The MEC BIOREFINERY

EBTP - 6th Stakeholder Plenary Meeting of the European Biofuels Technology Platform
Niels Henriksen, DONG Energy/Inbicon
Flagship project description

- Concept/history/ownership structure
- Societal impact
- Sourcing and Logistics
- The ethanol plant/new technology/timeline
- Remaining issues to be solved
THE CONCEPT
The Biorefinery – an ambitious Flagship project based on local residues and highly integrated
### MEC Biorefinery – timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>Start up of Biomass/gas fired CHP</td>
</tr>
<tr>
<td>2012</td>
<td>Start up of Biogas plant</td>
</tr>
<tr>
<td>2017</td>
<td>Expected start up of 2G bioethanol plant and biogas upgrading plant</td>
</tr>
<tr>
<td>After</td>
<td>Expected to add chemical production and waste handling facilities</td>
</tr>
</tbody>
</table>
The MEC Financial Model

- Investments in new plant and renovation of existing plants amounts to 294 MEUR
- Yearly turnover of the bio refinery of 147 MEUR
- Combination of good operation margins and “soft” finance offers attractive IRR
The MEC Group – A Public Private Ownership

- DONG A/S
  - Novozymes A/S
  - Other
  - 49%

- Vestforsyning
  - Varme A/S
  - 67%

- Struer Forsyning
  - Varme A/S
  - 33%

- Maabjerg Energy Concept A/S
  - MEC Holding A/S
  - 51%

- BioEthanol A/S
  - 94%

- BioGas A/S
  - 100%

- Biopower A/S
SOURCING AND LOGISTICS
Input & output

Input
- 90 GWh power
- 50,000 tons of household waste
- 100,000 tons of industrial waste
- 120,000 tons of waste water sludge
- 185,000 tons of biomass from dairies etc.
- 500,000 tons of manure
- 300,000 tons of straw

MEC – plants
Biomass based power and heating

- 58,000 t Lignin
- 92,000 t Vinasses

2. Generation bioethanol

Output
- 140 GWh power
- 1,766 TJ of heating for 20,000 households
- 80 mill. litres of 2G bioethanol
- 34,000 tons of lignin
- 10 mill. m³ of biogas
- 16 mill. m³ of CNG
- 600,000 tons of fertiliser

CNG
Biogas
Transport of manure and liquid waste (800,000 t/year)
The MEC Sourcing Model of straw (300,000 t/year)

- Unused straw amounts to 1.2 million tonnes in Jutland
- Denmark has 20 years of experience of large scale handling of straw supply for peak load in CHPs
- Establishment of a 10-year contract model for the straw supply based on tenders
- The contracts will be signed with one or several private companies that specialize in supplying straw in large quantities to the existing market for power plants
2G ETHANOL
C6+C5 mixed fermentation - projects based on Inbicon Version 2

The MEC project - DENMARK

- Capacity: 37.5 t/h wheat straw (DM 86%)
- Technology: Steam pretreatment and mixed sugar fermentation
- Integration: Existing Biogas and Combined Heat and Power plant
- Output: 2G ethanol, lignin and vinasses (high DM) for biogas production
Inbicon Version 2 - C6+C5 mixed fermentation - proven in demo scale

Inbicon Concepts

- Biomass
- Water
- Enzymes
- Advanced yeast (GMO)

- Bioethanol
- Solid Biofuel
- Vinasses

- Improving ethanol yield with 40% in comparison to Inbicon version 1
- Typical yield of 280-300 l etoh per ton of biomass dry matter
Inbicon Concepts

C6+C5 mixed fermentation – proven in demo scale 2013

Soft lignocellulosic biomass soaked, washed or wetted to DM > 35%

Pretreatment

Steam

Separation
(Solid and liquid fraction)

Solid fraction DM ≥ 40%

C5 bypass liquid fraction

Hydrolysis

Dilution water, pH adjustment, Commercial cellulase

Post hydrolysis

C6/C5 fermentation
Time table

August 2011 - April 2012: Feasibility Study

April 2012 - July 2014: Verification & Design

September 2014: Decision on realisation

September 2015: Final Investment Decision

September 2017: Operation
REMAINING ISSUES TO BE SOLVED
What is needed to finalize biorefinery

- Detailed engineering and tenders
- Financing
- Permission to ownership structure (new Public Private Partnership concept)
- Longterm off-take agreements on ethanol or blending mandate that can absorb the production
Lower CO\textsubscript{2} emissions and Green jobs

<table>
<thead>
<tr>
<th>CO\textsubscript{2}-reduction MEC</th>
<th>Calorific value</th>
<th>Energy</th>
<th>CO\textsubscript{2}</th>
<th>CO\textsubscript{2} reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Unit</td>
<td>Amount</td>
<td>(GJ/unit)</td>
<td>(GJ)</td>
</tr>
<tr>
<td>Bio-ethanol replaces petrol</td>
<td>m\textsuperscript{3}</td>
<td>78 720</td>
<td>21,20</td>
<td>1 668 864</td>
</tr>
<tr>
<td>Biogas replaces natural gas</td>
<td>m\textsuperscript{3}</td>
<td>18 779 000</td>
<td>0,02</td>
<td>439 429</td>
</tr>
<tr>
<td>Lignin replaces waste locally</td>
<td>t</td>
<td>56 999</td>
<td>10,00</td>
<td>569 990</td>
</tr>
<tr>
<td>Lignin replaces coal centrally</td>
<td>t</td>
<td>36 121</td>
<td>29,30</td>
<td>1 058 345</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Socio Economic effects**

<table>
<thead>
<tr>
<th>Source</th>
<th>Investment</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary activity (million DKK)</td>
<td>2 200</td>
<td>1 100</td>
</tr>
<tr>
<td>GDP influence (million DKK)</td>
<td>1 850</td>
<td>1 000</td>
</tr>
<tr>
<td>Total employment (number of full time jobs)</td>
<td>1 250</td>
<td>1 000</td>
</tr>
<tr>
<td>Public budget balance (million DKK)</td>
<td>1 550</td>
<td>680</td>
</tr>
<tr>
<td>Effects on net balance of payments (million DKK)</td>
<td>-1 350</td>
<td>680</td>
</tr>
</tbody>
</table>
Questions and comments