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# Waste-to-energy Compared To Mechanical Biological Treatment (MBT) And Co-combustion Of Municipal Waste

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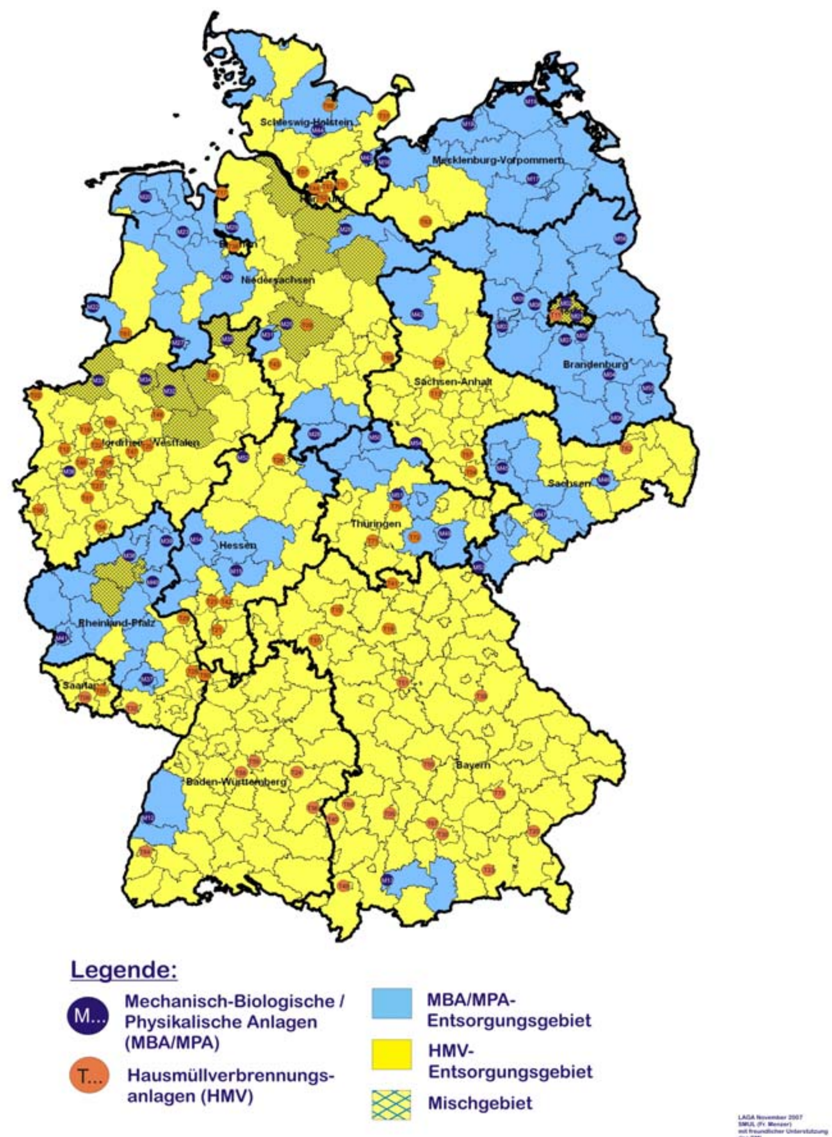
## Structure:

- **Background**
- **Results of studies comparing climate effects**
- **Summary**
- **Conclusions**
- **Outlook**

Restabfallbehandlung in Deutschland



# Background



- 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)
- AbfAblV (Waste disposal ordinance 2001): Disposal of untreated solid waste prohibited since 1.6.2005

## 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.)**

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# Situation in Germany

**Thermal treatment plants (2008):**

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

**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**

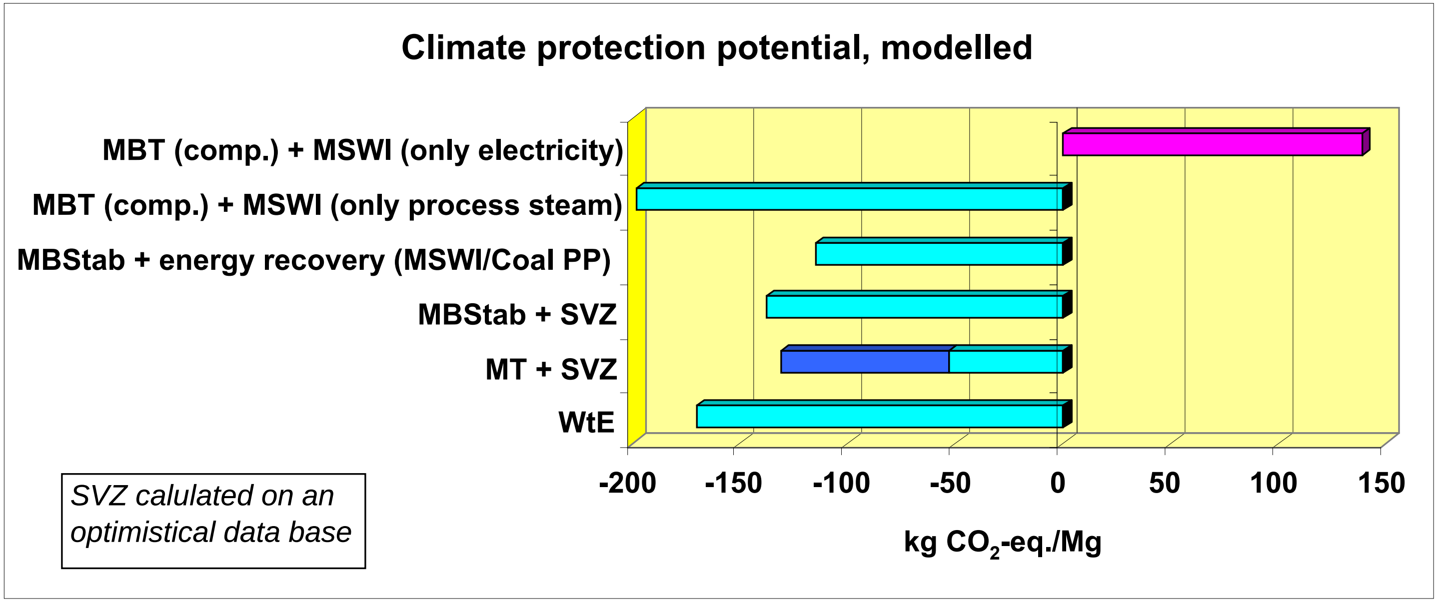
# Studies comparing ecological effects



## Studies regarding climate effects

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

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

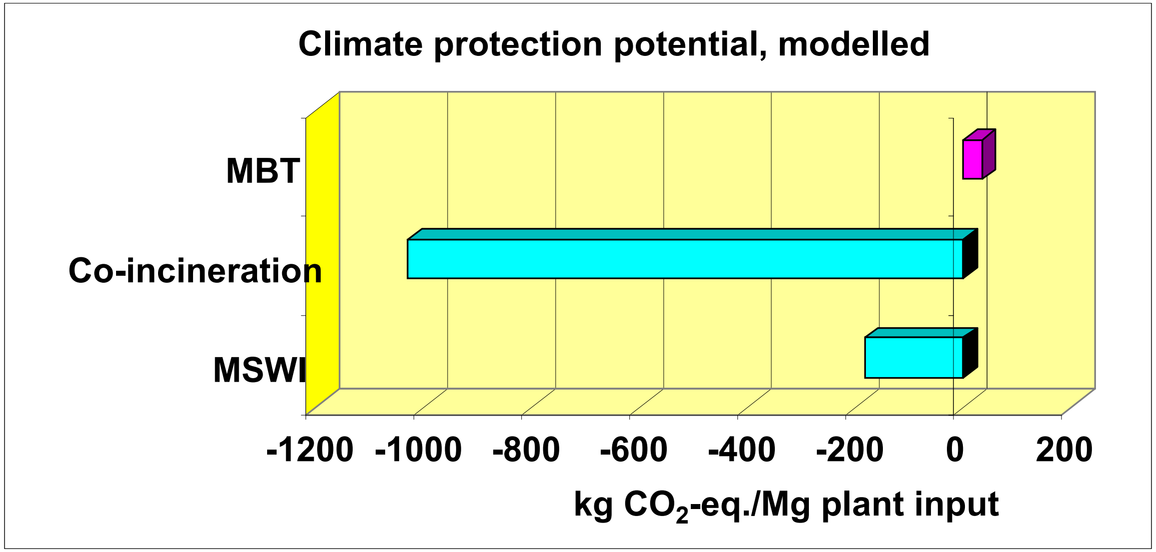



Positive values = environmental burden

Negative values = environmental benefit

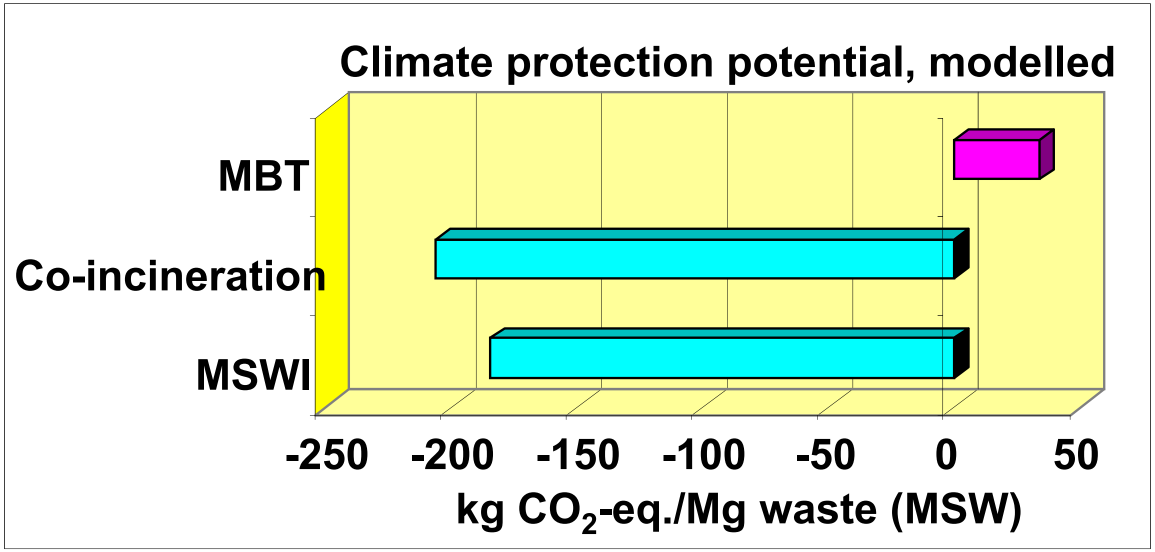
- **Most important measure for climate protection:**
  **Ending disposal of untreated wastes (reducing emissions of methane (GWP 25), nitrous oxide ($N_2O$; GWP 296)).**
- **Contribution of equivalent processes of waste treatment (electricity, heat, metals) distinctly smaller.**
- **Biggest optimization potential:**
  - **Increase in energy efficiency of thermal plants**
  - **Reduction of energy demand of non-thermal plants**

# „Status Report on the Waste Sector's Contribution to Climate Protection and Possible Potentials" (Germany)




**Results referring to 1 Mg plant input**

Values without credits for separated metals




**Results referring to 1 Mg waste**

# Öko-Institut 2005

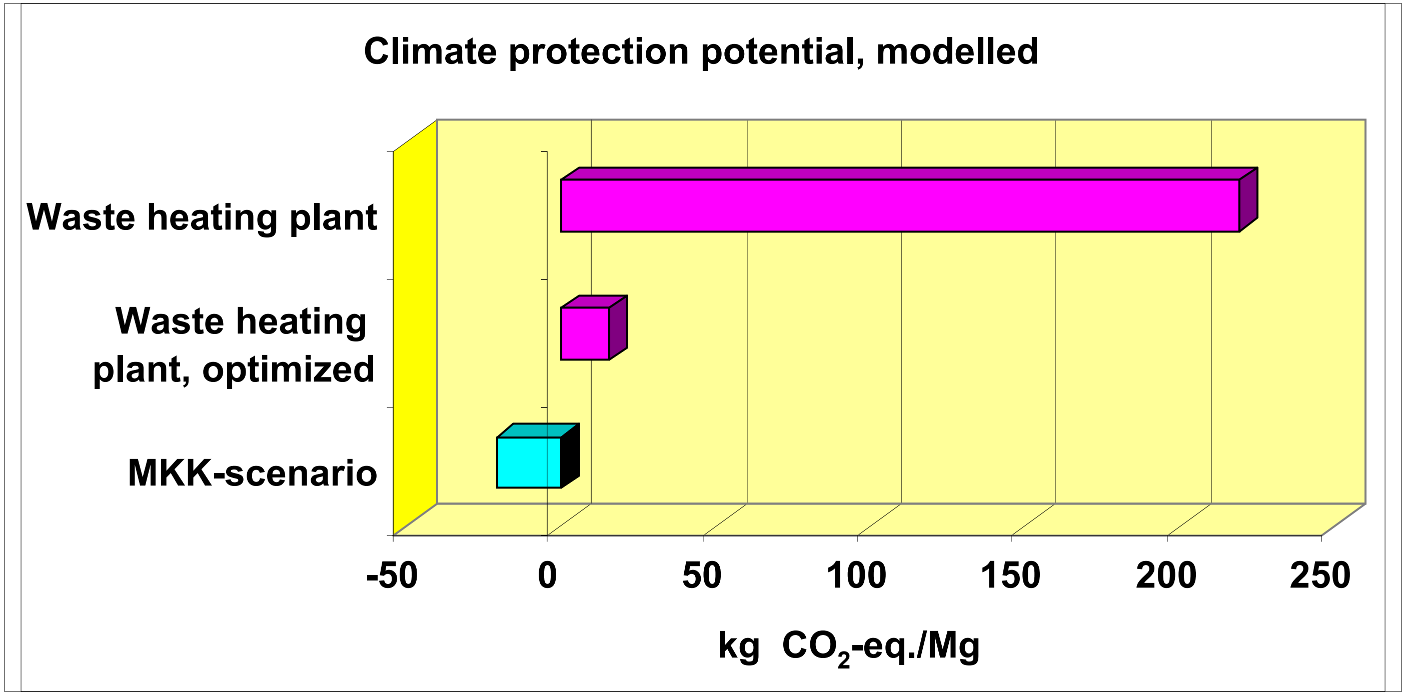


„Status Report on the Waste Sector's Contribution to Climate Protection and Possible Potentials" (Germany)

- Most important measure for climate protection:
  Ending disposal of untreated wastes.

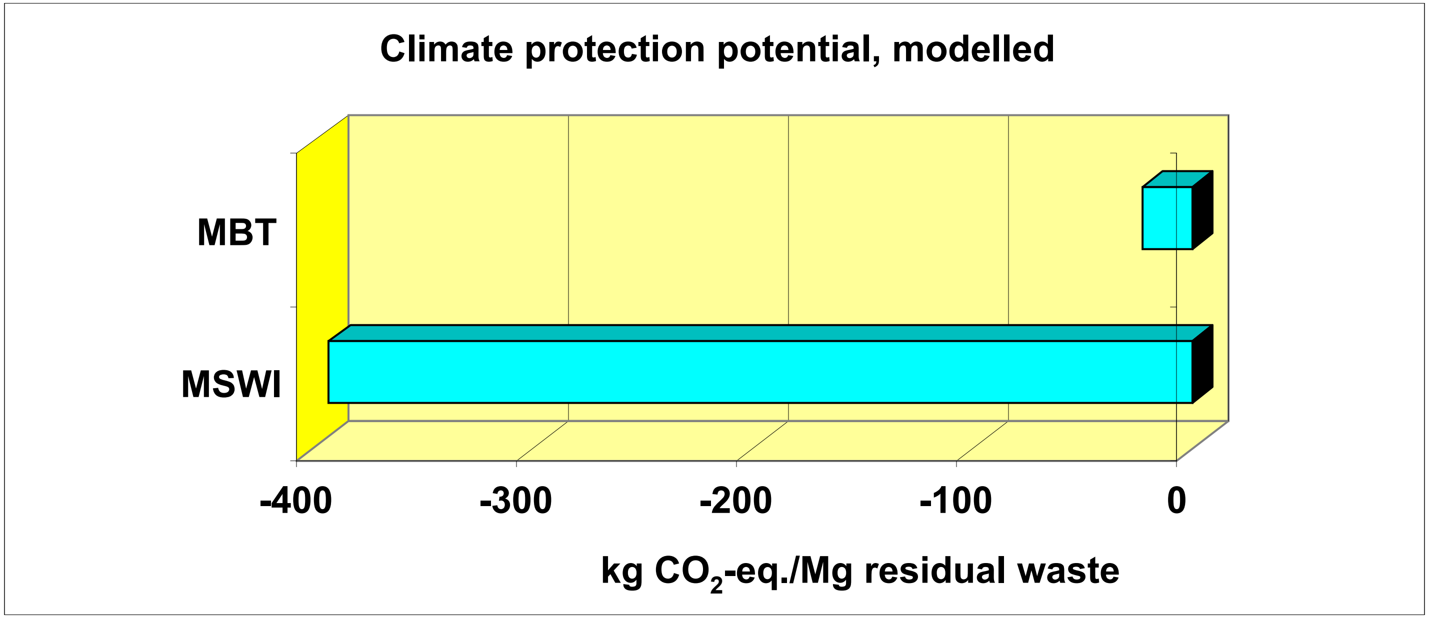
- Optimization potentials:
  1. Intensification of combined heat and power generation in waste incineration plants and substitute-fuel special-purpose power plants.
  2. Increased output and utilisation of process steam.
  3. Input of quality-assured secondary fuels into co-incineration processes.
  4. Intensification of efficient electricity generation in waste incineration plants, if possible in conjunction with combined heat and power generation.

# „Ecological and energetic balancing of the MKK-project“ (Bremen) (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“ (Bavaria)

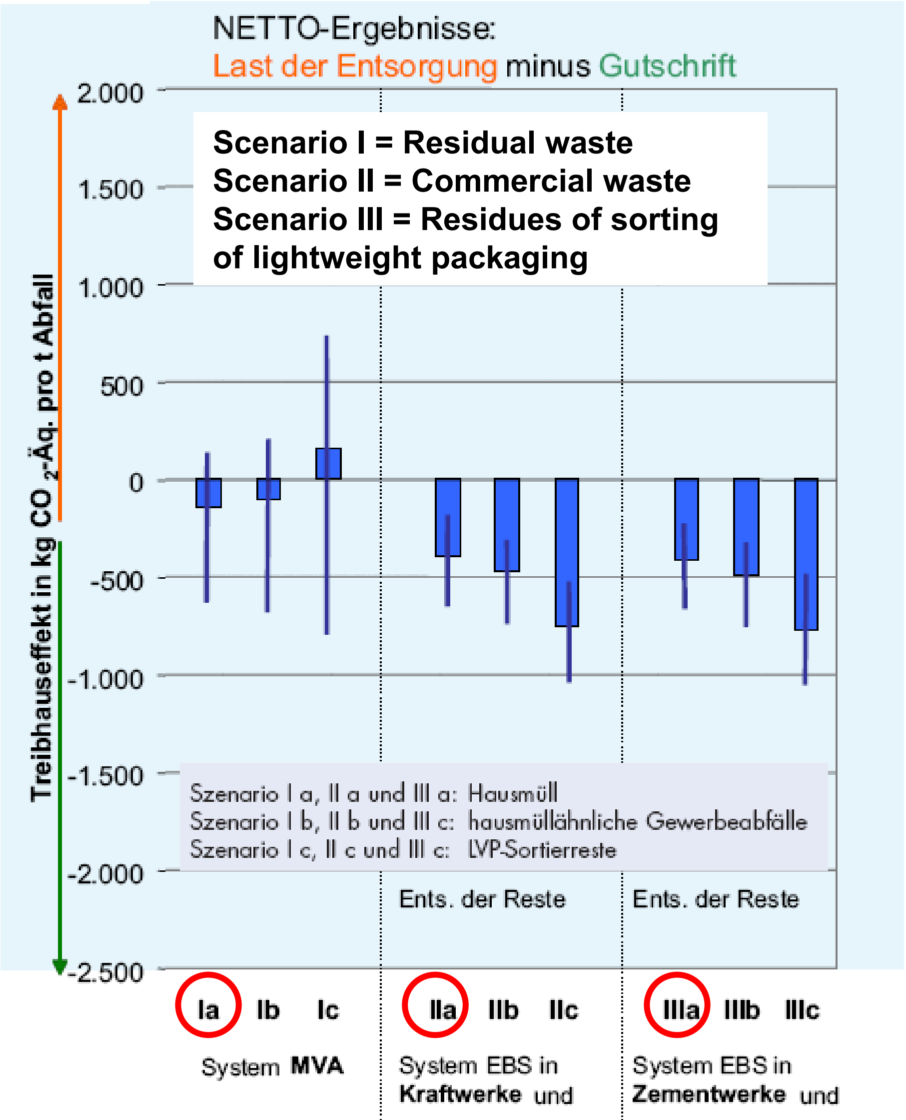



- **Most important measure for climate protection: Release of disposal of untreated wastes**
- **Particularity of Bavaria: a good 90 % of municipal solid wastes are treated in MSWI plants**
- **MBT-credit for ferrous metals for the equivalent of crude steel is relevant for result; no details of modelling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

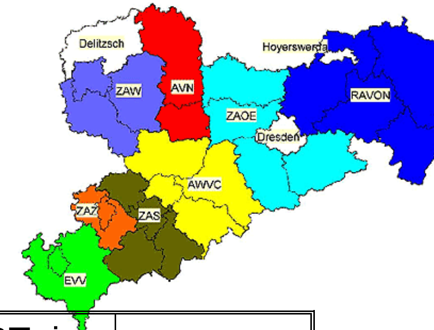
# „Life cycle assessment study of thermal waste treatment processes for combustible waste in North Rhine-Westphalia"

## 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

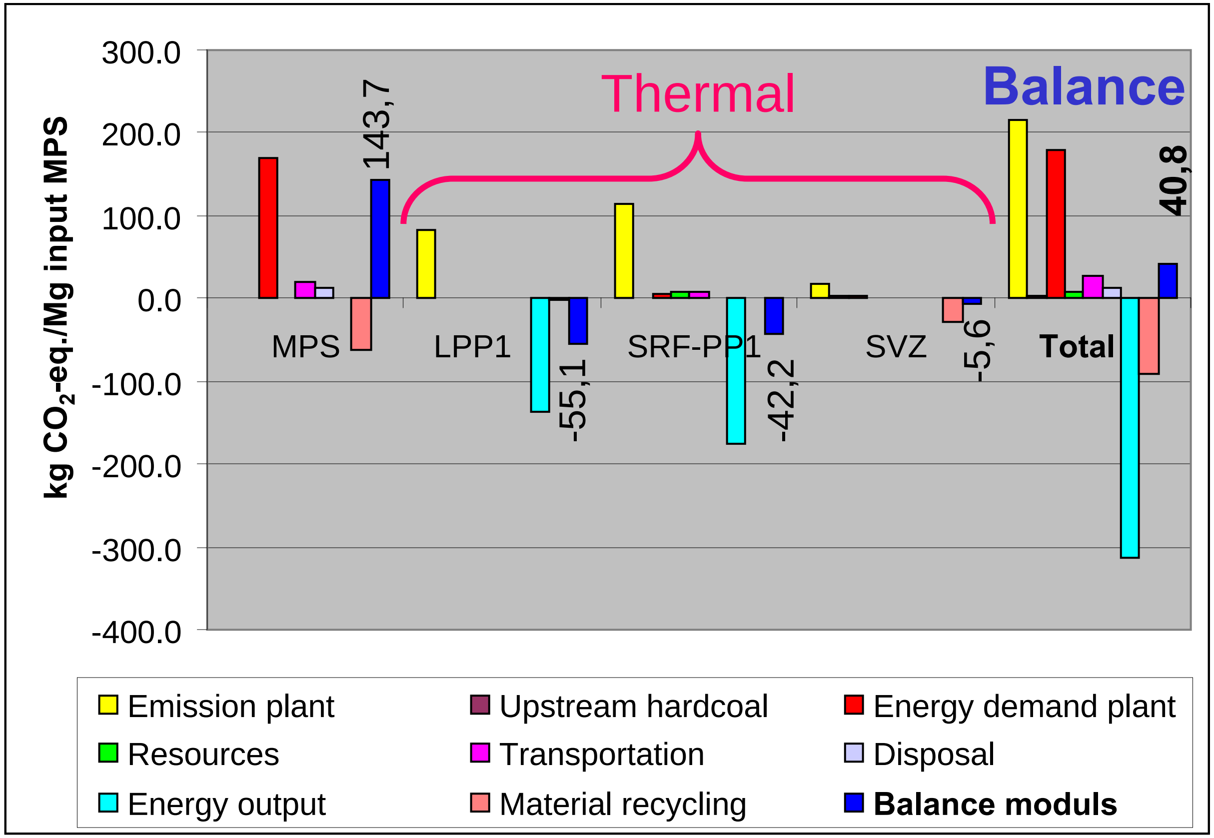


# Study on the climate impact of waste management in the waste associations of the Free State of Saxony




| County | Waste Association or City/District | Thermal, in Mg/a | model | MT in Mg/a | model | MBT, in Mg/a | model |
|---|---|---|---|---|---|---|---|
| | 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 |
| **Chemnitz** | **Sum** | **64.996** | | **0** | | **137.536** | |
| | 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 (LPP = lignite fired power plant; SRF-PP = SRF fired power plant; SVZ = gasification/methanol production plant)**



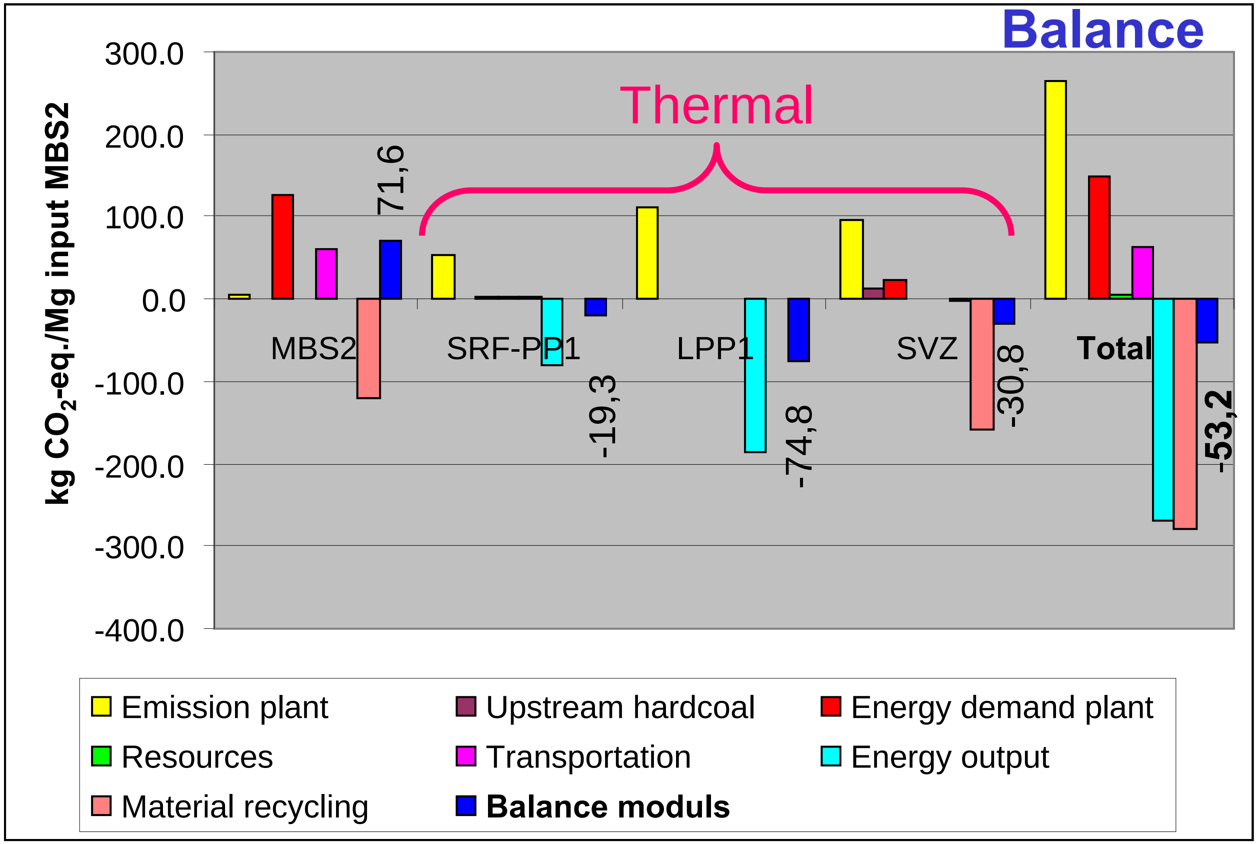

**Note**:

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

**Results deteriorate if**

- SRF-PP1 and LPP1: 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 (SRF-PP = lignite fired power plant; LPP = lignite fired power plant; SVZ = gasification/methanol production plant)**

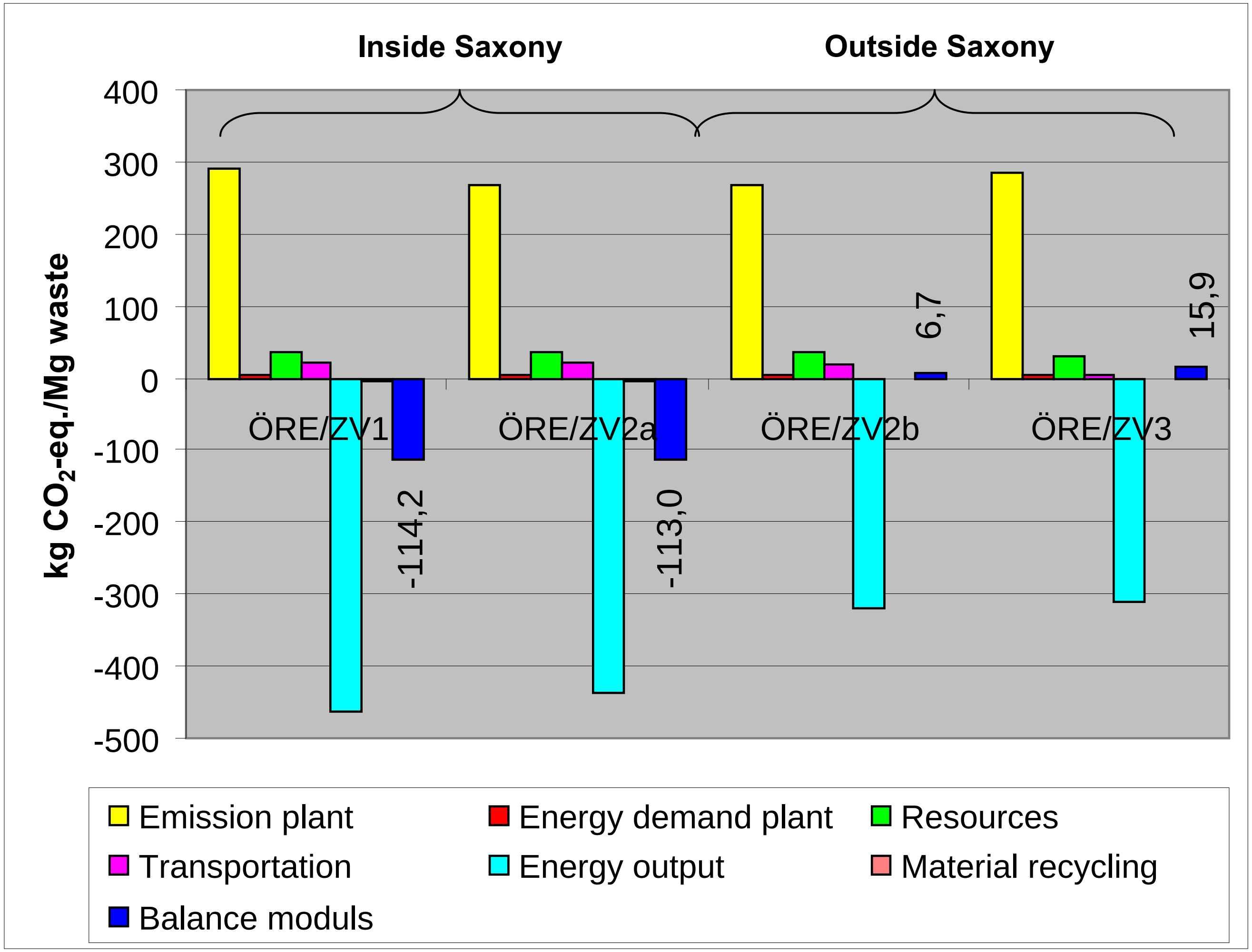



**Note**:

Results deteriorate if

- MBS2: smaller separation efficiency for ferrous and even more for nonferrous metals
- SRF-PP1 and LPP1: electricity production only, no CHP
- SVZ: higher energy demand than modelled

**Incineration of 1 Mg waste in a MSWI plant;**
**ÖRE/ZV = waste management area**




**Note**:

- MSWI in Saxony: Grants for the „Saxonian Electricity Mix“: 915 g $CO_2$-eq./kWh
- MSWI outside Saxony: Grants for „German Electricity Mix“: 604 g $CO_2$-eq./kWh
- All MSWI plants: only supplying electricity, no CHP

## 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 $CO_2/kWh_{el}$
  - German electricity mix: 604 g $CO_2/kWh_{el}$
  - Advantageous for scenarios with energy output within Saxony (ÖRE/ZV1)
  - 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.

# Summary



| Study | Results / Climate effects |
| --- | --- |
| **BIWA/BZL 2003** | Almost all variants of waste treatment lead in sum to a reduction of GHG emissions, 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 to a reduction of GHG emissions than MSWI does. Optimization potentials are available. The system MBT leads to climate impact. |
| **IKr 2006** | Reduction of GHG emissions by MKK (power plant using SRF with a medium calorific value), if electricity based on charcoal 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 o 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.** |

# Conclusions



- **Thermal Plants:**
  **There are hardly any differences between mono- and co-incineration with respect to climate relevance; 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.**

# Summary



- **Consideration of other environmental impact categories in LCA (bifa 2004, IFEU 2007) identifies optimization potential, but does not lead to fundamentally different statements.**

- **Achievable environmental benefits depend 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 like e.g. mercury (human toxicity) – the quality of emission protection of the plants.**

# Outlook



- The studies performed for Saxonia and Bremen show the great influence of the chosen equivalence process for electricity. “Greening” of electricity production in Europe will make such balances in the future more difficult – the higher the share of renewable energy sources in the selected electricity mix, the lower the credits for the substitution of this electricity. Some experts try to solve this problem by granting credits for the substitution of electricity produced by e.g. peak load power stations [BMU 2008].
- With the increase of material recycling, this problem may also arise in the calculation of credits for output material for recycling. On the other hand, the scarcity of non-renewable resources will increase the importance of material recycling yet and thus determine the amount of the credits.

# Outlook

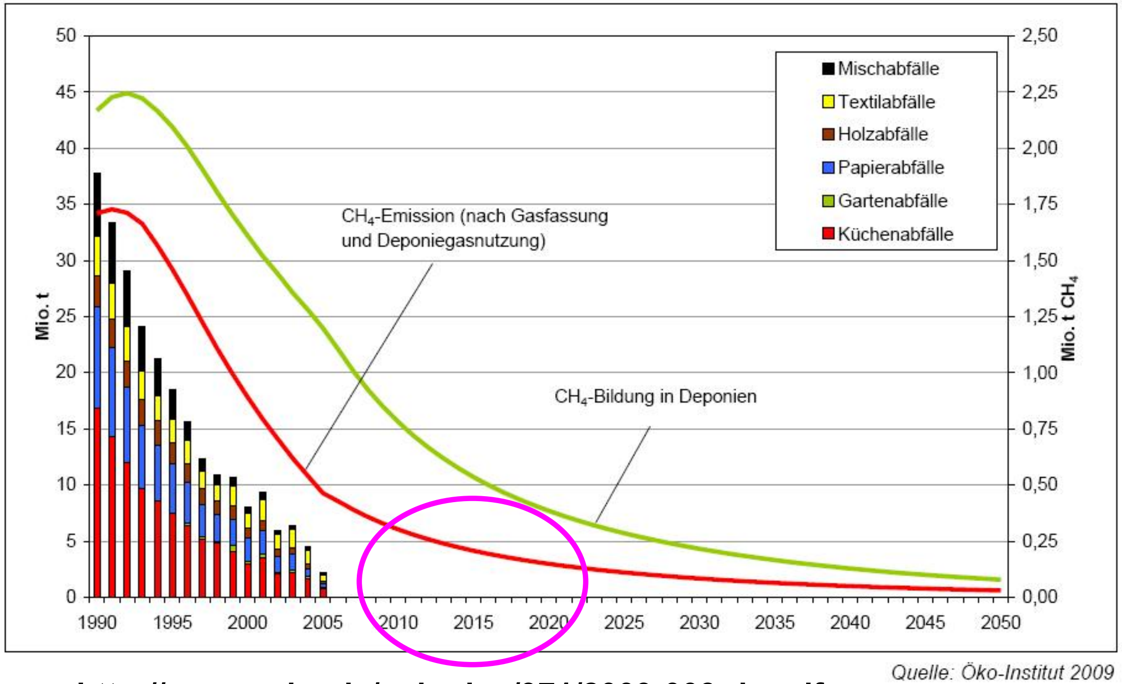


- **Actually, climate effects as an environmental impact category is dominating.**
- **Therefore: Ending disposal of untreated wastes is by far the most important measure to reduce greenhouse emissions.**
- **Today, well-established waste treatment and recovery processes achieve GHG savings, but compared to the avoided or even avoidable emissions from old landfills these savings are of secondary importance.**
- **Problem of old landfills → need for action.**

# Outlook



**Following Prognos / Öko-Institut, already closed landfills in Germany will release about 2 million Mg methane in the period of 2011 to 2020.**




**http://www.oeko.de/oekodoc/971/2009-003-de.pdf**

- **Conversion of only 10% to $CO_2$ by e.g. aerobic in situ stabilization would save about 5 million Mg $CO_2$eq.**
- **Even if this would cost 100 million €, the specific abatement costs will amount to only 20 €/Mg $CO_2$eq.**
- **Specific $CO_2$ abatement costs of photovoltaics range actually at ≥ 800 €/Mg $CO_2$eq.**

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