STEPS FORWARD IN ENERGY-UPGRADING OF WASTE TO ENERGY PLANTS (WTE)

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Middle East Waste Summit

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President C.E.O.
1. Actual Developed Societies with waste production uncontrolled and obsolete energy models are causes of climate change.

2. Security of Supply an important issue in many countries.

3. Future models need also to comply with the adequate environmental requirements, low greenhouse gas emissions and with real energy efficiency models.

4. European Waste Directive considers energy valorization (WTE) in a higher step level than landfills, so countries should take advantage of the energy contained in waste before landfill disposals.

5. Waste a Renewable Energy. Waste is not a problem is part of the solution.

6. SENER, considering future society needs has developed and patented, in the waste area, technologies that will have positive effects to fulfill the needs, as SENER-2 and SENER-4 processes.
STEPS FORWARD IN ENERGY-UPDRADING OF WASTE TO ENERGY PLANTS (II)

SENER-2 System (Patent): Is an adaptation of technology at modern combined-cycle plants to waste upgrading-plants

SENER-2 is a unique and integrated process
Plant: ZABALBARGI
STEPS FORWARD IN ENERGY-UPGRADING OF WASTE TO ENERGY PLANTS (III)

SENER-4 system (patent): Is a high efficiency innovative technology applied to conventional Waste To Energy Plants.

SENER-4 is a unique upgraded Waste to Energy Technology Plant: Under development (Robust-Proven Technologies)
SENER-2 (Zabalgarbi Plant)

Location: Bilbao (Basque Country) Spain
SENER-2 (ZABALGARBI PLANT)

TECHNICAL DETAILS

- Operation: 8,000 h/year
- Type of waste: Municipal solid and assimilable waste
- Nº Lines: 1 (30 t/h) 2 (under development)
- WTE incineration boiler 110 t/h
  steam – 106 bar 328 °C
- Processing capacity: 230,000 – 250,000 t/year
SENER-2 (Zabalgare Plant)
Rated power installed: 99.5 MW

- **Steam turbine:** 56.5 MW of average gross capacity, condensing, reheat, 96/20 bar, 539/539 °C
- **Gas turbine:** 43 MW of average gross capacity. Fuel: natural gas with intake air cooling (chiller)
- **Production of electricity:** 730 - 760 GWh / year, net
WTE conventional plants

Generating steam to power a turbo-generation unit.

- Restrictions on steam conditions:
  - Temperature: 400°C
  - Pressure: 35 - 40 bar
- Low energy output.
  - 30 t/h of municipal waste >>> 12 MW
Restrictions on steam conditions:

- Temperature: 540ºC
- Pressure: 100 bar

Energy output.

- 125,000 toe LHV/h >>> obtain a net output of around 72.5 MW
Comparison energy outputs WTE upgrading process.

30 t/h of municipal waste > 12 MW + 125,000 toe LHV/h > obtain a net output of around 72.5 MW = 84.5 MW

- Zabalgarbi: 30 t/h of municipal waste + 125,000 toe LHV/h > 95 MW

The new SENER-2 patented process obtains an extra 10.5 MW

Waste upgrading system: it is a unique process
Advantages of the SENER-2 Process.

- Overall net plant efficiency around 47%.

- The process has an electric efficiency of 60% in its normal operation mode which provides an efficiency superior to conventional MSW energy-upgrading systems.

- In other words, the extra power output represents an increase of 87.5% of the energy produced by a conventional MSW plant with the same capacity.

- Improved output with respect to other MSW upgrading plants has likewise been acknowledged by the European Union: the D.G. XVII of the European Commission granted the maximum distinction for this type of project on the Thermie programme (efficiency and savings programme) for Zabalgarbi plant. (SENER-2).
Other general characteristics

- Reducing emissions of CO\textsubscript{2} per kWh generated. Avoided CO\textsubscript{2} 275,000 tn/year.

- Improvements in operating conditions – reduced corrosion in furnace by reducing temperature.

- The size of a plant such as Zabalgarbi combines a MSW processing capacity of around 230,000 - 250,000 t/year, and a net installed electricity generation capacity of about 95 MW. Net production of electricity will be around 730/760 million kWh per year.
SENER-2 — Operation modes

Following operation modes are feasible:

(Flexibility)

- Mode A: Normal Operation
- Mode B: Combined Cycle Operation
- Mode C: Fresh air mode
- Mode D: Incineration and gas turbine through bypass stack
- Mode E: Gas turbine through bypass stack
- Mode F: Incineration only
- Mode G: Shutdown
SENER-2 (ZABALGARBI PLANT)

Boiler and Flue Gas Cleaning System
Flue Gas Cleaning System:

- **Control of combustion** (850°C, 2 seconds)
- **Reduction of NOx** (ammonia injection and flue gas recirculation)
- **Acid Gases** (SO₂, HF, HCl) scrubbing by spray drier with lime injection
- Elimination of heavy metals, dioxins - furans, and other pollutants by adsorption via active carbon injection
- **Bag filter** – for dust removal
- **Monitoring** and control of parameters for emissions into the atmosphere.
## Emissions from combustion of the WTE

<table>
<thead>
<tr>
<th>Emissions_{2008}</th>
<th>ZABALGARBI(_1) (mg/N m(^3))</th>
<th>UE emission limits(_2) (mg/Nm(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dioxins - Furans:</td>
<td>0,0031 (ng TEQ/N m(^3))</td>
<td>0.1 (ng TEQ/Nm(^3))</td>
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<tr>
<td>NOx</td>
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<td>Particulates</td>
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<td>HCl</td>
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<td>SO(_2)</td>
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<tr>
<td>Cd+Tl</td>
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</tr>
</tbody>
</table>
Environmental surveillance

Inmission

- Three air quality Stations: Arraiz (Bilbao), Alonsotegi and Larrazabal
- Soil and vegetation sampling.
- Surface water sampling.
- Continuously updated parameters (air): PM10, O3, NOx, SO2, COV, HCl, Meteorological tower.
SENER-2 (Zabalgarbi Plant)

- **Solid by-products (2008)**

- **Bottom ash. Considered to be inert. It accounts for 18,6 % in weight and around 8% in volume of incoming WTE.**

- **Ferric scrap material: 2,40 %**
Fly ash and flue gas cleaning residues represent about 3.7% in weight and less than 1% in volume of the MSW.

The residues collected undergo an inertisation process in order to stabilise any heavy metals they may contain and to prevent leaching and, finally, are confined in a secure authorized storage facility.
• In simple steam cycles in electrical generating plants the gross efficiency 25-30%.

• Applying higher pressure measurements in boilers, preheatings (10 stages) and reheatings (1-3), gross efficiency > 40%.

• Today’s boilers can reach 300 bars and temperatures >600ºC. Efficiencies are above 45%.

• In WTE plants corrosion limits should be considered in the boiler steam. Temperatures limitations for Boilers normally applied (≠ 400ºC) to prevent corrosion on tubes (Flue Gas Considering the limitations, applying moderated boiler steam temperatures, reheatings, Side) regenerative water preheatings, efficiencies >32%. Applying additional measurements SENER processes) efficiencies > 36%.

• SENER – 4 cycle has the advantages of moderate temperatures, which limits corrosion effects, and the latest technologies applied in reheatings an regenerative preheatings that allows higher efficiencies.
Technical details

- **Operation**: 8,000 h/year (Minimum)
- **Type of waste**: Municipal solid and assimilable waste (9100 kj/kg)
- ** Nº Lines**: 2 x 25 t/h
- **WTE incineration boiler**: 2 x 85 t/h steam
  - 92 bar, > 330 °C
- **Processing capacity**: 400,000 t/year
- **Thermal Gross Power**: 132 MWₜ
- **Electric Gross Power**: 46.2 MWₑ
- **Avoided CO₂**: 279,000 Tn/year
SENER-4 PROCESS

- In this cycle steam is generated in the waste boiler at a high pressure and moderate $T^a$, that will avoid accelerated corrosion in hottest parts of the boiler tubes.

- The design of the Thermal Cycle allows a higher efficiency (> 35%) and significant higher electric generation.
GREENHOUSE EFFECT

kTon CO₂ / Year for 240 kTn MSW/Year

Avoided CO₂ emissions

Direct CO₂ emissions

Landfill

LANDFILL without biogas engines
LANDFILL with biogas engines
MGe conventional
SENER 4
SENER 2
Thank you for your attention

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