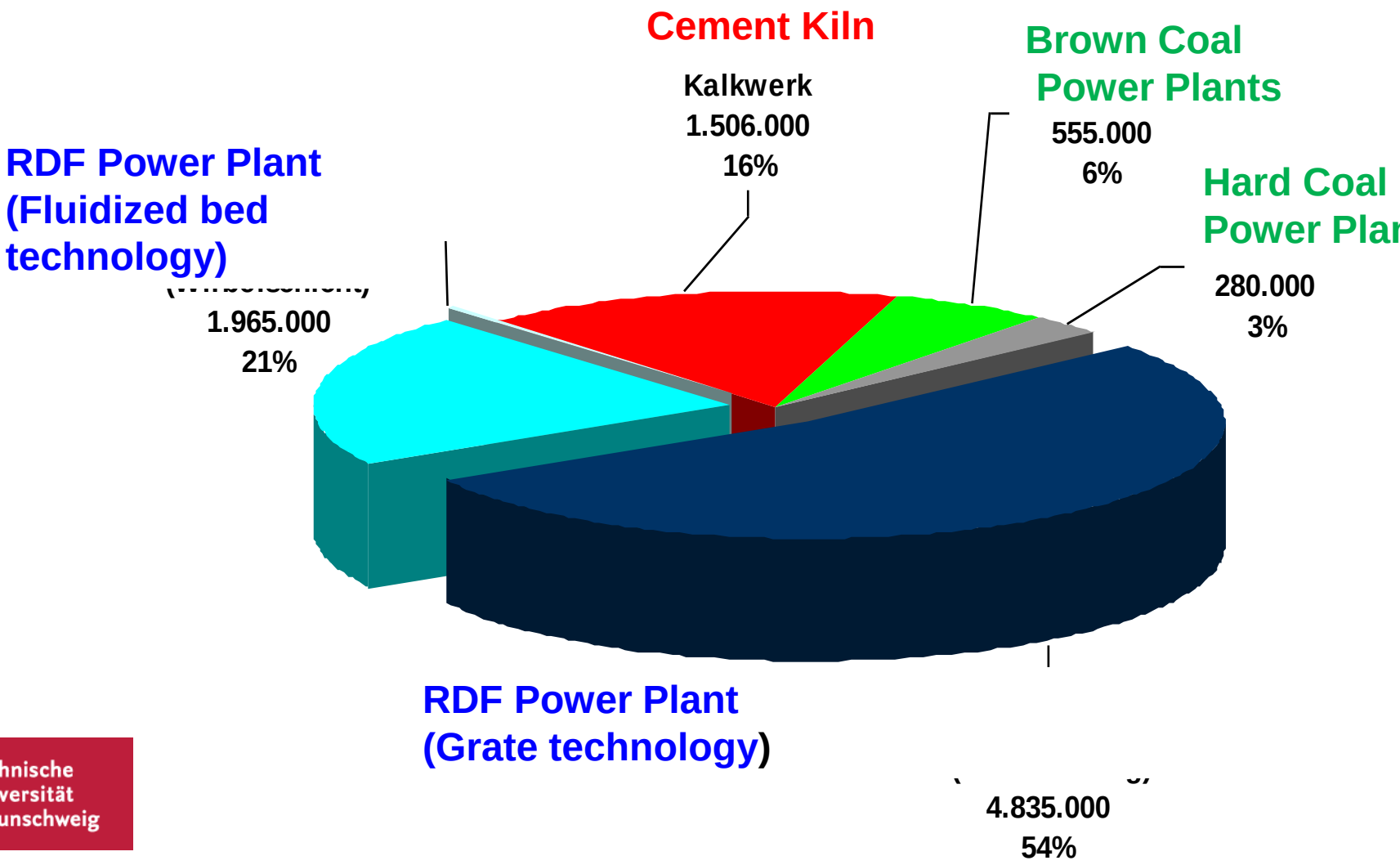
Energy Recovery
RDF-Production e.g. for Cement Plants





Source: Mod. Bayer, 2013

Alternatives RDF Use
RDF- Application in GER - 2012



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Treatment Before Landfill

Treatment Technologies

Waste incineration

GER 75%

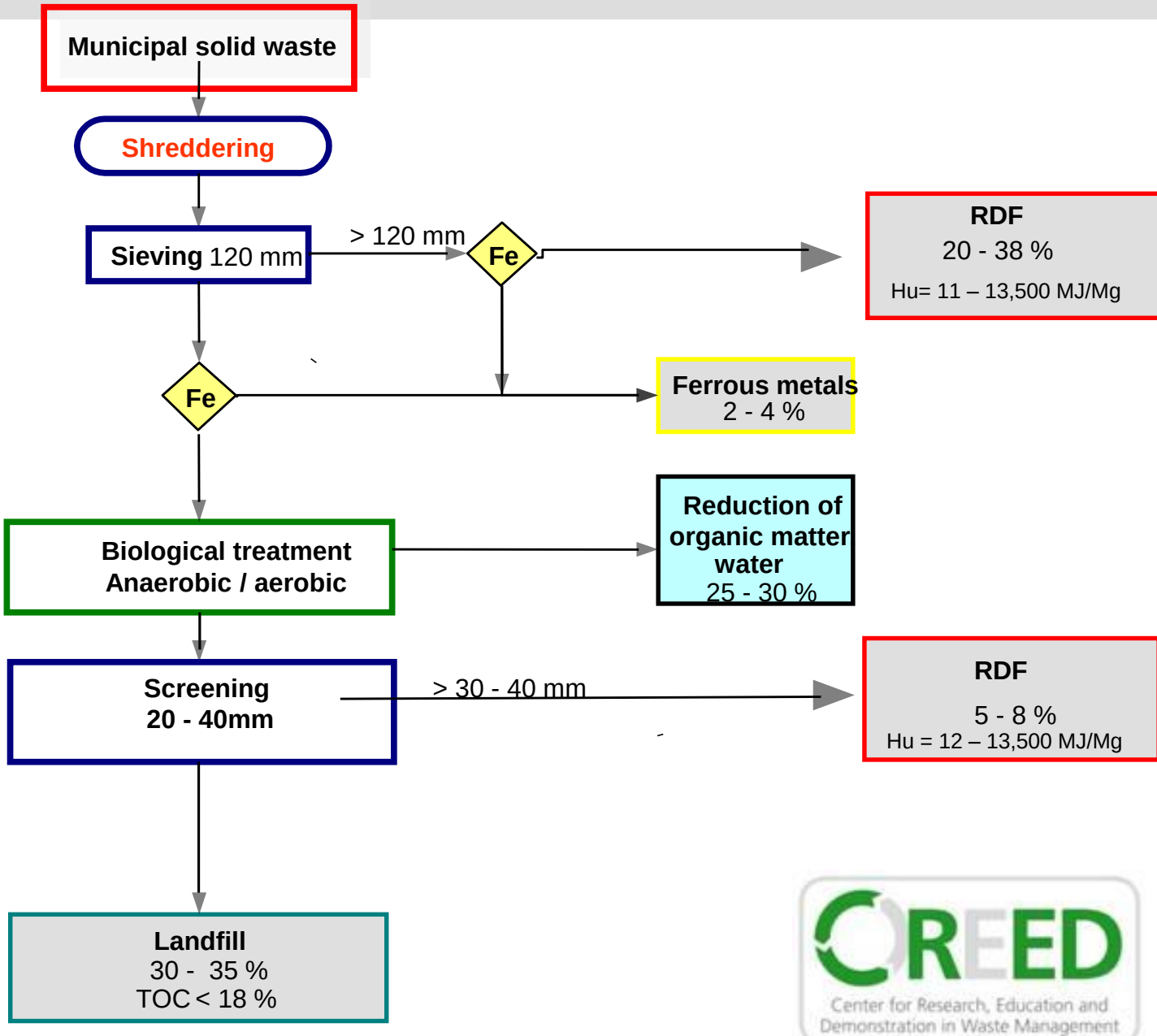
100% Grate technology

MBT plants

GER 25%

- 2013 in EU 369 MBTs in operation
- since 2009 every year 25 new MBT took into operation

MBT Mass Flow (GER)



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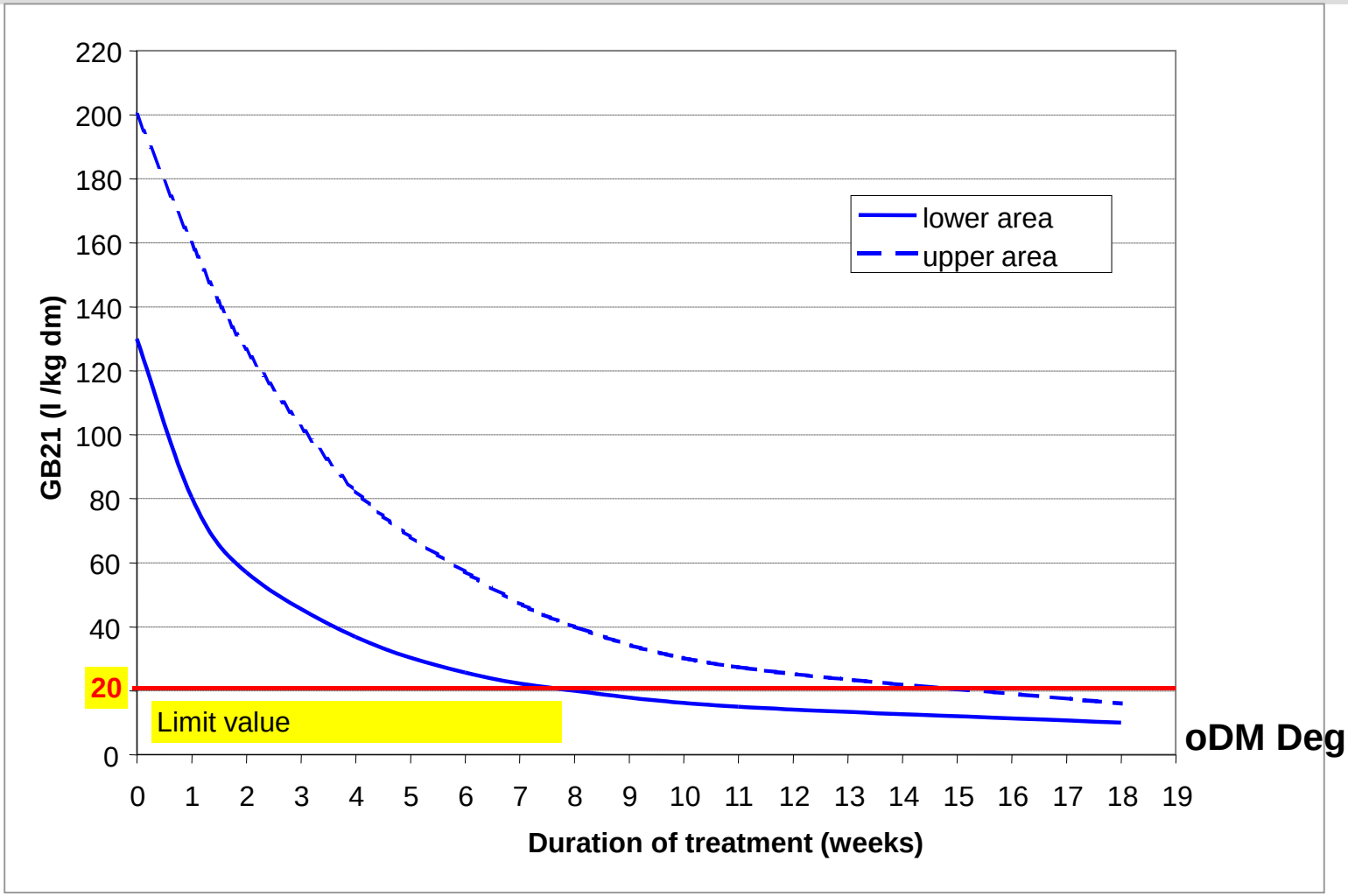
Reduction of Gas Potential During Aerobic Treatment



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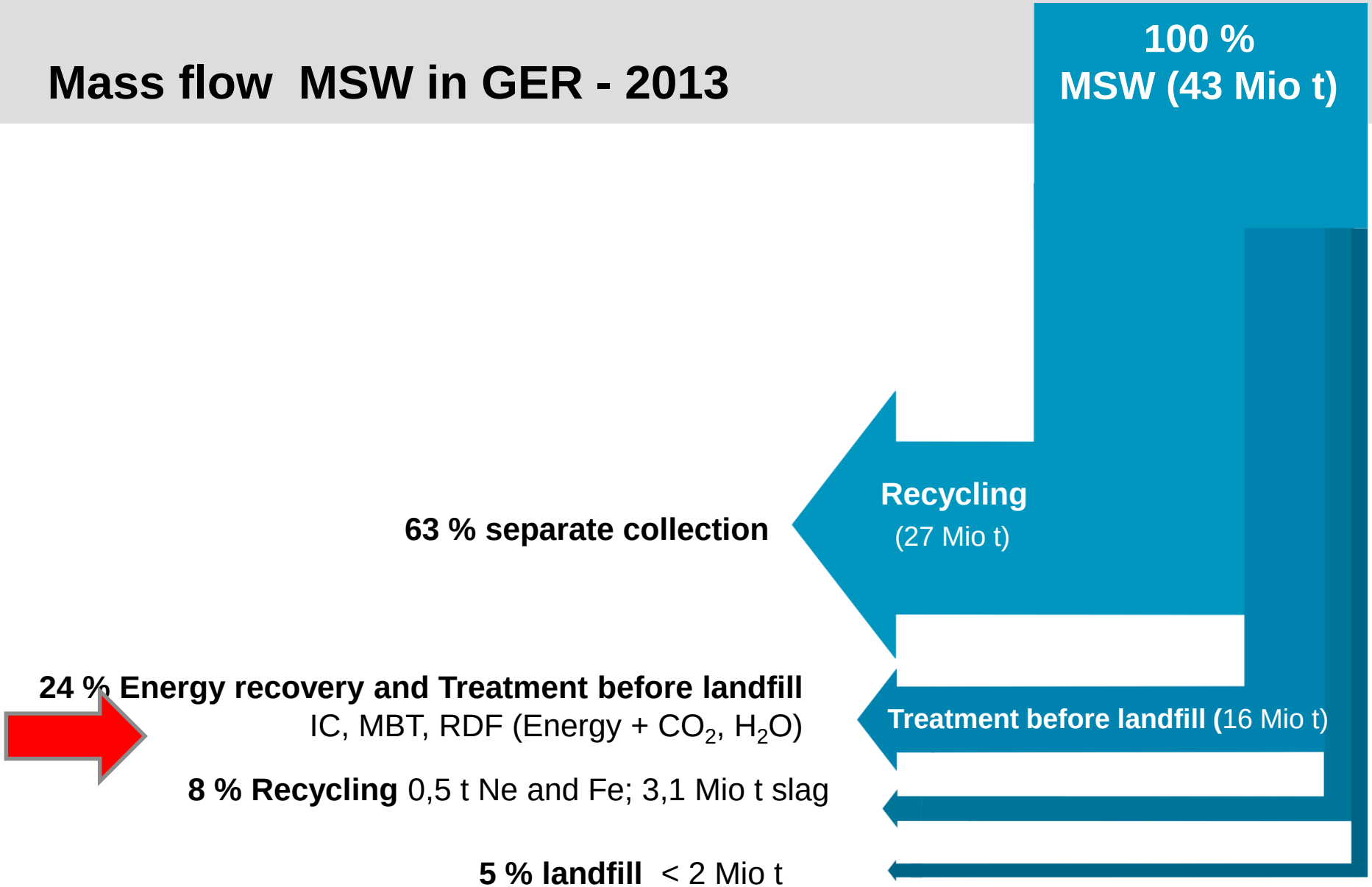
Mass flow MSW in GER - 2013



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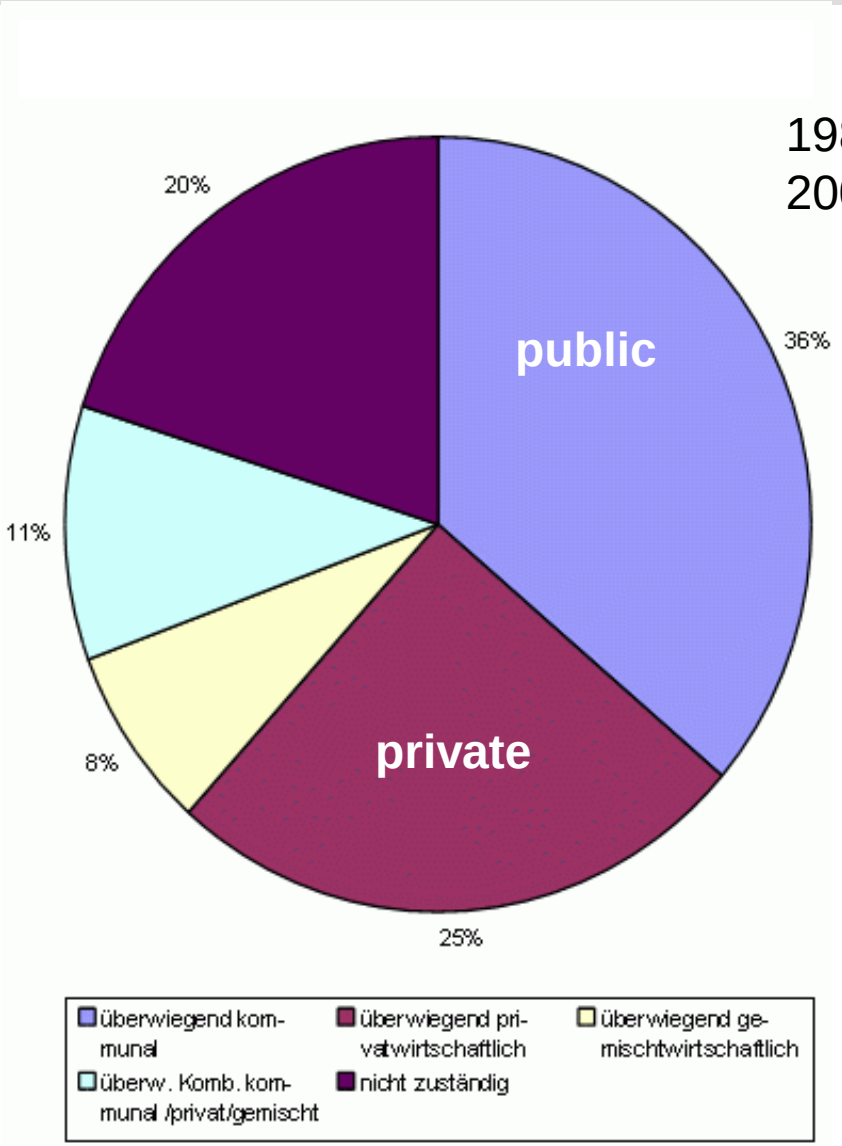
Private vs. Public



1980 - 2000t privatisation
2000 2015 th remunicipalisation)

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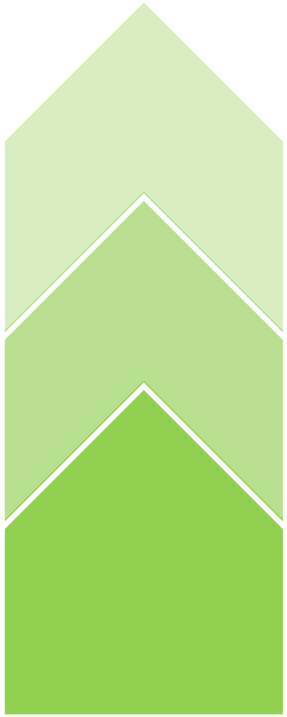
Summary Tendencies



- Reduction of glass and metal packages
- Shortage of resources - increasing revenues for secondary resources
- Increasing material recycling
- Decline of conventional incineration in favour of RDF-use
- Decline of composting in favour of anaerobic digestion
- Landfill ban for untreated waste
- Plasma technology????
- Porolysis e.g. Catalytic Pressureless Depolymerisation???
- Landfill bioreactor???
- Private versus public (privatisation and remunicipalisation)

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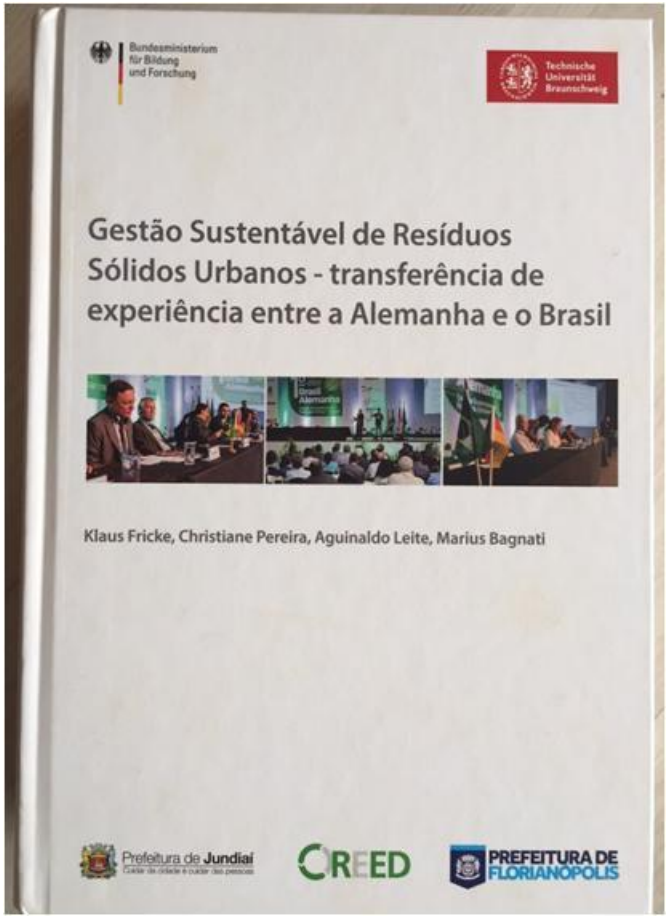
Thank you for your attention !

waste-bin race in Germany

Information



EPUB - https://drive.google.com/file/d/0B5vLOUqm4lTFZFVHV0RLVExWbFk/view?usp=sharing

MOBI - https://drive.google.com/file/d/0B5vLOUqm4lTFR2ZuUGxuTFR6dDQ/view?usp=sharing

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