

**6th Beacon Conference 2009
Malmö, November 24th, 2009**

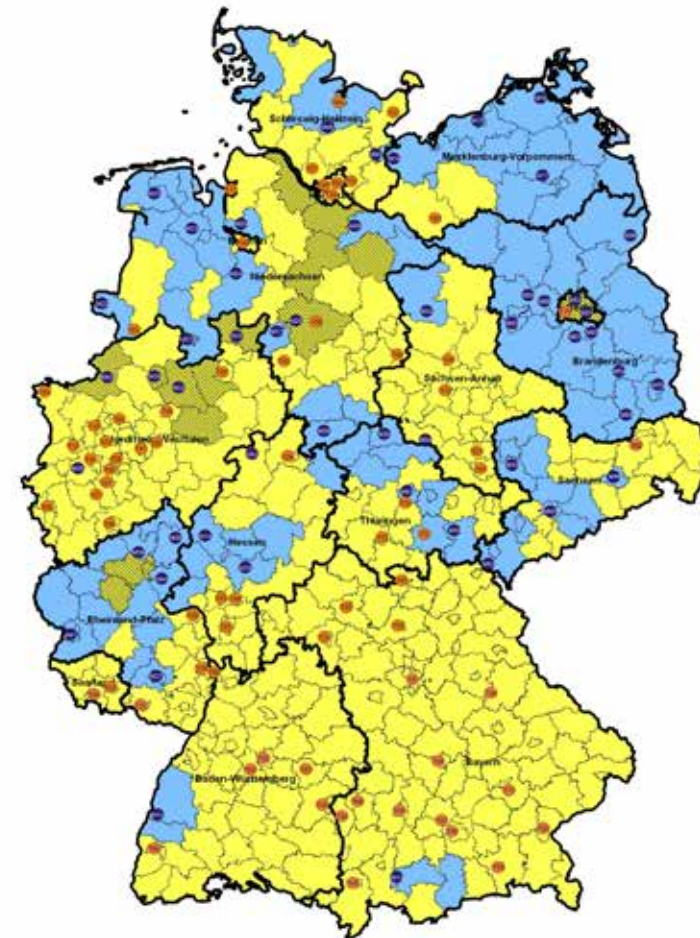
**A comparison between waste-to-energy and
mechanical biological treatment (MBT)**

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Structure:

- ★ Background
- ★ Studies comparing ecological effects
 - ◆ Climate effects
 - ◆ Further effect categories
- ★ Summary
- ★ Conclusions

Restabfallbehandlung in Deutschland



Legende:

- | | |
|--|---|
|  Mechanisch-Biologische / Physikalische Anlagen (MBA/MPA) |  MBA/MPA-Entsorgungsgebiet |
|  Hausmüllverbrennungsanlagen (HMV) |  HMV-Entsorgungsgebiet |
| |  Mischgebiet |

- ★ **TA Siedlungsabfall (TASI) 1993: Classification values for disposable fractions, but long transition period until 31.5.2005**
- ★ **MBT as „alternative“ to thermal treatment (in many cases realized on open dumps to extent their operation time)**
- ★ **AbfAbIV (Waste disposal ordinance 2001): Disposal of untreated solid waste prohibited since 1.6.2005**



- ★ **AbfAbIV 2001: Disposal permitted if limit values for organic carbon and other parameters in disposable fraction or its leachate are kept**
- ★ **Limit values depending on the kind of pretreatment:**
 - ◆ **Thermal treatment residues (AbfAbIV Annex 1)**
 - **Solid: organic part of the dry residue, in mass-%: 5 % ignition loss or 3 % TOC, or HCV < 6.000 kJ/kg**
 - **Leachate: 80 mg TOC/l**
 - ◆ **Non-thermal treatment residues (organic part) (AbfAbIV Annex 2)**
 - **Solid: dry residue: 18 mass-% TOC or HCV < 6.000 MJ/kg**
 - **Solid: biological degradability: AT₄ (respiratory activity within 4 days) < 5 mg/g or GB₂₁ (rate of gas formation within 21 days) < 20 l/kg**
 - **Leachate: 300 mg TOC/l**

Since end of 1990s: Development of modern (technical)
MBT plants in Germany
2008: 61 M(B)T plants

★ Material flow separation

- ◆ 18 rotting plants
- ◆ 10 digestion plants
- ◆ 10 others (u. o. mechanical)

★ Stabilization

- ◆ 10 biological drying
- ◆ 3 thermal drying

★ M(B)T for SRF production

- ◆ 10 plants



All: one or more output fraction(s)
with enriched calorific value (plastics etc.)

Thermal treatment plants (2008):

- ★ 68 MSWI plants (WtE)
- ★ 21 SRF fired power plants →
- ★ Co-incineration: 8 power plants

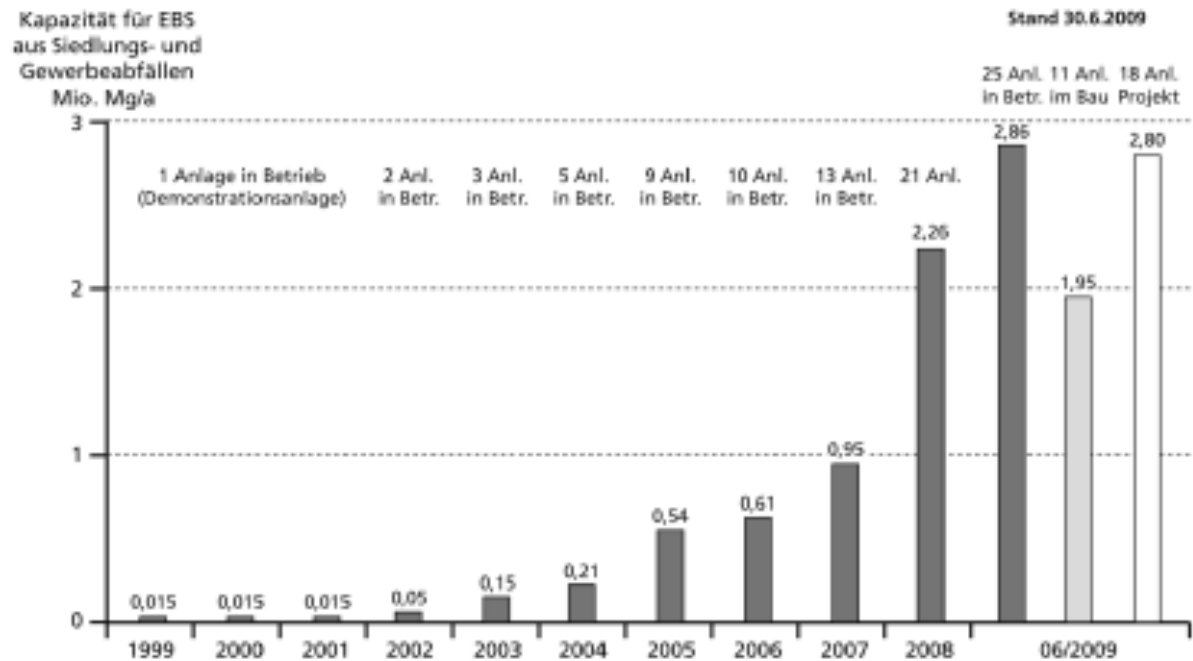


Bild 1: Ersatzbrennstoff-Kraftwerke in Deutschland – Entwicklung der Anlagenzahl und der Kapazität für Ersatzbrennstoffe aus Siedlungs- und Gewerbeabfällen von 1999 bis Juni 2009

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- ★ German cement kilns: 54 % of thermal energy input has been secondary materials like used tyres, plastic wastes and other fractions from industrial and commercial wastes (in sum about 2.9 Mio. Mg/a)

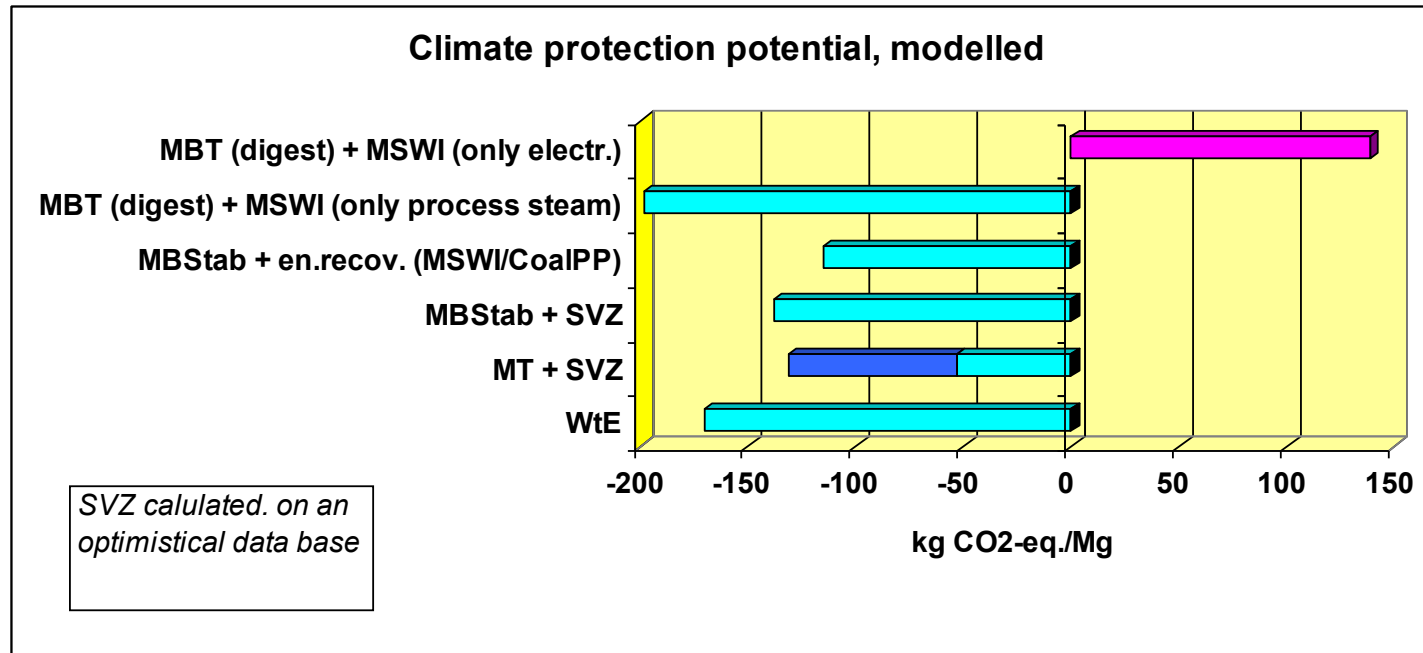
★ Studies regarding climate effects

- ◆ BIWA/BZL 2003 (Saxony)
- ◆ Öko-Institut 2005 (Germany)
- ◆ IKr - Institut für Kreislaufwirtschaft 2006 (Bremen)
- ◆ BIFA 2007 (Bavaria)
- ◆ BIWA/BZL/Prof. Born, 2009 (Saxony)

★ Studies regarding further ecological aspects

- ◆ bifa, 2004 (Bavaria, Germany, Switzerland)
- ◆ MUNLV/IFEU 2007 (North Rhine-Westphalia)

„Climate relevance of waste management in the Free State of Saxony“

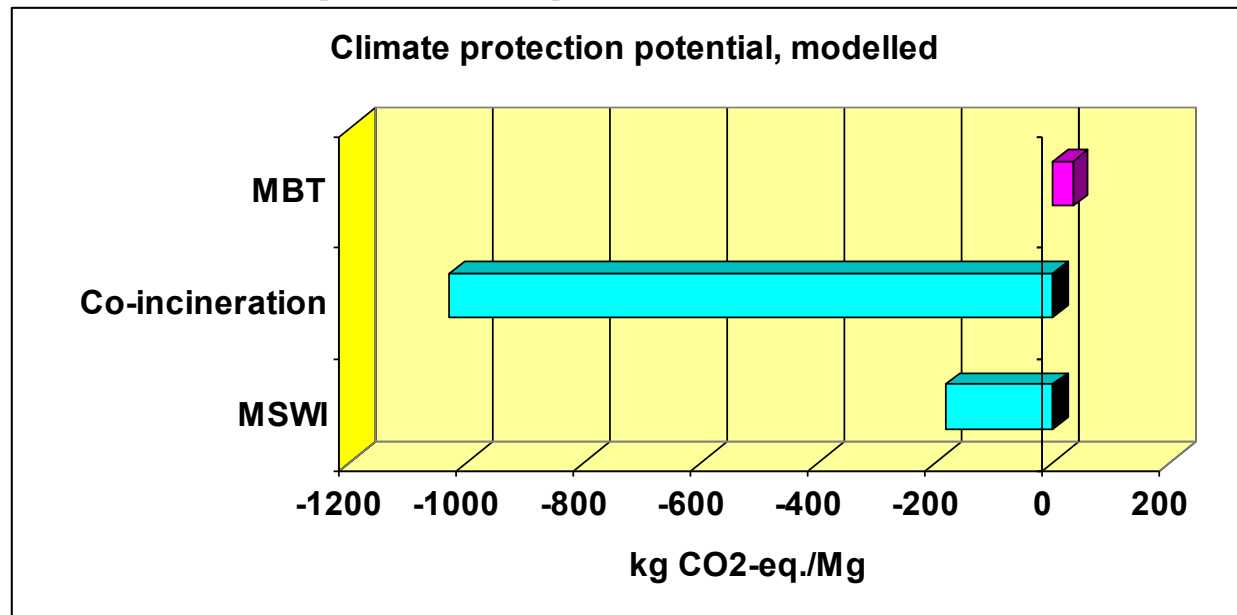


Negative values = environmental benefit

Positive values = environmental burden

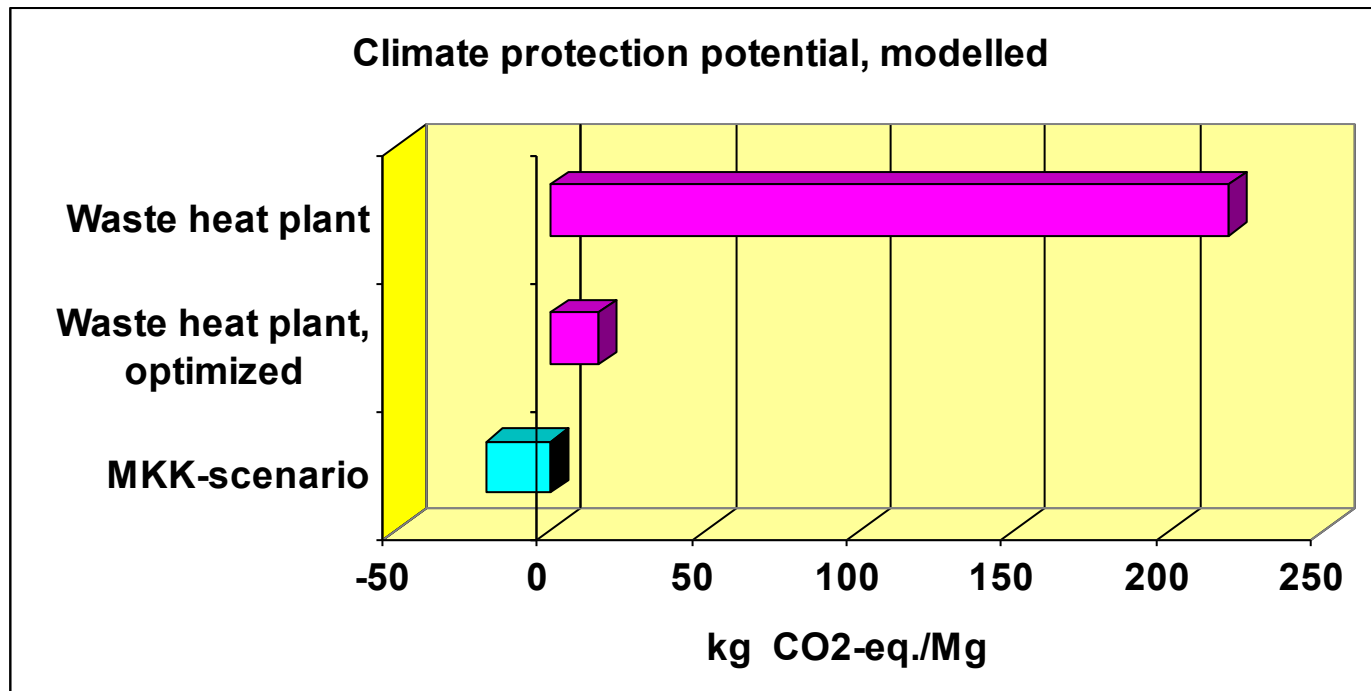
- ★ **Most important measure for climate protection: Ending disposal of untreated wastes (methane – GWP 25, nitrous oxide (N₂O; GWP 296)).**
- ★ **Contribution of equivalent processes of waste treatment (electricity, heat, metals) distinctly smaller.**
- ★ **Biggest optimization potential:**
 - ◆ Increase in energy efficiency of thermal plants
 - ◆ Reduction of energy demand of non-thermal plants

„Status report on the contribution of waste management to climate protection and possible potentials“

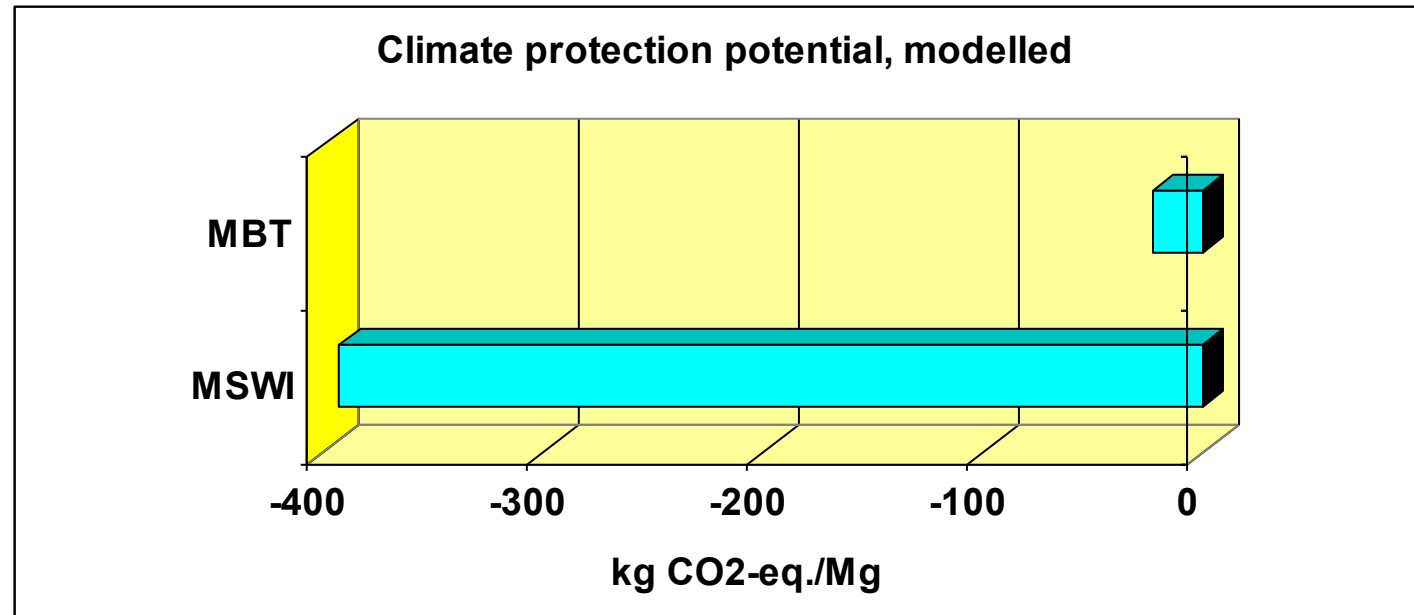


- ★ **Most important measure for climate protection: Ending disposal of untreated wastes.**
- ★ **Optimization potentials:**
 - ◆ Intensifying of combined heat and power (CHP) at MSWI and SRF fired power plants
 - ◆ Enhanced provision and use of process steam
 - ◆ Use of quality-assured fuels in co-incineration
 - ◆ Intensification of the electrical efficiency of MSWI, preferably in conjunction with the CHP.

**„Ecological and energetic balancing of the MKK-project“
(MKK = power plant using SRF with a medium calorific value)**



- ★ „The high credits from the substitution of the current mix of Bremen, which are essentially based on the Mittelkalorikkraftwerk (MKK), makes it possible to achieve a positive climate balance in this disposal option.”

„Waste management and climate protection “

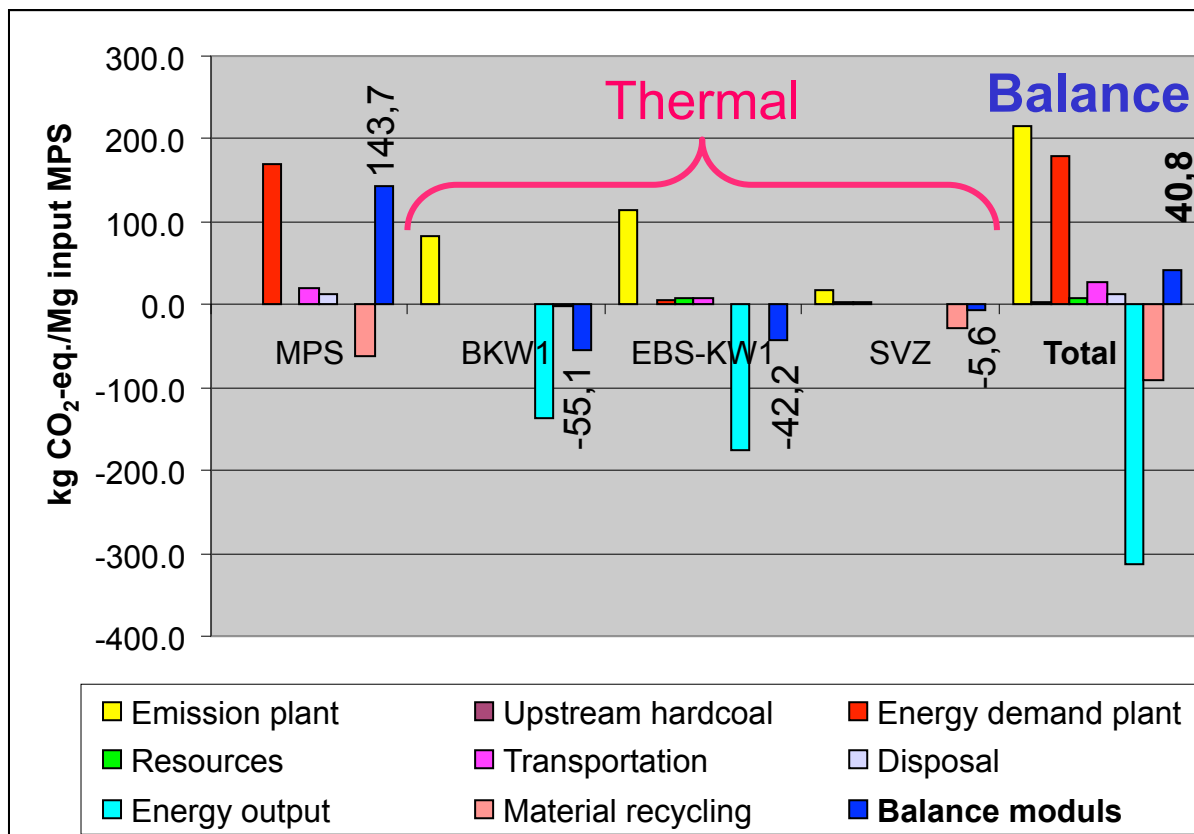
- ★ **Most important measure for climate protection: foregoing of disposal of untreated wastes**
- ★ **Particularity of Bavaria: a good 90 % of municipal solid wastes are treated in MSWI plants**
- ★ **MBT-credit for ferrous metals for the equivalent of crude steel is relevant for result; no details of modelling available**

Study on the climate impact of waste management in the waste associations of the Free State of Saxony



County	Waste Association or City/District	Thermal, in Mg/a	model	MT in Mg/a	model	MBT, in Mg/a	model
Chemnitz	ZAS	62.038	MVA3	0		0	
	AWVC	2.958	MVA1	0		70.281	MPS
	EVV	0		0		43.603	MBS1
	ZAZ	0		0		23.652	MPS
	Sum	64.996		0		137.536	
Dresden	Dresden, City	1.665	MVA1	0		79.138	MBS2
	ZAOE	76.804		9.852	MA	300	MBS1
	MVA1	29.908	MVA1				
	MVA2	46.896	MVA2				
	RAVON	84.776	MVA1	0		0	
	Hoyerswerda, City	172	MVA1	0		6.907	MBS2
Dresden	Sum	163.417		0		86.345	
	AVN	0		36.014	MA	2.342	MBA
	ZAW	0		0		135.907	MBA
	Delitzsch	0		0		24.001	MBA
Leipzig	Sum	0		36.014		162.250	
Saxony	Sum	228.413		36.014		386.131	

MPS MT plant with physical drying (fired with natural gas) (MPS) and energy recovery of its higher calorific fraction in different types of thermal plants (BKW = lignite fired power plant; EBS-KW = SRF fired power plant; SVZ = gasification/methanol production plant)



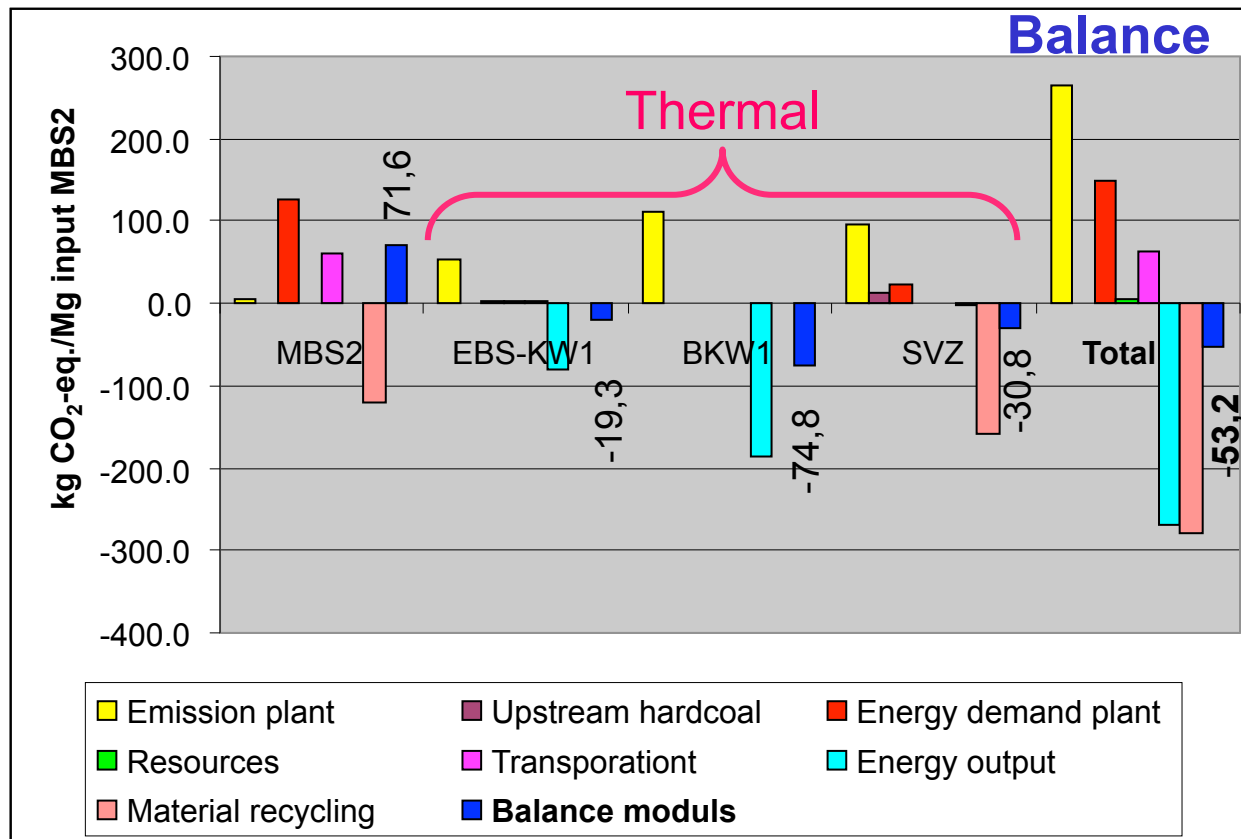
Note:

- ♦ High energy input in MPS – especially draying process with natural gas has strong effect on climate impact
- ♦ Decoupling of energy and materials (methanol) is not enough to compensate

Results deteriorate if

- ♦ EBS-KW1 and BKW1: electricity production only, no CHP
- ♦ SVZ: higher energy demand than modelled

MBS MBS (stabilization) plant with energy recovery of its higher calorific fraction in different types of thermal plants (BKW = lignite fired power plant; EBS-KW = SRF fired power plant; SVZ = gasification/methanol production plant)



Note:

Results deteriorate if

- ◆ MBS2: smaller separation efficiency for ferrous and even more for nonferrous metals
- ◆ EBS-KW1 and BKW1: electricity production only, no CHP
- ◆ SVZ: higher energy demand than modelled

Result of sensitivity analysis

- ★ Influence of energy efficiency of especially thermal plants > 20 % and more
- ★ Influence of kind of energy substituted:
 - ◆ Electricity mix Saxony: 915 g CO₂/kWh_{el}
 - ◆ German electricity mix: 604 g CO₂/kWh_{el}
 - ◆ Advantageous for scenarios with energy output within Saxony (MSWI/MVA1)
 - ◆ Disadvantageous for scenarios with energy demand in Saxony (MBT), but energy output outside Saxony, e.g. in MSWI or co-incineration plants in Brandenburg or Saxony-Anhalt, as the credits for energy output – and therefore climate thanks - are much smaller.

★ Studies regarding climate effects

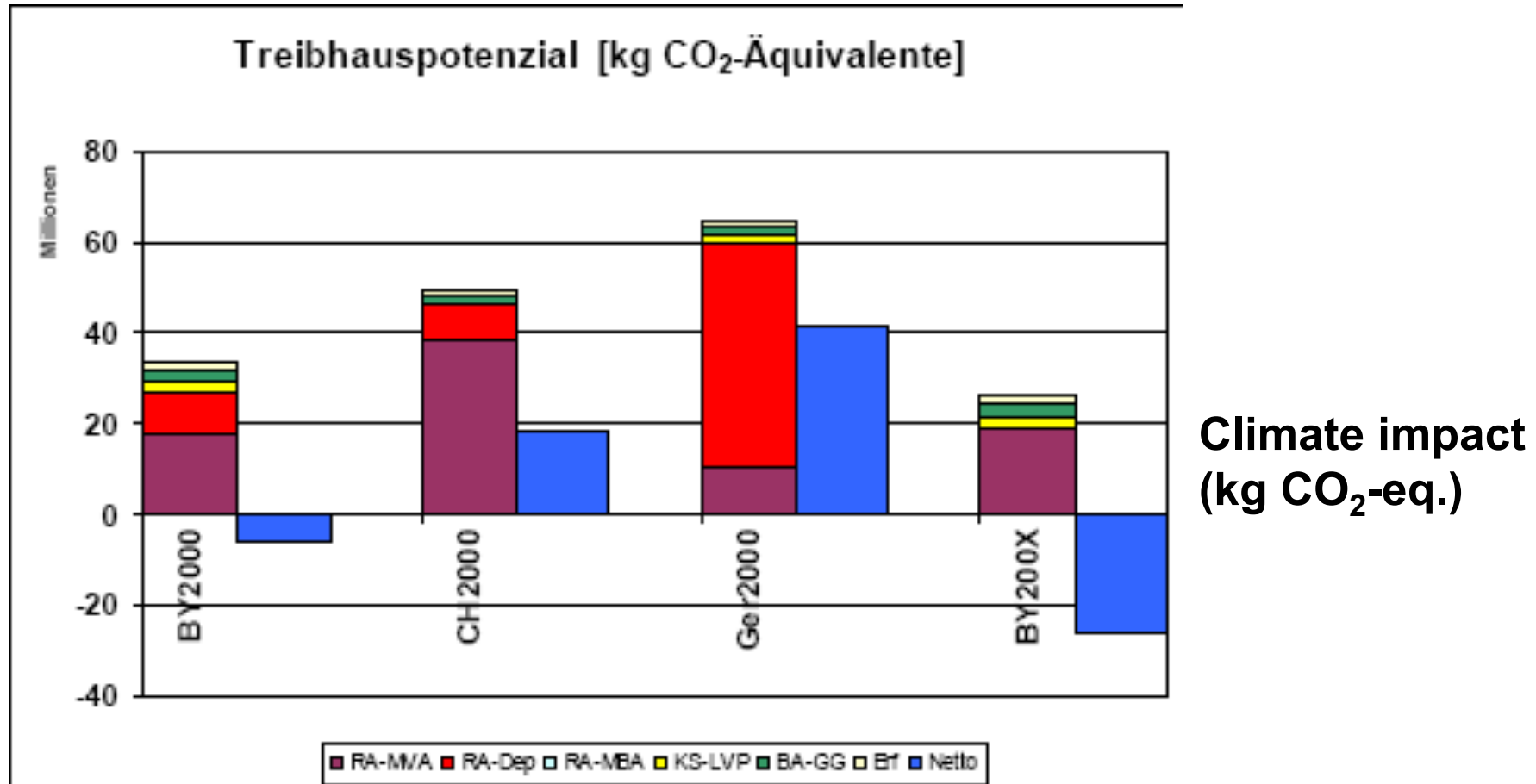
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★ Studies regarding further ecological aspects

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„Ecoefficiency of public waste disposal structures “

Sector and processes	Bavaria BY 2000	Germany GER 2000	Switzerland CH 2000	Bavaria optimized BY 200X
MSWI	17 MSWI located in Bavaria	17 MSWI located in Bavaria plus one „average-MSWI“ for all German MSWI plants	One „average-MSWI“ for all Swiss MSWI plants	17 MSWI located in Bavaria with improved efficiency
Recovery of residue	Backfilling of mines or crude steel production	Backfilling of mines or crude steel production	Partly crude steel production	Only crude steel production
Disposal of residues	Slag disposal or underground repository	Slag disposal or underground repository	Slag disposal or underground repository	Slag disposal or underground repository
MSW-MBT	„Average-MBT“ supplemented with data of Bavarian plants	„Average-MBT “	Not provided	Not provided
MSW-Disposal	„Average-disposal“ supplemented with data of Bavarian plants	„Average-disposal “	„Average-disposal“ supplemented with data of Swiss plants	No disposal of untreated MSW



- ★ **CH2000 / GER2000: Net environment burden from landfill methane emissions (red column)**
- ★ **BY2000/200X: Environmental benefits because of only slight or no disposal**

Cumulated energy demand (CED) and acidification potential (AP)

- ★ **Significant environmental benefits (net) for CED / AP in all scenarios due to substitution of credits for electricity, process steam, district heating,**
- ★ **in addition to the acidification potential also**
 - ◆ **crude steel production in the scenarios BY2000 and BY200X**
 - ◆ **PET-production (about 50 % of the benefits) in CH2000**
- ★ **Scenario BY200X: maximum discharge through improved efficiencies of MSWI**

Terrestrial eutrophication potential (EP)

- ★ **All scenarios: Environmental impact (net), mainly due to ammonia emissions of biowaste/green waste treatment (share of residual waste at the net result not shown).**

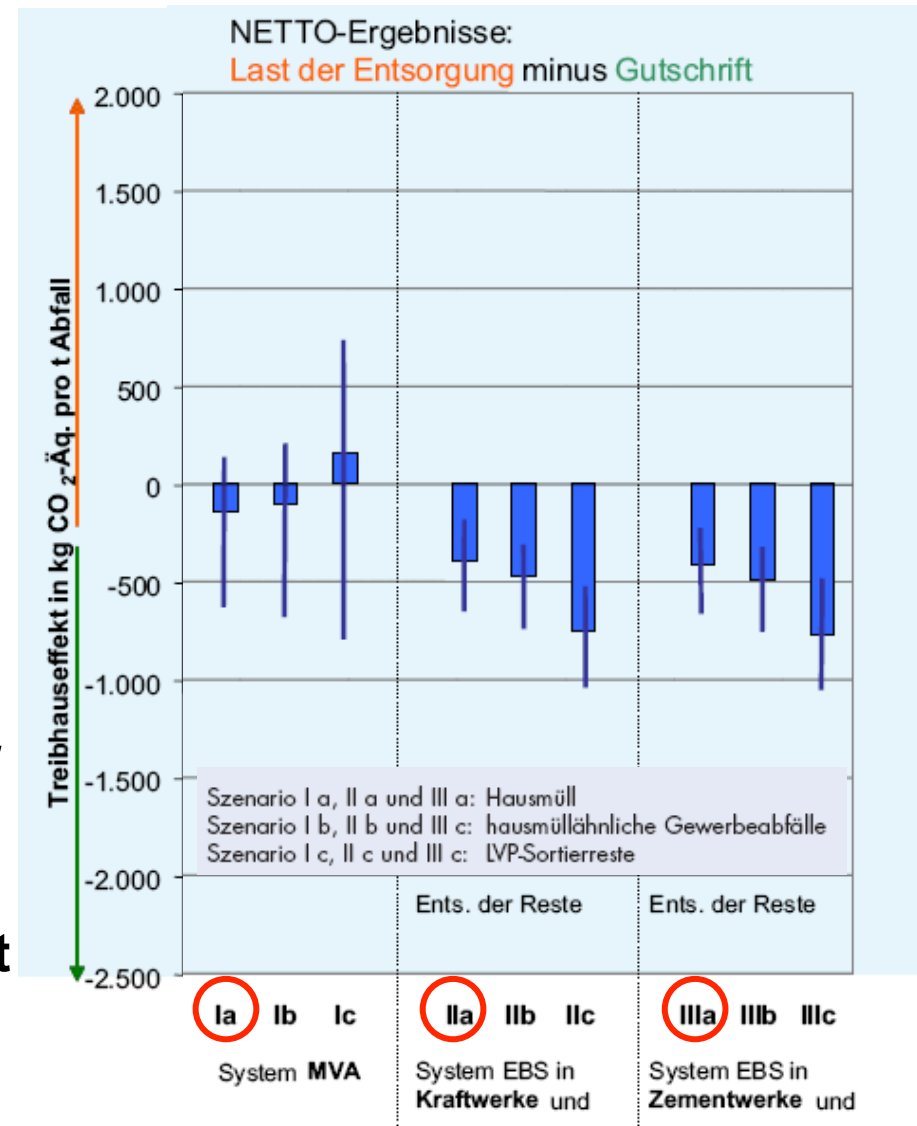
Photochemical Ozone Creation Potential (POCP)

- ★ **Result is largely determined by landfill, so environmental burden in all scenarios except BY200X.**

„Life cycle assessment study of thermal waste treatment processes for combustible waste in North Rhine-Westphalia“

Greenhouse effect

- ★ The disposal systems co-incineration in cement kilns or power plants have on average a slightly better balance than the disposal system MVA/MSWI.
- ★ For optimal energy use (complete steam recovery) the disposal system MVA/MSWI can achieve a similar result to the incineration systems (EBS/SRF).
- ★ Major influencing factors:
 - ◆ MBT: Produced amount of EBS/SRF after treatment
 - ◆ Kind of substituted regular fuel
 - ◆ Energy efficiency of MSWI plant for the treatment of MBT residual fraction

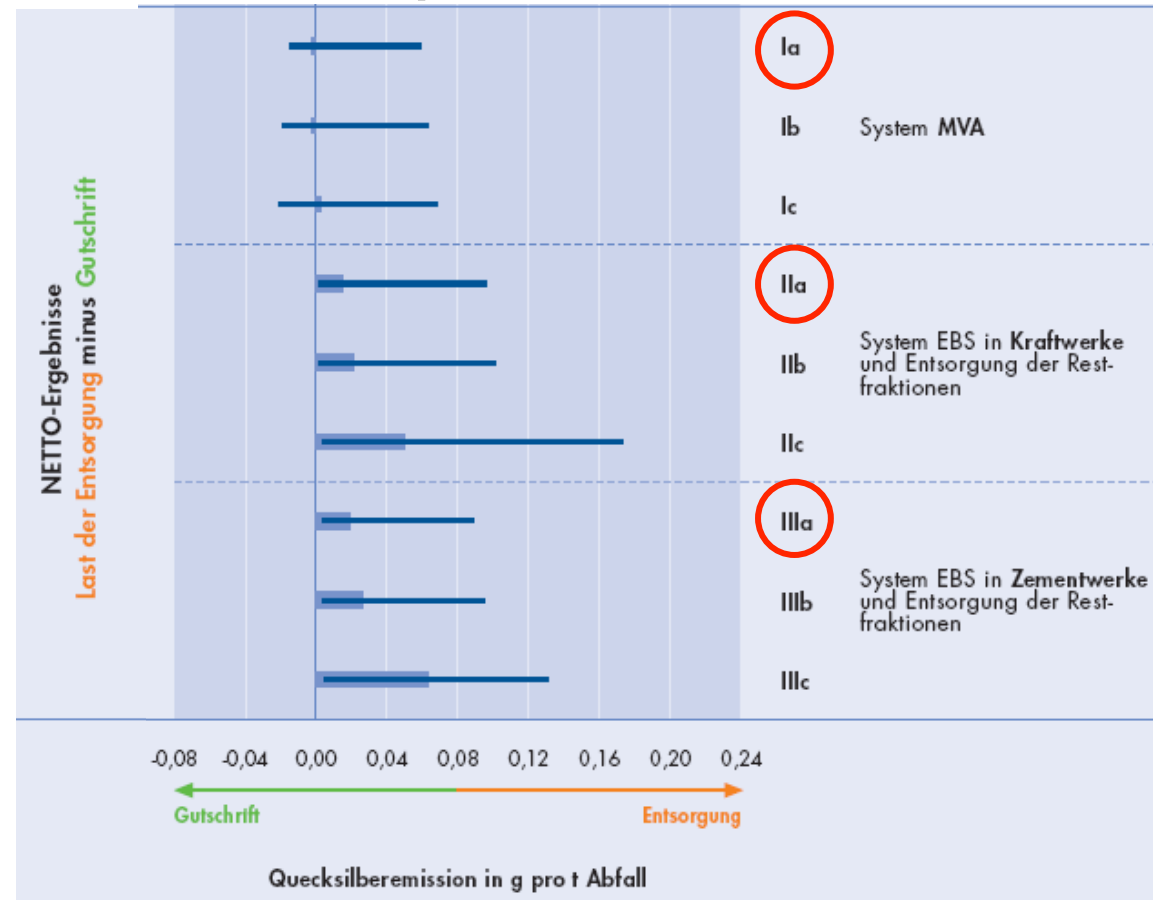


„Life cycle assessment study of thermal waste treatment processes for combustible waste in North Rhine-Westphalia“

Human Toxicity (Mercury)

- ★ MSWI can result in a net environmental relief.
- ★ Disposal system co-incineration always leads to an environmental impact.
- ★ Important influence factors:

- ◆ Selectivity of sorting/processing to SRF
- ◆ specific Hg-emission reduction means of power plants and cement kilns (coke adsorption, selective deposition in the wet scrubber of power plants, dust bypass at cement kilns).



„Life cycle assessment study of thermal waste treatment processes for combustible waste in North Rhine-Westphalia“

Acidification potential (AP)

- ★ **Only minor differences observed.**
- ★ **Co-incineration scenarios consistently reduce environmental burden.**
- ★ **Vast majority of MSWI plants reduce environmental burden, too; the result depends mainly on NO_x emission concentration.**

Eutrophication potential (EP)

- ★ **Co-incineration scenarios are polluting consistently.**
- ★ **The six most energy efficient MSWI plants with low NO_x emissions, however, provide a net discharge.**

Study	Results / Climate effects
BIWA/BZL 2003	Almost all variants of waste treatment lead to a climate relief, depending on the modeling of the case. Only the system MBT can lead to climate impact in case of poor energy recovery.
Öko-Institut 2005	Co-incineration solutions currently lead to a significantly higher climate relief as MSWI. Optimization potentials are available. The system MBT leads to climate impact.
IKr 2006	Climate relief by MKK (power plant using SRF with a medium calorific value), if charcoal electricity is substituted.
Bifa 2007	Big climate relief potential for MSWI, and small (but existent) for MBT.
IFEU 2007	In general environmental relief, depending on the efficiency of thermal treatment plants; depending on energy efficiency, MSWI may be superior to co-incineration.
BIWA/BZL/ Prof. Born, 2009	Result (climate relief or impact) depending mainly on the energy efficiency of especially thermal plants and – in the special case of the Free State of Saxony – on the kind of energy substituted.
In general	The result is substantially provided by the energy efficiency of the recovering plant (MSWI, SRF fired plant). For MBT, the modeling of the case is mainly determining the result.

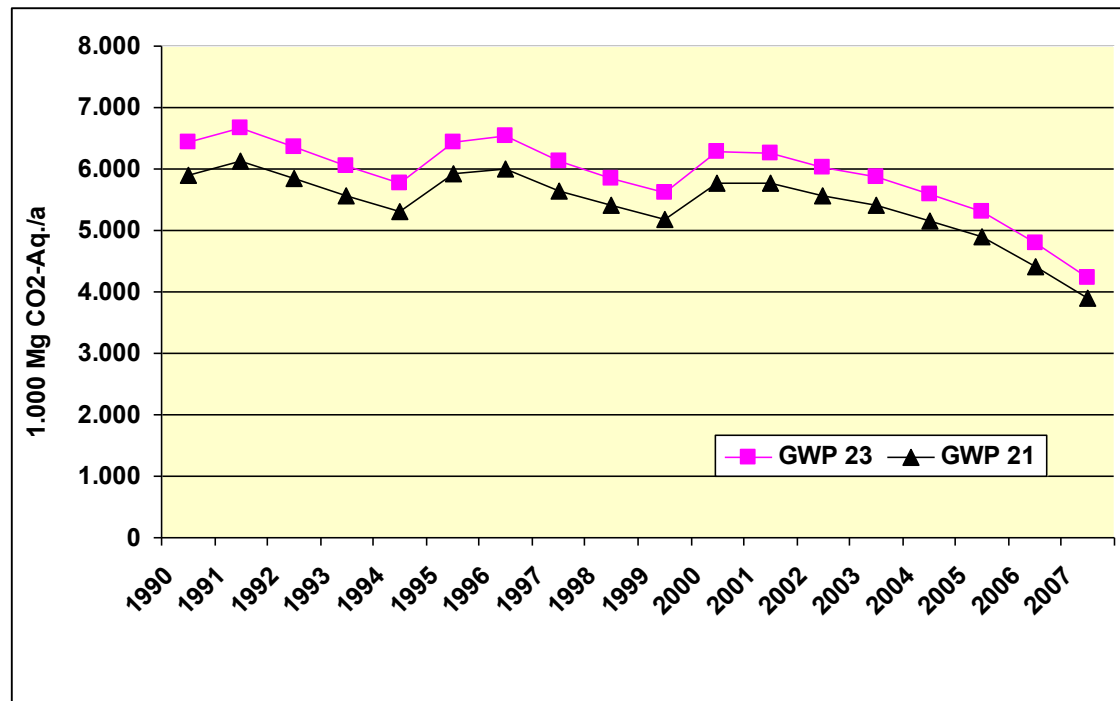
- ★ **Actually, climate effects as an environmental impact category is dominating.**
- ★ **Therefore: Ending disposal of untreated wastes is by far the most important measure to reduce greenhouse emissions.**

★ **Problem of old landfills → need for action.**

Total emissions (projection) from the old landfills and dumps in Saxony from 1990 to 2006, including the amount of gas flared or recycled, in 1,000 Mg CO₂eq./a

Source:

BIWA/BZL/ Prof. Born, 2009



- ★ Today, well-established waste treatment and recovery processes achieve GHG savings, but compared to the avoided or even avoidable emissions from old landfills these savings are of secondary importance.
- ★ There are hardly any differences between mono- and co-incineration with respect to climate relevance; the energy efficiency of thermal plants is the crucial point.
- ★ Non-thermal plants: energy demand and amount and quality of recyclable material flows and even direct plant emissions are relevant for climate effects
- ★ MBA concepts usually show no or only slight climate relief effects.

- ★ **Consideration of other environmental impact categories in LCA identifies optimization potential, but does not lead to fundamentally different statements.**

- ★ **Achievable environmental benefits are dependent on the constellation of the case, e.g. from**
 - ◆ **the issue of energy efficiency of the plants / the total system,**
 - ◆ **the credits for the chosen equivalence processes**
 - ◆ **and – for the non-climate-related impact categories – the emission standards of the plants.**

Thank you and bye!

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