PROGRESS TOWARDS COMMERCIALISING WASTE GASIFICATION:
A Worldwide Status Report

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Topics for Presentation

- An updated status report on Waste Gasification trends around the world
- Why has progress towards commercialization slowed down outside Japan?
  
  ... and what does this mean for the future outlook?
<table>
<thead>
<tr>
<th>Location</th>
<th>Current Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>STALLED - lots of interest but no action</td>
</tr>
<tr>
<td>USA</td>
<td>NONE (except for a very few States / companies)</td>
</tr>
<tr>
<td>Canada</td>
<td>INTEREST IS PICKING UP</td>
</tr>
<tr>
<td>Australia</td>
<td>INTEREST IS DYING DOWN</td>
</tr>
<tr>
<td>Japan</td>
<td>VERY ACTIVE</td>
</tr>
</tbody>
</table>

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EfW orders placed in Japan (1997 - 2001)

Source: Nippon Steel
<table>
<thead>
<tr>
<th>Country</th>
<th>Main Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Shortage of landfill / Desire to avoid incineration</td>
</tr>
<tr>
<td>USA</td>
<td>Proposed RCRA exemption</td>
</tr>
</tbody>
</table>
| Europe      | Desire to avoid incineration  
                Landfill diversion targets |
<p>| Canada      | Desire to avoid incineration |
| Australia   | Desire to use ‘green’ solutions |</p>
<table>
<thead>
<tr>
<th>Country</th>
<th>Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>State of the economy</td>
</tr>
<tr>
<td>USA</td>
<td>Cheap disposal (in most States), delays to RCRA</td>
</tr>
<tr>
<td>Europe</td>
<td>Process risk</td>
</tr>
<tr>
<td>Canada</td>
<td>Increased costs</td>
</tr>
<tr>
<td>Australia</td>
<td>Cheap disposal, disillusionment with suppliers</td>
</tr>
<tr>
<td>Country</td>
<td>Main Applications</td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Japan</td>
<td>MSW, incinerator residues, ASR</td>
</tr>
<tr>
<td>USA</td>
<td>Industrial wastes, MSW (a few States), biomass</td>
</tr>
<tr>
<td>Europe</td>
<td>Residual wastes, EoL, Industrial wastes</td>
</tr>
<tr>
<td>Canada</td>
<td>MSW, bio-wastes, tyres</td>
</tr>
<tr>
<td>Australia</td>
<td>MSW, biomass</td>
</tr>
</tbody>
</table>
## Japanese gasification technologies

<table>
<thead>
<tr>
<th>Gasification process type</th>
<th>Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluidised bed gasification + melting furnace</td>
<td>Ebara, Sumitomo, KHI, MHI, Hitachi Zosen, Kobe Steel,</td>
</tr>
<tr>
<td>Pyrolysis kiln + melting furnace</td>
<td>Mitsui, Takuma, Toshiba, Hitachi Zosen, IHI</td>
</tr>
<tr>
<td>Shaft furnace (updraft gasifier)</td>
<td>Nippon Steel, JFE (NKK)</td>
</tr>
<tr>
<td>High temperature gasification</td>
<td>Ebara, JFE (Kawasaki), Mitsubishi Materials</td>
</tr>
</tbody>
</table>
Status of the Technology in Japan

• Only one gasification technology is currently classified as ‘fully commercial’ for MSW applications by Juniper:
  ■ Nippon Steel (at ~ 150,000 tpa)
  ■ can now be described as ‘mature technology’

• We expect to be able to shortly uprate 3 others for similar applications:
  ■ Ebara TIFG (TwinRec)
  ■ JFE (Thermoselect)
  ■ Mitsui R21
Kazusa, Japan, Nippon Steel, 2002, 60,000 kTpa
Aomori, Japan, Ebara, 2001, 135,000 kTpa (ASR)
Kawaguchi, Japan, Ebara TIFG, 2002, 125,000 kTpa
Toyohashi, Japan, Mitsui R21, 2002, 120,000 kTpa
Technology trends in Japan

- All leading Japanese thermal process companies now offer gasification solutions alongside incineration.

- Companies are developing new concepts to respond to changing market parameters & export market needs.

- For example, Ebara is developing a family of fluidised bed processes:
  - Optimised to specific applications
  - New concepts for carbon sequestration
  - Industrial wastes (RCRA criteria)
  - ‘Stackless’ facilities
Will these processes meet the RCRA exemption?

- Slagging gasifiers that produce a syngas: 31%
- Slagging gasifiers that produce a flue gas: 69%

Source: Juniper database
<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity kTpa</th>
<th>Process</th>
<th>Date</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVZ, Germany</td>
<td>250,000</td>
<td>Envirotherm BGL</td>
<td>2001</td>
<td>Gasification + Melting</td>
</tr>
<tr>
<td>Karlsruhe, Germany</td>
<td>225,000</td>
<td>Thermoselect</td>
<td>2001</td>
<td>Gasification + Melting</td>
</tr>
<tr>
<td>Ibaraki, Japan</td>
<td>135,000</td>
<td>Nippon Steel</td>
<td>1980</td>
<td>Gasification + Melting</td>
</tr>
<tr>
<td>Aomori, Japan</td>
<td>135,000</td>
<td>Ebara</td>
<td>2001</td>
<td>FB gasification + Combustion + Melting</td>
</tr>
<tr>
<td>Kawaguchi, Japan</td>
<td>125,000</td>
<td>Ebara</td>
<td>2002</td>
<td>FB gasification + Combustion + Melting</td>
</tr>
<tr>
<td>Toyohashi, Japan</td>
<td>120,000</td>
<td>Mitsui</td>
<td>2002</td>
<td>Pyrolysis + Combustion + Melting</td>
</tr>
<tr>
<td>Akita, Japan</td>
<td>120,000</td>
<td>Nippon Steel</td>
<td>2002</td>
<td>Gasification + Melting</td>
</tr>
<tr>
<td>Oita, Japan</td>
<td>115,000</td>
<td>Nippon Steel</td>
<td>2003</td>
<td>Gasification + Melting</td>
</tr>
<tr>
<td>Chiba, Japan</td>
<td>100,000</td>
<td>Thermoselect</td>
<td>2002</td>
<td>Gasification + Melting</td>
</tr>
<tr>
<td>Hamm, Germany</td>
<td>100,000</td>
<td>Techtrade</td>
<td>2002</td>
<td>Pyrolysis + Combustion</td>
</tr>
</tbody>
</table>

Source: Juniper database
Top Process Companies in terms of References *

* commercial facilities processing > 30kTpa

Source: Juniper database
Topics for Presentation

✓ An updated status report on Waste Gasification trends around the world

- Why has progress towards commercialization slowed down outside Japan?
  - and what does this mean for the future outlook?
Assessing bankability

Processes above this line are ECONOMICALLY VIABLE

Processes to the right of this line have an ACCEPTABLE RISK PROFILE
Assessing bankability

- **Low cost but not yet proven**
- **Not currently viable**
- **Proven but not economic**
- **Bankable**

Net Cost

Provenness

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Reasons for Lack of Progress outside Japan

- **Plasma Gasification**
  - Proven but not economic
- **Japanese systems**
  - Proven but not economic
- **incineration**
  - Not currently viable

**Net Cost**
- Low cost but not yet proven
- many smaller market entrants especially in US, Europe & Aus

**Provenness**
- Not currently viable
- Leading Western contenders

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Impact of Recent Trends

- **Plasma Gasification**
  - Low cost but not yet proven
  - Not currently viable
  - Proven but not economic
  - many smaller market entrants especially in US, Europe & Aus

- **Japanese systems**
  - Proven but not economic

- **Leading Western contenders**

Net Cost vs. Provenness chart

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… but the market has been changing!

- **Bankable**
- **incineration**
- **Japanese systems**
- **Not currently viable**
- **Proven but not economic**
- **Provenness**
- **Net Cost**
- **leading Western contenders**

Not currently viable

Proven but not economic

Japanese systems

Provenness

Net Cost
So, what’s the outlook in Europe?

• **Short-term**
  - further consolidation in number of suppliers
  - relatively few projects converted to orders

• **Medium term**
  - growing demand for alternatives to incineration
  - new market sectors in EoL and other residual waste applications
  - big market for gasification if:
    - Japanese processes can be adapted to be cost-effective
    - local suppliers can demonstrate their technology at scale