Energy from Waste and other Opportunities in GCC

Company Presentation
Hitachi Zosen Inova

Waste is our Energy

- Energy and material from waste solutions
- In-house turnkey & system solutions
- Operation, maintenance & service business
- 600+ employees in Switzerland, USA & UK
- More than 520 reference projects worldwide
- A Hitachi Zosen Corporation Subsidiary
  - 9,000+ employees
  - Environmental systems, industrial plants, infrastructure & precision machinery

Hitachi Zosen Locations

[Images of various industrial facilities]
More than 80 Years Experience in EFW Plants
More than 500 Projects built

1881
Establishment of Osaka Iron Works

1933
Construction of first waste incineration plant in Dordrecht, Netherlands

1937/39

1960
Beginning of long-term partnership

1965
deRoll-type grate incinerator completed for Osaka municipality

2010
Since December 20th a company of Hitachi Zosen Corporation
HZI is number 1 with a three year average market share of 34.4%

**Market Shares by Suppliers**

2014

- **HZI**: 59.0%
- **Vølund**: 20.1%
- **Energos**: 7.7%
- **Andritz AE&E**: 8.0%
- **Termomeccanica**: 2.0%
- **Valmet**: 3.2%

Total: 5'623 tpd

2012-2014

- **HZI**: 34.4%
- **CNIM (Mortle grate)**: 7.2%
- **Vølund**: 12.8%
- **Energos**: 4.4%
- **Andritz AE&E**: 1.7%
- **Valmet**: 2.0%
- **Termomeccanica**: 2.6%
- **Doosan Lenlies**: 2.6%
- **Westinghouse Altec NRG**: 4.2%
- **Martin**: 3.3%

Total: 25'923 tpd

Technology to be introduced

1. Waste to Energy (WtE)
2. Organic Waste to Biogas (Anaerobic Digestion)
3. Desalination
Energy from Waste
Transformation of Waste into Electricity

1t municipal solid waste

= Energy content of 1.8 Barrel Oil

= Generates 800 kWh electricity

= 123 m3 drinking water

Waste @ 10 MJ/kg
How it Works: Example Ferrybridge UK

<table>
<thead>
<tr>
<th>Fuel reception and storage</th>
<th>Combustion and boiler</th>
<th>Flue gas treatment</th>
<th>Energy recovery</th>
<th>Residue handling and treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Tipping hall</td>
<td>5 Feed hopper</td>
<td>12 Ammonia injection</td>
<td>18 Turbine</td>
<td></td>
</tr>
<tr>
<td>2 Shredder</td>
<td>6 Ram feeder</td>
<td>13 Semi-dry reactor</td>
<td>19 Turbine building</td>
<td></td>
</tr>
<tr>
<td>3 Solid fuel bunker</td>
<td>7 HZI grate</td>
<td>14 Fabric filter</td>
<td>20 Air-cooled condenser</td>
<td></td>
</tr>
<tr>
<td>4 Solid fuel crane</td>
<td>8 Primary air</td>
<td>15 Induced draft fan</td>
<td>21 Transformer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 Secondary air</td>
<td>16 Silencer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Five-pass boiler</td>
<td>17 Stack</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 Economiser</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key Figures
- 2 process trains, one turbine
- Waste capacity 2 * 31.3 t/h
- 1’500 t/d, 500’000 t/a
- Thermal capacity 2 * 117.4 MW

Energy Efficiency
- Net Electrical efficiency: 29%
- Calorific value of waste 16.5 MJ/Kg (max)
- Net Electrical output 1’100 kWh / t of waste
Project Finance Structure
Public Private Partnership / BOT, BOOT, BOO,....

- SPC Owned by Project Sponsor
- SPC Acting as borrower
- Equity to be provided by project sponsor/municipality

- Debt Financing: Covered loan facilities provided by bank consortium
- Transfer of SPC/Plant to Municipality after concession period
Hitachi Zosen is the global leader in EfW
More than 500 references

Thun, Switzerland

London, United Kingdom

Paris, France

Osaka, Japan
Maishima - Osaka
EfW Plant: High Efficiency for Large Cities

Riverside, United Kingdom

- Client: Riverside Resource Recovery Ltd.
- Start-up: end of 2010
- Technology:
  - Furnace: Grate furnace (air-cooled)
  - Energy recovery: 4-pass boiler, turbine
  - Flue gas treatment: SNCR, semi-dry process
- Technical Data:
  - Fuel: Municipal waste
  - Waste capacity: 585,000 t/a (3 x 31.8 t/h)
  - Net calorific value: 9.0 MJ/kg
  - Thermal capacity: 3 x 79.5 MW
  - Steam: 3 x 54 t/h (72 bar, 427° C)

- Largest EfW facility in the UK
- Hitachi Zosen Inova as full turnkey contractor including jetty and road works
- 80% of waste delivery via barges from Thames River
- Highly efficient plant at higher steam conditions
- **Steam goes to 73 MWel turbine**
- Plant operation during first 4 years carried out by Hitachi Inova Zosen
EfW Plant Riverside: Aerial View
## EfW Plant: Urban Integrated Infrastructure

**Issy-les-Moulineaux (Paris), France**

<table>
<thead>
<tr>
<th>Client</th>
<th>SYCTOM Paris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up</td>
<td>2007</td>
</tr>
<tr>
<td>Technology</td>
<td></td>
</tr>
<tr>
<td>Furnace</td>
<td>Grate furnace (water-cooled)</td>
</tr>
<tr>
<td>Energy recovery</td>
<td>4-pass boiler, turbine</td>
</tr>
<tr>
<td>Flue gas treatment</td>
<td>Dry with bicarbonate, ESP, fabric filter with coke injection, SCR</td>
</tr>
</tbody>
</table>

### Technical Data

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Municipal waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste capacity</td>
<td>460,000 t/a (2 x 30 t/h)</td>
</tr>
<tr>
<td>Net calorific value</td>
<td>10 MJ/kg</td>
</tr>
<tr>
<td>Thermal capacity</td>
<td>2 x 85.1 MW</td>
</tr>
<tr>
<td>Steam</td>
<td>2 x 100 t/h (50 bar, 400° C)</td>
</tr>
</tbody>
</table>

- Plant for 1.1 million inhabitants in 22 municipalities and 3 districts of Paris
- Located on the outskirts of Paris
- **Large part of the plant embedded in the ground with 52MW electrical output and 150t/h heat output**
- After loading waste, no waste truck has to drive more than 15km to reach the plant
- Hitachi Zosen Inova supplier of process components for combustion, steam production and flue gas cleaning
EfW Plant Issy-les-Moulineaux: Aerial View
EfW Plant in the Heart of the Parisian West

Issy-les-Moulineaux
Biogas from Organic Waste with Kompogas®
Designed for a large variety of input materials

- Household bio-waste
- Catering and kitchen waste
- Organic fraction of MSW / residual waste
- Compost
- expired food from supermarkets

- Green waste
- Market and vegetable waste

- Gas and Electricity
Doha, Quatar
One out of 75 references for AD

Large integral waste processing plant combining mechanical sorting, Kompogas dry AD and incineration systems

Largest Kompogas dry AD plant in the world with 15 x PF1300 concrete digesters operating in parallel (12 x OFMSW + 3 x green waste)

Main driver for dry AD: production of compost

Biogas usage in Combined Heat and Power (CHP) plant

Client
Ministry of Municipality & Urban Planning

Start-up
2011

Technology
Plant type
Integrated MSW Management Centre
Input material
MSW / Organic Fraction of MSW, green waste
Digester type
15xPF1300-3 concrete digester
Biogas usage
CHP

Technical Data
Plant Capacity
840'000 Mg/a (AD: 274'000 Mg/a)
Biogas production
24'200'000 Nm³/a
Electricity production
56'900'000 kWh/a
Desalination Projects worldwide

- Algeria: one plant
  Daily output: 90,000 m³

- Saudi Arabia: six plants
  Daily output: 600,000 m³

- Oman: six plants
  Daily output: 230,000 m³

- UAE: four plants
  Daily output: 270,000 m³

- Japan: 25 plants
  Daily output: 20,000 m³
Desalination Projects in GCC

Desalination Plants EPC business in ME (17PJ, since 1979)

Qatar (2 PJ)
- Ras Abu Fontas A2 / 36MIGD
- UHP IWPP / 136.5MIGD (U.C.2018)

Abu Dhabi (4 PJ)
- Ruwais Refinery Expansion / 7.4MIGD
- Umm Al Nar IWPP / 25MIGD
- Tawelalh B Expansion / 23.1MIGD
- Ruwais GUP Expansion / 3.3MIGD

Saudi Arabia (5 PJ)
- Al-Khobar Phase-3 / 61.6MIGD
- Al-Jubail Phase-2 / 53.5MIGD
- Yanbu / 4.3MIGD
- Al-Jubail Stage-1 / 4.3MIGD
- HAQL Phase-1 / 0.2MIGD

Oman (5 PJ)
- Barka IWPP Phase-1 / 20.7MIGD
- Ghubrah Phase-5 / 6.2MIGD
- Ghubrah Phase-3 / 6.2MIGD
- Ghubrah Phase-2 / 12.3MIGD
- Ghubrah Expansion / 6.2MIGD
Waste is our Energy.

Engineering is our Business.

Sustainable Solutions are our Mission.