Facts at a glance

- **Main office in Denmark**
- **Founded in 1898**
- **100% owned by The Babcock & Wilcox Power Generation Group Ltd., USA since 2000**
- **350 employees**
- **Turnover 100 million EUR**
Main Business Areas

- Waste to energy systems
- Biomass energy systems
- Gasification

- After sales service
  - Refurbishment/rebuilding
  - Components/parts
  - Inspection/analysis
Up-draft gasification

Up-draft technology originally acquired from Dr. Gatzke

- A B&W Vølund research area since 1988

- Licensed to:
  - JFE Engineering Corp. - Japan
The Harboøre CHP plant

- First of a kind – focus on having the overall concept working – not optimization of the performance
- Fuel: Woodchips. Moisture content: 35-55 %
- 3.5 MW\text{th} / 1 MW\text{e}
- Commissioned in 1996
- CHP capability added in 2000
- Originally designed for district heating
Experiences with up-draft gasifiers

- **First pilot plant (1 MW)** set up in 1989 at the Kyndby CHP. Dismantled.
- **Mid 1990’s**: experiments on a 500 kW unit at Kommune Kemi – a Hazardous Waste facility. Dismantled.
- **1993-96**: Erection of the Harboøre plant. In operation.
- **2006**: Ansager plant - a 200 kW unit with a stirling engine. In operation.
- **2007**: Yamagata (8 MW\textsubscript{fuel}/2 MW\textsubscript{power}) plant in Japan by JFE. In operation.
- **2008**: Ishikawa (2.5 MW\textsubscript{power}) plant in Japan by JFE. In operation.
- **2008**: Daio paper 12MWth plant in Japan by JFE. In operation.
Operational status

- **Gasifier operated for more than 120,000 hours**
- **Gas engines operated more than 80,000 hours**
- **More than 36,000 MWh supplied to the power grid**
- **Present power production: more than 500 MWh per month**
Gas composition:

\[ \begin{align*}
H_h & 6.5 - 7 \text{ MJ/Nm}^3_{\text{dry}} \\
18-19 \% \text{ H}_2 \\
27-30 \% \text{ CO} \\
7-10 \% \text{ CO}_2 \\
3-5 \% \text{ CH}_4 \\
< 0.5 \% \text{ O}_2
\end{align*} \]
Tar in Raw gas:
Tar: 40 - 100 g/Nm³ dry
Light tar: 70-100 g/Nm³ dry

Tar in cleaned gas:
Tar (condensable): < 2 mg/Nm³ dry
Wastewater as condensate without additional treatment:
- 0.1-0.2 m³/h
- pH 5-7
- COD 10 - 100 mg O₂/l
- N_{total} 1 - 100 mg/l
- Acetic acid 1 - 15 mg/l

Thermal treatment of waste water contaminated with organics.
Tar: 28-30 MJ/kg
Ash:
1 % (w/w\textsubscript{dry})
TOC: 0.1 – 1.0 %\textsubscript{dry}
PAH: < 0.5 mg/kg\textsubscript{dry}
Dioxin: below detection limit
Harboøre CHP – Fuel consumption

Harboøre CHP - Energy source

- Oil total
- Wood chips

MWh

2002 2003 2004 2005 2006 2007 2008 2009 2010

Harboøre CHP – Energy production

Harboøre CHP - Energy production

- Heat to net
- Power to the grid

MWh


2002 2003 2004 2005 2006 2007 2008 2009 2010
Harboøre CHP – Gasengine operation
Wood-chips

Heating: Test ~ 100%

Gas fired Boiler

Power: Test: 28%\text{\textsubscript{gros}}
2006 average: 23%\text{\textsubscript{gros}}

Heat: Test: ~ 55%\text{\textsubscript{gros}}
2006 average: 57%\text{\textsubscript{gros}}

Tar storage

Storable energy as tar:
Test: 10-17%
2006 average: 13%

Air

Ash

Stack
Advantages

✓ High efficiency
✓ High potential for further developments
✓ Flexibility
✓ Turn-down ratio
✓ Fast ramping
B&W Vølund gasification

Licensee JFE – Japan:

- Yamagata plant in operation (8 MWth)
- Ishigawa plant in operation (9 MWth)
- Daio plant in operation (12 MWth)
Yamagata – a 2 MWe plant
Autumn 2007 at Yamagata (2 MWe)
Spring 2009 at Ishigawa
Spring 2009 – Fuel for Daio plant
Commercialising the technology: Concepts

- Combined heat and power stations
- Burnable gas generator
- Wasteboost – external superheater for Waste fired power plants
- Combined cycle gasifier based power station
Combined Cycle Gasifier - Process
Financial and technical figures
2MWe

4-6 MEUR/MWe installed

\( \eta_e = 28\% \) CHP

\( \eta_{th} = 55\% \) CHP

Bio oil = 13%

1 week per year for maintenance

O&M excluding manpower but including wearparts, consumable, service, office cost, insurance

225.000 EUR per year
Financial and technical figures
5MWe

4-5 MEUR/MWe installed

$\eta_e = 38\%$ CCGP

1 week per year for maintenance

O&M excluding manpower but including wearparts, consumable, service, office cost, insurance

375,000 EUR per year
General for Fuel

Wood chips, rounded and homogenous and with a good ‘sliding effect’:

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash content, approx.</td>
<td>%</td>
<td>0 – 2</td>
</tr>
<tr>
<td>Ash softening temperature</td>
<td>°C</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Apparent density</td>
<td>kg/m³</td>
<td>200-300</td>
</tr>
<tr>
<td>Moisture content</td>
<td>%</td>
<td>35 – 55</td>
</tr>
<tr>
<td>Heat value, lower</td>
<td>MJ/kg</td>
<td>8.4 – 11.6</td>
</tr>
</tbody>
</table>
Challenges

• Location with subsidies on the feed in tariff
• Location with heat or steam demand
• All the crock around the world gives a bad rumor