
Philipp Schmidt-Pathmann, President
Waste Recovery Seattle International, LLC.
Assisting Agencies/Organizations

- German Federal Ministry for the Environment, Nature Conservancy and Nuclear Safety, Bonn
- German Green Party, Berlin
- Research Institute Karlsruhe, Germany
- Oekoinstitut, Freiburg, Germany
- BASF, Germany
Headlines
Outline

• An Environmental Perspective
• Waste Management Directive in Europe
• Dioxins & Furans
• The ‘State of Waste’ in the US
• WTE Technologies
• Thermal Recycling – Turnkey Technology
• Bottom Ash
• Finding Solutions
Arguments given against WTE:

Excerpts of an article 07-12-06:
There are basically two problems with incinerators – no matter what name you may give them.

• First, they produce dangerous wastes in the form of gases and ash, often creating entirely new hazards, like dioxins and furans, that were not present in the raw waste.

• Secondly -- and even more importantly -- incinerators destroy materials that must then be replaced.

...Incinerators prevent us from adopting sensible modern ways of doing business, namely "zero waste" and "clean production."
Arguments given against WTE:

People who think we can make the transition to a sustainable economy without stopping incinerators (in all their forms) are badly mistaken.

Once you build an incinerator, you must "feed the machine" for the next 40 years to get your investment back. Once you build an incinerator, resource conservation, recycling and waste reduction become "the enemy" because the machine must have a new load of fresh garbage every day. The machine needs waste, so its very existence serves as a major deterrent to less wasteful life styles and ways of doing business.

In sum: incinerators promote waste. They thrive on waste. They need waste. They demand waste. Incinerators are a major deterrent to clean production, full recycling, resource conservation, zero waste, and a sustainable economy.
Direct landfilling of MSW in %
Direct landfilling of MSW in the EU in %
Waste management Strategies

avoidance

reuse

recycling

problems
health risk emissions economy

benefits
saving of resources by recovering of
- materials
- energy

inertisation & energy recovery

landfill

waste management strategies
Recycling early 1900s

Three Container System in Berlin (1907)

- paper, glass, textiles, metals
- ashes, garbage
- kitchen waste
Incineration late 1800s

1896  1. plant on continent in Hamburg-Bullerdeich (Germany)
1900  further plants on other cities
EU legislative framework on waste


- Landfill Directive 1999/31/EC
- Dec. 2000/532/EC List of Wastes

regulated waste streams

- waste oils
- sewage sludge
- batteries accumulat.
- packaging waste
- ELV
- PCBs
- WEEE
EU - Targets

main targets

- reduction of biodegradable waste disposal
  - 25 % in 2006
  - 50 % in 2009
  - 65 % in 2016

⇒ landfill ban in some countries

future disposal routes

- material recycling
- composting
- anaerobic digestion
- combustion with energy recovery
The heterogeneous waste stream

- Municipal solid waste (MSW) is a mix of all kinds of materials which have to be disposed of in an environmentally acceptable way.
- In history of mankind waste disposal meant landfilling.
- However, MSW contains reactive biogenic constituents which, for example cause the formation of climate active methane and the risk of groundwater contamination by leachates.
- Landfilling should not be considered for untreated MSW.
Organics in the waste-stream

- Organic waste disposal problematic
  - Health risk
  - GHG emission
  - Ground water contamination
- Mixed MSW contains typically > 50% biogenic energy
- Composting questionable
  - Compost quality
  - GHG emission
  - Area demand
- Anaerobic digestion emerging (suited for wet biomass)
- WtE by combustion established and recommended technology for MSW to make best use of its biogenic energy inventory
  - Low emissions
  - Inert bottom ashes
  - Substitution of fossil fuel
  - CO₂ reduction
EU waste management directive:

- The main target in view of sustainability is the prevention of direct disposal of reactive waste on a landfill.
- The tools to comply with these principles are recycling and material recovery as well as waste incineration with energy recovery as final inertisation step.
- A number of countries have already enacted respective national regulations and the realization shows that recycling and incineration are not competing but both essential parts of integrated waste management systems.
- In the EU like in other industrialized countries the amount of residual waste available for energy recovery can supply approx. 1% of the primary energy demand.
- About 50% of the energy inventory of MSW in most EU countries is of biogenic origin and MSW is in to the same extent to be looked upon as regenerative fuel.
- Hence part of the CO2 released from waste incineration is climate neutral.
Energy Substitution and CO2 reduction

- MSW in the EU is mainly burnt in dedicated combustion facilities - preferentially in European mass burners which are based on grate technology.

- A modern waste incinerator has a high potential for energy recovery. Its primary or boiler efficiency exceeds 80 %, the power efficiency amounts to 20 – 25 % and in modern plants with new boiler concepts to even more to than 30 %. The best strategy, however, is combined heat and power (CHP). In such configurations the overall energy efficiency can reach more than 60 %.
Energy Substitution and CO2 reduction (cont.)

- This biogenic energy share is in the EU countries roughly in the order of 50% and this fact has already been acknowledged by a number of national authorities.
- In these countries power from waste incineration is to a certain extent rewarded as coming from renewable energy sources.
- The biogenic fraction in MSW means also that the respective share of emitted CO2 has to be looked upon as climate neutral and could be categorized as such in CO2 trading systems.
- For the highly industrialized EU countries this accounts for approx. 1% of the annual CO2 emission.
- Taking into account that the current discussion on climate change and global warming initiated a world wide strong political support for bio-energy, the need for inertisation of residual waste prior to final disposal should be seen as a chance to exploit the energy in waste as extensively as possible.
- Such tendency is seen in Europe and is reason to expect waste incineration being the fastest growing bio-energy sector in the EU during the next years.
- The positive results obtained so far in the EU could be a model for other parts in the world.
The Waste Management Hierarchy

• The historical mission of waste management to secure hygienic conditions in urban areas is – at least in Central Europe - fulfilled by now. Today three other aspects became more prominent and are the challenges of a sustainable waste management system:
  • protection of man and environment,
  • conservation of resources (energy, material, land), and
  • aftercare-free waste management.
The Waste Management Hierarchy (cont.)

- In this context usually a hierarchy of waste management strategies is discussed which base on
  - prevention of waste generation,
  - reuse and recycling of constituents like paper, metals, glass, and eventual plastics,
  - composting or anaerobic digestion of organic waste fractions,
  - inertisation of the residual waste by thermal treatment with energy recovery, and finally
  - disposal.
<table>
<thead>
<tr>
<th></th>
<th>WTE</th>
<th>Landfilling</th>
<th>MBT</th>
<th>Best Environ. Performer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy - Conservation</td>
<td>Highest</td>
<td>Low</td>
<td>Lowest</td>
<td>WTE</td>
</tr>
<tr>
<td>Resource – Consumption</td>
<td>Lowest</td>
<td>Highest</td>
<td>High</td>
<td>WTE</td>
</tr>
<tr>
<td>Waste - Reduction</td>
<td>Highest</td>
<td>Lowest</td>
<td>Low (only 1/3&lt;sup&gt;rd&lt;/sup&gt;)</td>
<td>WTE</td>
</tr>
<tr>
<td>Smog, GHG’s, Ozone Destruction, Acid Rain</td>
<td>Reduces</td>
<td>Increases</td>
<td>Increases</td>
<td>WTE</td>
</tr>
<tr>
<td>Risk – Water &amp; Air pollution</td>
<td>Lowest</td>
<td>Highest</td>
<td>Low</td>
<td>WTE</td>
</tr>
</tbody>
</table>
State of the Art and Outlook

- Almost three decades of research on the formation of PCDD/F in waste incineration have disclosed the major formation reaction mechanisms and their main parameters of influence.
- Since slightly more than 20 years Forschungszentrum Karlsruhe contributed to a great extent to the progress in this area which is not only of high scientific interest but is also a key topic in the ongoing controversial discussion of waste incineration.
- Today we know:
  - PCDD/F are mainly formed by the de novo synthesis in the back end of the boiler,
  - optimization of combustion control and burnout are suitable tools to reduce the PCDD/F level in raw gas and solid residues,
  - filter systems should be operated at temperatures below 200 °C,
  - increased halogen levels do not increase the PCDD/F formation as long as a good burnout is achieved,
  - permanent high sulphur levels inhibit the PCDD/F formation, PCDD/F are also formed inside the combustion chamber but these congeners are destroyed in the post combustion area,
  - instationary conditions have to be avoided.
Explanatory Note:
'Dioxins' and 'furans' are generic terms for a group of more than 200 individual chemical compounds, all of which are of different toxicity. They cause chloric acne and are cancerogenic. Dioxins and furans will form spontaneously from chlorine atoms, carbon that has not been fully oxidised, and various catalysts in cooling smoke; hence, the process is the same for waste incineration plants and tiled stoves alike. Each of the 200 dioxin and furan compounds is of a different degree of toxicity; for that reason, their so-called toxicity units (TUs) are determined and summarised into units of grams per toxicity unit (g TU).
Carcinogenic Toxicants / Fine Dust

Without waste incineration plants, there would be more toxicants in the air

Dioxins are formed in the smoke gases of fires; it is only in very small proportions that they occur in waste from the very beginning. Arsenic, cadmium, nickel, and other cancerogenic toxic heavy metals, on the other hand, enter waste incineration plants together with waste. In order to prevent them from leaving any waste incineration plant via its chimney, under the 17th Ordinance on the Implementation of the Federal Immission Control Act ("17th BImSchV") expensive filtering devices were installed by 1996. The result: prior to 1990, contaminants of a toxicity comparable to that of 188 tonnes of arsenic were distributed into the air; today\(^3\), at least 3 tonnes are extracted from the air. Admittedly, this is an idea that needs some getting used to. But that credit is a result of the power and heat generation produced by the incineration of household waste\(^4\). If that energy were generated using traditional power stations, there would be three more tonnes of toxicant in the air.
PCDD/F in a state-of-the-art waste incineration plant

- Waste: 20 - 70 ng/kg = 100%
- Post boiler: 1 - 30 ng/kg <5%
- Post filter: 1 - 5 ng/m³ <10%
- Post APC: <0.1 ng/m³ <1%
### PCDD/F emission sources in Germany

<table>
<thead>
<tr>
<th>sources</th>
<th>emission per year in g I-TEQ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990</td>
</tr>
<tr>
<td>metal industry</td>
<td>740</td>
</tr>
<tr>
<td>sintering plants</td>
<td>575</td>
</tr>
<tr>
<td>iron- &amp; steel production</td>
<td>35</td>
</tr>
<tr>
<td>waste incineration</td>
<td>400</td>
</tr>
<tr>
<td><strong>municipal solid waste</strong></td>
<td>399</td>
</tr>
<tr>
<td>hazardous waste</td>
<td></td>
</tr>
<tr>
<td>medical waste</td>
<td></td>
</tr>
<tr>
<td>sewage sludge</td>
<td></td>
</tr>
<tr>
<td>power plants</td>
<td>5</td>
</tr>
<tr>
<td>industrial combustion facilities</td>
<td>20</td>
</tr>
<tr>
<td>domestic stoves</td>
<td>20</td>
</tr>
<tr>
<td>traffic</td>
<td>10</td>
</tr>
<tr>
<td>crematoria</td>
<td>4</td>
</tr>
</tbody>
</table>
Greenpeace, Vienna, Austria about the WTE facility Spittelau, Vienna, 1999: "...The Austrian incineration plants have a high environmental standard as far as air and water emissions are concerned..."
PCDD/F Conclusion:

• In general it can be concluded that PCDD/F are no longer to be seen as a barrier to waste incineration.
• A negative impact on health or environment can be excluded if all technical knowledge is applied.
Today

• No new facilities in the US!
• Why?
  – Low energy prices
  – Ongoing pollution concerns
  – Lack of education
  – Wrong Priorities –Zero Waste -> landfills
  – Out of sight out of mind attitude
  – Political dilemma (Kyoto vs. public)
  – WTE industry has no credibility
  – Idealistic mind set
  – Over 100 new facilities worldwide
Today

• What is changing?
  – climate
  – energy prices
  – resource depletion
  – public awareness
  – political support
Today

• Past 20 Years in Germany ....
  – High capital expenditure
  – Material recycling and energy recovery of waste + (avoidance) – priority
  – extended producer responsibility
  – Stop land filling of biodegradable waste
    June 1st 2005
  – Contribution to climate protection (one of 2 countries that will achieve Kyoto)
  – German model for European Union
Today

• US Developments:
  – Climate Change (Kyoto Objectives)
  – Financial Dilemma
  – Political attention on alternative energies (?)
  – Waste Management promoting their WTE division, Wheelabrator
WTE Technologies

- Gasification
- Pyrolysis
- Hydrolysis
- Composting
- Mechanical Biological Treatment
- Biogas

=> Incineration / Mass Burn
Germany’s experience with alternatives:

- Work on homogenized wastes
- Pyrolysis, Gasification, Hydrolysis, Anaerobic Digestion, Mechanical Biological Treatment, Composting, Biogas …
- All alternatives still require some type of disposal afterwards (incineration/treatment at very high temperatures)
- High capital expenditures – little (if any) return
What is Thermal Recycling®?

- Highest energy delivered into grid
- No landfilling
- Maximum Recycling – 100% recovery
- Most efficient GHG reductions
- Lowest emissions (every 64000 tons of MSW disposed = emissions of one car equipped with a catalytic converter)
- The next step toward a sustainable society
- Model for the European Union and Germany (endorsed by Green Party)
Marketable products of the process:

- Energy in form of electricity and/or steam
- Non-Ferrous Metals
- Ferrous Metals
- Hydrochloric Acid @ 30%
- Gypsum – higher grade than natural
- Salts – for industry use
- Fly & Boiler Ash (1%)
- Bottom Ash / Slag
Flue-gas Cleaning @ MVR
Flue-gases @ MVR

Heavy Metals

- Spec. Concentration [mg/Nm³]

<table>
<thead>
<tr>
<th>Substance</th>
<th>1999 - 2004</th>
<th>License MVR (yearly average values)</th>
<th>17th Ordinance German Emission Control Act</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd + Ti</td>
<td>0.0005</td>
<td>0.003</td>
<td>0.009</td>
</tr>
<tr>
<td>Hg</td>
<td>0.00003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn</td>
<td>0.009</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Flu-gases @ MVR

Dioxins and Furans; As, ..., BaP *)

Spec. Concentration [ng TEF/Nm³]

<table>
<thead>
<tr>
<th>Concentration [μg/Nm³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>0.02</td>
</tr>
<tr>
<td>0.04</td>
</tr>
<tr>
<td>0.06</td>
</tr>
<tr>
<td>0.08</td>
</tr>
<tr>
<td>0.1</td>
</tr>
<tr>
<td>0.12</td>
</tr>
</tbody>
</table>

| 0.001                  |
| 1.7                    |

- emission 1999 – 2004
- license MVR (yearly average values)
- 17th Ordinance German Emission Control Act

*) New emission limit for As, ..., BaP due to an amendment to the 17th German Emission Control Ordinance 2003
## Flue-gases @ MVR

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td></td>
<td>2002</td>
<td>2003</td>
<td>2004</td>
</tr>
<tr>
<td>Particulates</td>
<td>473 kg</td>
<td>4,726 kg</td>
<td>17.0 %</td>
<td>23.6 %</td>
<td>10.0 %</td>
</tr>
<tr>
<td>C&lt;sub&gt;tot&lt;/sub&gt;</td>
<td>509 kg</td>
<td>12,603 kg</td>
<td>3.4 %</td>
<td>3.3 %</td>
<td>4.0 %</td>
</tr>
<tr>
<td>CO</td>
<td>12,375 kg</td>
<td>78,771 kg</td>
<td>13.4 %</td>
<td>14.8 %</td>
<td>15.7 %</td>
</tr>
<tr>
<td>HCl</td>
<td>188 kg</td>
<td>4,726 kg</td>
<td>6.9 %</td>
<td>3.7 %</td>
<td>4.0 %</td>
</tr>
<tr>
<td>NO&lt;sub&gt;x&lt;/sub&gt;</td>
<td>108,098 kg&lt;sup&gt;a&lt;/sup&gt;</td>
<td>157,542 kg&lt;sup&gt;b&lt;/sup&gt;</td>
<td>64.0 %</td>
<td>71.4 %</td>
<td>68.6 %</td>
</tr>
<tr>
<td>SO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>2,758 kg</td>
<td>23,631 kg</td>
<td>31.9 %</td>
<td>13.4 %</td>
<td>11.6 %</td>
</tr>
<tr>
<td>HF</td>
<td>26 kg</td>
<td>158 kg</td>
<td>15.7 %</td>
<td>17.7 %</td>
<td>16.5 %</td>
</tr>
<tr>
<td>Cd/Tl</td>
<td>698 g</td>
<td>3,150 g</td>
<td>22.3 %</td>
<td>23.2 %</td>
<td>22.2 %</td>
</tr>
<tr>
<td>Hg</td>
<td>332 g</td>
<td>31,510 g</td>
<td>1.0 %</td>
<td>1.2 %</td>
<td>1.1 %</td>
</tr>
<tr>
<td>Sb,As,Sn</td>
<td>11.4 kg</td>
<td>78 kg</td>
<td>12.6 %</td>
<td>15.3 %</td>
<td>14.6 %</td>
</tr>
<tr>
<td>As,BaP</td>
<td>2.2 kg</td>
<td>78 kg&lt;sup&gt;2) &lt;/sup&gt;</td>
<td>--</td>
<td>2.7 %</td>
<td>2.8 %</td>
</tr>
<tr>
<td>PCDD/F</td>
<td>1.12 mg</td>
<td>78 mg</td>
<td>6.4 %</td>
<td>2.1 %</td>
<td>1.4 %</td>
</tr>
</tbody>
</table>

<sup>a</sup> incl. ancillary steam generators  
<sup>b</sup> according to limit of 17th Immission Control Ordinance
**Energy from Waste:**
**KC + Seattle approx. 2 million tons MSW**

<table>
<thead>
<tr>
<th>Option:</th>
<th>MW/Basic</th>
<th>MW/Additional</th>
<th>MW/Total</th>
<th>Households supplied with energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>140</td>
<td>N/A</td>
<td>140</td>
<td>140,000</td>
</tr>
<tr>
<td>Reheat System</td>
<td>140</td>
<td>60</td>
<td>200</td>
<td>200,000</td>
</tr>
<tr>
<td>10% Tires added</td>
<td>140</td>
<td>40</td>
<td>180</td>
<td>180,000</td>
</tr>
<tr>
<td>Reheat + Tires</td>
<td>140</td>
<td>40 + 80</td>
<td>260</td>
<td>260,000</td>
</tr>
</tbody>
</table>
Example: Bottom Ash
(not mixed with boiler or fly ash)
Bottom ash ‘up close’
Aging of Bottom Ash

Mineralogical changes during bottom ash-ageing

Raw bottom ash

Bottom ash after 12 weeks of ageing

AREA 1
use without any restrictions

AREA 2
use possible under certain circumstances

AREA 3
use not possible

AREA 1
bottom ash aged for 6 months

AREA 2
bottom ash aged for 1 year

AREA 3
bottom ash aged for 3 years

bottom ash aged for 7 years

AREA 2
use not possible
‘Size Matters’

0.5 to 2 mm  2 to 8 mm  8 to 16 mm  16 to 32 mm
Applications of Bottom Ash

– Construction of roads (big & small)

– Stabilization of road surfaces

– Stable Foundation Base: Container Terminals, Warehouses, Shopping Malls, Office Buildings, Schools, etc...

– Earthwork measures (Noise protection barriers and embankments)
Container-Terminal Altenwerder, Hamburg (3 million TEUs annually)
Application of ash during construction
What the Future Holds

- Oil prices continue to rise
- Energy demands grow
- Climate change will escalate and cost $\text{$$$$$$$$}$
- Continued focus on waste avoidance and recycling
- Environmental opposition will diminish because of common ground interests & compromise
  \[\rightarrow \rightarrow \rightarrow \text{German model}\]
- Thermal Recycling® will play a vital part in achieving recycling and Kyoto objectives
- Cities and counties will set the pace to achieve landfill diversion goals – eventually 100%
How long do we want to continue to “waste” a renewable resource while leaving a legacy of irresponsibility?
German Green Party Statement

Paper for the 2006 Berlin Waste Conference:

• The goal of Green waste management policy is the practical implementation of the idea of the closed substance cycle, which will make the “concept of waste” redundant in future, replacing it with the idea of “resources”.
German Green Party Statement

Paper for the 2006 Berlin Waste Conference:

- Not only can the sorting residues that are left over be used to generate energy in waste incineration plants operated to very high standards, the by-products of waste incineration can also be reused.
- Slags are now attaining levels of quality that permit at least their limited emplacement without protective measures, for example in road construction.
- The reusable products of waste incineration include high-quality hydrochloric acid and gypsum for use in the construction materials industry.
Today

• Political environment (example Sacramento)
  – At stalemate with environmentalists
  – No direction
  – No compromises
  – Industrial Concerns
  – City of LA – a new approach?
Today

- WTE
- Landfill
- Recycling
- Public/Consumer
- No Solution
- Energy Producer
- Government
- Environmental Orgs.
- Industry
Environmental Demands:

1) No competition with recycling √
2) No harmful emissions √
3) Oil independence √
4) Energy recovery √
5) No landfilling √
6) Economic performance √
7) Protection of natural resource √
8) Respecting the rights and existence of future generations √

Total Score: 100% = Passed √
Approach

• Need for new policy
• Paradigm shift
• Stepping outside the “Box”
• Political leadership
• Offering Thermal Recycling® as a part of the solution not “The Solution”
Today?

- WTE
- Landfill
- Recycling
- Public/Consumer
- Energy Producer
- Government
- Environmental Orgs.
- Industry

Compromise
Final Thoughts

• We need to continue our efforts to minimize waste production
• Not all waste produced can be recycled
• But we should not waste our waste - it is too valuable
• Landfilling is neither environmentally responsible nor is it economical – All we do is leave future generations a legacy of irresponsibility!
“If you are not part of the solution you are part of the problem”

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