Thermal treatment of waste in Greece

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• Constraints of WtE projects in Greece
• Opportunities and best practices: Biomass
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Introduction

Thermal treatment of waste

Waste to energy:
1. Incineration of Municipal solid waste
2. Incineration of RDF

Biogas – landfill gas utilization

Waste to Energy plant in Vienna (en.wikipedia.org)
Recent development and trends

Trends in [Unit] x 10^3 from 1986 to 2016

- 1986: [Value]
- 1996: [Value]
- 2006: [Value]
- 2016: [Value]

Skordilis, 2006
Waste management in Greece

No incineration in Greece
Example of a WtE plant in Greece for MSW

1983
Small-scale WtE plant to serve Zakinthos

Construction cost: funded 100% by EEC
Operational cost: Local authorities (to undertake…)
MSW at that time: high water content, low heat value; no business plan!
- Addition of oil (by the bucket!)
- The plant operated just for 3 months!
Consideration of WtE in Greece

Mid – 90s – Island of Santorini

Estimated capacity: 15,000 t/year.
- Plant was to operate 6-7 months/y;
- for the remaining months: balling of waste.
- Plant was not constructed due to (allegedly):
  > High operational cost,
  > Political myopism; institutional missing capacity
  > Limited experience on such projects
## Consideration of WtE in Greece – Construction cost of WtE plants in Europe

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Capacity (t/year)</th>
<th>Construction cost (million €)</th>
<th>Construction cost (€/t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kempten, Germany</td>
<td>1996</td>
<td>78,000</td>
<td>82</td>
<td>1.051</td>
</tr>
<tr>
<td>Pirmasens, Germany</td>
<td>1998</td>
<td>155,500</td>
<td>189</td>
<td>1.215</td>
</tr>
<tr>
<td>Hamburg R. Damm, Germany</td>
<td>1999</td>
<td>225,000</td>
<td>140</td>
<td>622</td>
</tr>
<tr>
<td>Niklasdorf, Austria</td>
<td>2003</td>
<td>100,000</td>
<td>55</td>
<td>550</td>
</tr>
<tr>
<td>Freiburg, Germany</td>
<td>2005</td>
<td>150,000</td>
<td>77</td>
<td>513</td>
</tr>
<tr>
<td>Zorbau, Germany</td>
<td>2005</td>
<td>300,000</td>
<td>100</td>
<td>333</td>
</tr>
<tr>
<td>Antwerpen, Belgium</td>
<td>2005</td>
<td>400,000</td>
<td>180</td>
<td>450</td>
</tr>
<tr>
<td>Ringaskiddy, Ireland</td>
<td>2007</td>
<td>100,000</td>
<td>75</td>
<td>750</td>
</tr>
<tr>
<td>Garranstown, Ireland</td>
<td>2007</td>
<td>150,000</td>
<td>85</td>
<td>567</td>
</tr>
<tr>
<td>Halle, Germany</td>
<td>2007</td>
<td>80,000</td>
<td>47</td>
<td>588</td>
</tr>
<tr>
<td>Amsterdam, Holland</td>
<td>2006</td>
<td>500,000</td>
<td>340</td>
<td>680</td>
</tr>
<tr>
<td>Posieux, Switzerland</td>
<td>2006</td>
<td>45,000</td>
<td>20</td>
<td>444</td>
</tr>
<tr>
<td>Roosendaal, Holland</td>
<td>2007</td>
<td>180,000</td>
<td>90</td>
<td>500</td>
</tr>
<tr>
<td>Urvier, Switzerland</td>
<td>2007</td>
<td>60,000</td>
<td>30</td>
<td>500</td>
</tr>
<tr>
<td>Barzenheit, Switzerland</td>
<td>2008</td>
<td>40,000</td>
<td>30</td>
<td>750</td>
</tr>
</tbody>
</table>

(Psomas, 2005)
In comparison: Landfilling in Greece is still in some areas charged (but not really costs, of course): 5 – 20 €/t!
Waste derived fuel - Terminology

RDF (Refuse Derived Fuel)
REF (Recovered Fuel)
PPF (Paper and Plastic Fraction)
PEF (Processed Engineered Fuel)
TDF (Tire Derived Fuel)
PDF (Packaging Derived Fuel)
SRF (Solid Recovered Fuel)

RDF Pellets
RDF Production in Greece (existing, foreseen, potential)

MBT at Ano Liossia:

RDF capacity: 350 t/day
Location of potential RDF consumers in Greece

<table>
<thead>
<tr>
<th>Nr</th>
<th>Name</th>
<th>Location</th>
<th>Number of furnaces</th>
<th>Capacity</th>
<th>Fuel type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AGET</td>
<td>Portaria</td>
<td>4</td>
<td>3.3 $10^6$ t Clinker 4.3 $10^6$ t Cement</td>
<td>750,000</td>
</tr>
<tr>
<td>2</td>
<td>AGET</td>
<td>Avlida</td>
<td>2</td>
<td>2.5 $10^6$ t Cement</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>AGET</td>
<td>Milaki</td>
<td>1</td>
<td>1.6 $10^6$ t Clinker 1.7 $10^6$ t Cement</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>TITAN</td>
<td>Kamari</td>
<td>2</td>
<td></td>
<td>550,000 t Pet coke and bituminous coal 8,000 t TDF 10,000 t Tank residues with sawdust</td>
</tr>
<tr>
<td>5</td>
<td>TITAN</td>
<td>Efkarpia</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>TITAN</td>
<td>Drepano</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>TITAN</td>
<td>Elefsis</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CHALIPS</td>
<td>Aspropirgos</td>
<td>1</td>
<td>10$^6$ t Cement</td>
<td>80,000 t</td>
</tr>
</tbody>
</table>
One tonne RDF may replace approximately 2.6 tonnes of lignite.
RDF supply-demand scenarios

1st scenario (replacement of 4% of conventional fuel by RDF at cement plants, supply from MBT at Ano Liossia)
2nd scenario (replacement of 4% of conventional fuel by RDF at cement plants and 0.3% of lignite at power plants, supply from MBT at Ano Liossia and Thessaloniki)
3rd scenario (replacement of 5% of conventional fuel by RDF at cement plants and 0.5% of lignite at power plants, supply from MBT at Ano Liossia and MBTs at Thessaloniki, Kozani, Patra, Crete and Imathia)

Key parameters: Logistics, quality, social acceptance, mono-/oligo-polistic market situations, cost transparency
Landfill gas utilization

- 45 constructed sanitary landfills.
- 56 at various stages of licensing and construction.

LFG utilization:
- Ano Liosia: 13.9 MW_e.
- Tagarades: 5 MW_e.
Landfill gas utilization

Tagarades (Grossraum Thessaloniki): 5 MW<sub>e</sub>

Ano Liossia (Grossraum Athen): 13.9 MW<sub>e</sub>
Sanitary landfill at Ano Liosia

- Largest disposal site in Greece (probably among the 3 largest in the EU). Continuous extensions.
- Surface: 870,000 m².
- Period of operation: 35 years (1973 – 2008) already, up to…?
Ano Liossia biogas plant (landfill)
Psittaleia biogas plant (WWTP)

Quelle: EYΔΑΠ
### National energy potential from animal farming

<table>
<thead>
<tr>
<th>Quellen</th>
<th>Einheiten</th>
<th>Kapazitaeten</th>
<th>Abfaelle t/year</th>
<th>Leistung (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle farms</td>
<td>32.875</td>
<td>727.040 cattle</td>
<td>14.540.800</td>
<td>278</td>
</tr>
<tr>
<td>Big farms</td>
<td>36.593</td>
<td>140.645 pig-‘mothers’</td>
<td>2.268.220</td>
<td>37</td>
</tr>
<tr>
<td>Slaughterhouses</td>
<td>101</td>
<td>77.242 t/year (cat 2)</td>
<td>204.932</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>127.690 t/year (cat 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese producers</td>
<td>548</td>
<td>160.362,4 τ/y for production</td>
<td>425.647</td>
<td>7,21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>447.705,2 τ/y production</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>17.439.599</strong></td>
<td><strong>350,21</strong></td>
</tr>
</tbody>
</table>
Animal waste potential (source: CRES)

17 Mtons/year cattle and pig slurries

315 MW

Cattle breeding mainly northern Greece (Thessaloniki, Pella)

Pig breeding equally distributed over Greece

Poultry farming mainly in three regions
Incineration of medical waste: 3,500 t/year.
Production of medical waste in Attiki: 7,000 t/year
Rest: Hydroclave (as well as in rest of country)
Incineration of medical waste in Attiki: problems in collection and transportation

- Sharp items in bags.
- Leakages.
- Radioactive materials.
- Excessive weight of waste in packages.
- Inappropriate temporary storage rooms

Kouloumoundras, 2007
Collection and transportation issues
Kiln operation
Barriers of Waste to Energy projects in Greece (1/2)

- History barrier.
- Political barrier.
- The landfill dependence and cost barrier.
- A new WtE lobby…

MBT at Ano Lioissia (Skordilis, 2006)
Barriers of Waste to Energy projects in Greece (2/2)

- The Waste Management Authorities barrier.
- The RDF market barrier (quality, demand).
- The national legislation and public administration barrier.

RDF at Ano Liossia
(Skordilis, 2006)
Conclusions (1/4)

• Currently landfilling is unfortunately still the prevailing waste management option in Greece.

• Therefore, LFG-to-energy projects are of interest (also in a rising local LFG management market) and partly already implemented.

• Beside LFG, engineered thermal treatment is applied only on medical wastes and (also for energy recovery) certain types of biomass.
There are various reasons (or, rather, excuses, of also varying significance and technical seriousness) which still hinder the construction and operation of mass-burn WtE facilities. Most ‘important’ ones:

- High construction and (mainly) operational costs (in comparison to still very cheap landfilling and absence of strict PPP and PAYT schemes).
- Disamenity / mistrust of general public (historic / cultural…).
- Perception of (less) environmental impacts (fading excuse) and (more) technical failures (floating excuse, no matter what the guarantees…also from academics and NGOs).
- Negative experience of a (old, over 20 years ago…) badly planned WtE project in Zakinthos (fading excuse).
• Compared to MSW, RDF/SRF is currently promoted by certain actors in Greece as a ‘silent WtE substitute’ to overcome public opposition.

• Significant numbers (and total capacity) of RDF potential consumers.

• It was thought that fewer barriers were to overcome in comparison to MSW incineration. This seems to change.

• A new MBI era seems to rise on a political and social level (tbc in praxis) both in Greece’s mainland and to the islands.

• There is still registered opposition of residents and NGOs against co-combustion of RDF in cement plants.

• Milder paths are implemented also by the cement industry (e.g. biomass) …
Conclusions (4/4)

- Key RDF parameters:
  - Logistics (collection, pretreatment),
  - Quality (standards, market value, certification),
  - Social acceptance (around receivers, not producers) and security of supply,
  - Mono-/oligo-polistic market situations (receivers),
  - Cost transparency (to pay or to be paid?).

- Rising market: Paper industry

- Showcases: >100 SME-scale (mostly agro-) industrial facilities are combusting biomass and organic residues for energy recovery since the 1970’s.
Rice husk WtE plant (industrial area of Thessaloniki).
Waste-wood EfW facility (Akritas co) in Evros
Waste-wood EfW facility (Shellman co) outside Thessaloniki
Concluding remarks

- End-of-waste criteria and mentality in the WtE field (renewable energy, additional material recovery)
- Basic milestone: Streamline the permitting procedure (not to reach crisis situations)
- Extensive small-scale and long-term know-how from numerous industrial biomass applications.
- MBI in Greece:
  - Last EU case with no MBI for MSW. For how much longer?
  - A recent public survey in Thessaloniki presented from AUT on 13.10.2008 indicated a significant pro-WtE shift of public opinion in Thessaloniki compared to landfilling.
Thank you for listening