SYNERGIA
Waste-to-Energy Research and Technology Council

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WASTE MANAGEMENT IN GREECE & POTENTIAL FOR WASTE - TO - ENERGY

ISWA Beacon Conference - Strategic Waste Management Planning in SEE, Middle East and Mediterranean Region
The Waste-to-Energy Research and technology council (SYNERGIA, www.wtert.gr) was founded on July 2008 with founding members

- The Earth Engineering Center of Columbia University, New York
- Members of the Thermodynamics and Transport Phenomena Laboratory, School of Chemical Engineering, National Technical University of Athens (N.T.U.A)
- Members of the Laboratory of Heat Transfer and Environmental Engineering, Department of Mechanical Engineering of the Aristotle University of Thessaloniki (A.U.TH.)
- The Greek Company INTRAKAT
Members also include:

- Confederation of European Waste-to-Energy Plants / CEWEP (380 of the 432 European waste to energy plants)

- Professors from various Greek and Foreign Universities

SYNERGIA is a member of the International Solid Waste Association / ISWA
A close collaboration of academic, research, public and industrial organizations will help Greece develop thermal treatment of waste (waste-to-energy WTE) with:

- Sustainable waste management
- Conservation of the precious Greek land for future usage
- Empowerment of the energy balance of the Country

SYNERGIA has the expertise to monitor all environmental aspects of WTE projects (emissions, control of bottom and fly ash)
Recent Presentations of SYNERGIA

- 29/1/09: Presentation to the Special Permanent Council of Environmental Protection of the Greek Parliament
- 20/3/09: Presentation to the Rhodes Municipalities for the construction of WTE plant on the island
- 5/5/09: SYNERGIA Conference in Kozani
- 19/5/09: Presentation on 17th NAWTEC, USA
- 19/6/09: 1st SYNERGIA FORUM in Athens
- 30-31/10/09: 7 Presentations on the 3rd International Conference of the Hellenic Solid Waste Management Association
- 11-12/11/09: 2 Presentations on the 14th National Conference of the Institute of Energy for South-East Europe
On the 17th of June 2008 the Environmental Committee at European Parliament decided that efficient waste to energy, is an energy recovery process.

During 2007 in Europe over 65 million tones of waste were treated thermally.
Waste Management in Greece

- Landfilled: 84%
- Recycled: 14%
- Composting: 2%
- Incinerated: 0%

*Eurostat 2007
Waste management in Greece **depends heavily on sanitary landfill sites**
In Greece there are still **411 illegal dump sites**
In Greece there are 5 Mechanical Biological Treatment plants
1. Ano Liossia (Athens)
2. Chania (Creta)
3. Heraklio (Creta)
4. Kefalonia
5. Kalamata
Recycling in Greece is based on communal collection points (blue containers), especially in major cities.

The collected packaging materials, are separated into the Recycling Sorting Centers and are driven to recycling.
It is instantly obvious that in the E.U. recycling is excellently combined with waste to energy, whereas in countries where landfill is dominant, recycling and waste to energy are lagging behind.
According to the European Union legislation for sanitary landfills 1999/31 only residues of waste management can be disposed to landfills, whereas by 2020 there will be a gradual reduction of the biodegradable fraction that is landfilled.

According to the European Union directive 2000/76 (harmonization 22912/2005 for Greek legislation) the emission limits (mg/Nm³) of Waste to Energy plants are set.

On the 19th of November 2008 according to the EU directive 2008/98, WTE is upgraded in the hierarchy of Solid Waste Treatment in Europe.
According to Greek Legislation L. 3468/2006, “…the biodegradable fraction of industrial and municipal solid waste” is considered biomass, thus R.E.S.

According to data from CEWEP, the fraction of waste considered as R.E.S. from the following countries is:

- France: 50%
- Holland: 47%
- Switzerland: 50%
- U.S.A.: 66%
- Denmark: 80%
Methods of thermal treatment of waste

➡ Gasification: Very energy intensive, not available yet on a commercial scale, untested in municipal solid waste. Very few units of low capacities operational. Plasma gasification shows much more promise but lacks reference.

➡ Pyrolysis: Hasn’t been used efficiently in municipal solid waste.

➡ Incineration: Proven, dominant, tested on a large scale (over 600 units worldwide), efficient, waste management process.
Thermal treatment of waste with energy recovery (Waste to Energy, WTE)

- Incineration plant producing 500-650 kWh/ton of post recycled municipal solid waste.

- With the incineration of 1 ton of waste we save 1 ton of lignite.
1) **MSW Feed**: Daily Arrival of 1,200 ton. of municipal solid waste, 80 trucks in 10 unloading points.

2) **MSW warehouse**: The MWS storage has a capacity of 15,000 m³ for around 8,000 ton. In that point the mixing of the MSW from the crane handler and the feed in the hopper of the combustion chamber, are taking place.

3) **Combustion grates**: The thermal treatment is taking place in water-cooled combustion grates (or air-cooled), with a capacity of 20 ton/hr/line.

4) **Boiler**: The hot exhaust gases produce the steam.

5) **Flue-Gas Cleaning System**: The major systems are scrubbers, electrostatic filters, bag filters and cyclones, activated carbon filters, chemicals (like NH₃, CaO, Ca(OH)₂...).

6) **Mixing of CaO and activated carbon**: This mixing is taking place within the WTE Plant in the Flue-Gas Cleaning System.

7) **Emissions/Chimney-Stack**: On Line emissions measurement with state of the art equipment for dioxins, furans, PAHS, etc., in the exhaust gases and in the wastewaters of the process, according to the EU Directive 2000/76 for the protection of the Environment.

8) **SteamTurbine & Generator**: The produced thermal energy is converted to electricity or teleheating.

9) **Bottom ash**: The solid waste after incineration (bottom ash) is disposed to sanitary landfill or reused as additive in construction activities and in roads.

10) **Fly ash**: stabilization and deposit in underground mines (treatment as hazardous waste).
WTE Plant
Efficiency Formula R1-2008/98/EU

\[
R1 = \frac{E_P - E_F - E_I}{0.97 \cdot (E_F + E_W)}
\]

According to the 2008/98 EU directive, a WTE plant should overcome the following limits, in order to be considered an energy recovery procedure:

➢ For plants constructed before 31/12/2008, R1 > 0.60

➢ For plants constructed after 1/1/2009, R1 > 0.65

A hypothetical Greek WtE plant with a capacity of 300,000 tpa, could produce 25 MWe, having an efficiency of 26.5% & R1 = 0.697
According to CEWEP, $R1 > 0.65$ is achievable even with exclusive electrical production application.
Energy recovered from thermal treatment of waste contributes to the reduction of greenhouse gases in two ways:

1. Prevents the production of methane CH₄ (21 times more potent greenhouse gas than CO₂) and other emissions from landfill sites
2. Emits less CO₂ compared to fossil fuels which it replaces (i.e. lignite)

In thermal treatment processing plants it is possible to co-incinerate industrial waste with similar composition to municipal waste, sludge from biological treatment and biomass.
Emissions from the Brescia plant, Italy

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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter</td>
<td>10</td>
<td>3</td>
<td>10</td>
<td>0.4</td>
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<tr>
<td>Sulphur Dioxide</td>
<td>150</td>
<td>40</td>
<td>50</td>
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<tr>
<td>Nitrous Oxides (NOx)</td>
<td>200</td>
<td>100</td>
<td>200</td>
<td>&lt;80</td>
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<tr>
<td>Hydrochloric Acid (HCl)</td>
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<td>3.5</td>
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<td>Hydrofluoric Acid (HF)</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>Carbon Monoxide</td>
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<td>40</td>
<td>50</td>
<td>15</td>
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<td>Heavy Metals</td>
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<tr>
<td>Cadmium (Cd)</td>
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<td>0.05</td>
<td>0.002</td>
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<tr>
<td>Merucy (Hg)</td>
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<td>0.02</td>
<td>0.05</td>
<td>0.002</td>
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<tr>
<td>Polycyclic Aromatic Hydrocarbon (PAH)</td>
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<td>0.01</td>
<td>0.05</td>
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<tr>
<td>Dioxin (TCDD Teq)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.002</td>
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</table>
Thermal treatment of waste with energy recovery (Waste to Energy, WTE)

Dioxin Emissions, Germany 1994-2000

Source: Richter, S., Johnke, B.: Status of PCDD/F-emission control in Germany on the basis of the current legislation and strategies for further action; Chemosphere 54 (2004) 1299-1302
Reduction of mercury emissions from WTE
**Bottom Ash**

- Aggregate on asphalt (France, United Kingdom, USA)
- At landfills as a covering material (partial replacement of daily coverage dirt)

**Fly Ash**

- Added to cement
- Filling in salt mines and quarries (soil stabilization)
- Usage in road construction (Germany)
- Neutralization of acid wastes (i.e. Titanium Industry in Norway)
- Construction material (gravel for concrete and blocks of pulverized ash, Holland)
<table>
<thead>
<tr>
<th>Proposal</th>
<th>Capacity (tpa)</th>
<th>Residual (tpa)</th>
<th>Electricity Power Production (MW)</th>
<th>Inhabitants for electricity supply</th>
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</thead>
<tbody>
<tr>
<td>Proposal 1</td>
<td>400.000 MSW</td>
<td>80.000</td>
<td>35</td>
<td>150.000</td>
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<td>Proposal 2</td>
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<td>60</td>
<td>250.000</td>
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<td>Proposal 3</td>
<td>700.000 MSW + 300.000 SRF/RDF</td>
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</table>
1. Gate fee:
   - Large WtE plants: 60 - 80 € per tone
   - Sanitary landfill cost: 40 - 60 € per tone
   - As it is obvious the cost per capita in case of WtE method will be raised from 25 € per annum to 30 € per annum, by having solved the waste management in Greece

2. Compensative benefits for Municipalities:
   - Electricity production
   - Steam supply for district heating and/or district cooling
Conclusions

SYNERGIA as the first scientific and research council in Greece recommends for WTE:

- To develop an integrated recycling system based on recycling and composting at the source. To stay away from mistakes and omissions from the past.

- To implement the environmentally friendly and energy efficient thermal processing of municipal solid waste.

- To follow the proven and dominant practice of our European fellows and adopt waste to energy through incineration.
Conclusions

- The technology of thermal treatment with energy recovery is used in more than 432 plants across Europe, located even inside European capitals, which in combination with recycling at the source, consists of an integrated and proven waste management practice.

- The European Green Capitals (Stockholm, Copenhagen, Hamburg) use a combination of recycling at the source and thermal treatment with energy recovery.

- Thermal treatment methods “contribute to the prevention of the climate change” according to the conclusion paper of the Special Permanent Council of Environmental Protection of the Greek Parliament, as SYNERGIA presented in a session of this council on 29th January of 2009.
Examples of WtE plants – Photographs

Spittelau - Vienna
Examples of WtE plants – Photographs

Brescia - Italy
Examples of WtE plants – Photographs

Oreade – Le Havre France
Examples of WtE plants – Photographs

“Isséane” Plant - Paris
Isséane Waste to Energy Plant/WTE, Paris

“Isséane” Plant - Paris
Examples of WtE plants – Photographs

Alkmaar WTE, Netherlands
Examples of WtE plants – Photographs

Isle of Man
Examples of WtE plants – Photographs

Uppsala, Sweden