Biomethane to Grid
UK Project Review
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Biomethane Market Overview

1. REA
2. UK Gas Pipeline Network
3. Barriers Overcome
4. UK Biomethane Ownership Model
5. Project Review
6. Market Forecast and Statistics
7. Conclusions
About the REA

Largest UK trade association for renewables:

• Over 900 corporate members
• All sizes – one man bands to multinationals
• All sectors (power, heat, green gas and transport & waste)
• members’ activities span all technologies
• unparalleled track record of policy wins
• work with other associations
• members of all sizes with democratic, 1 member, 1 vote structure
• FITS & RHI campaign with FOE
UK GAS PIPELINE NETWORK
UK Gas Transmission Network

- National Transmission System (NTS) transports gas to the Distribution Networks
- Owned by National Grid
UK Gas Distribution Network

- 20 million customers
- 85% of domestic customers on gas
- Gas central heating dominates heating market
- >95% of industry on gas
UK BIOMETHANE PROJECT
BARRIERS OVERCOME AND
OWNERSHIP MODEL
Barriers Overcome 2007 - 2013

• Feed in tariff for biomethane introduced
  – Attractive rate of 7.3 p/kWh
  – Not available for landfill gas

• Ownership model agreed
  – Technical standards

• Gas grid entry specification
  – Oxygen changed from 0.2% to 1%
  – Siloxanes – the large Sewage bogas projects underway, will inform final siloxanes spec

• Created biomethane supply chain
  – UK Biomethane Day 2014
Ownership Summary (1)
Ownership Summary (2)

- The Gas Distribution Network (GDN) provides capacity in the gas grid
  - GDN not involved in any physical assets on site
  - The GDN sets out technical and commercial requirements
  - The biomethane producer funds, owns and operates the Grid Entry Unit

- Cost of first Grid Entry Unit was around 1 million Euros, cost now 400,000 Euros
  - Work underway to change some rules and reduce by further 25%
PROJECT REVIEW
Didcot – UK’s First BtG Project

Propane Storage

Propane Injector

Biogas upgrader

H2S and Siloxane filters

Anaerobic Digesters

Gas bag

Telemetry

Energy & quality Measurement

Flow of biogas - 100 m³/hr
First gas to grid on 3rd Oct 2010
Rainbarrow Farm at Poundbury

- UK’s first commercial project
- Membrane CO₂ removal plant
- Gas injected into 2 bar grid
- 500 kwh CHP
- The development is a joint venture between Duchy of Cornwall and some of its tenants
- Achieving 98% availability

Flow of biogas - 500 m³/hr
First gas to grid – October 2012
Vale Green

- Membrane and cryogenic CO$_2$ separation plant
- Vegetable waste
- Separated CO$_2$ used to grow more tomatoes
- 75% gas to grid with a 490kWh CHP
- 7 bar gas grid

Flow of biogas - 600 m$^3$/hr
First gas to grid – August 2013
Future Biogas Doncaster

- Agricultural feedstock
- 80% gas to grid – with 499kWh CHP
- Membrane CO$_2$ removal plant
- 7 bar gas grid

Flow of biogas – 900 m$^3$/hr
First gas to grid – October 2013
ReFood Widnes

- Food waste feedstock
- 100% gas to grid
- Water-wash CO$_2$ removal plant
- 2 bar gas grid

Flow of biogas – Estimated 2,000 m$^3$/hr
First gas to grid – Estimated Q2 2014
Severn Trent Water Minworth

- Sewage feedstock
- 20% gas to grid – with existing 7MW CHP
- Water-wash CO$_2$ removal plant
- 20 bar LTS grid
- Blending allowed so no propane required

Flow of biogas – Estimated 1,200 m$^3$/hr
First gas to grid – Estimated Q2 2014
Project in Scotland

- Industrial food waste feedstock
- Water-wash CO2 removal plant

When commissioned in late 2014, not only will it be the first facility of its kind, it will be the largest of any biogas-to-grid project so far announced or operating in the UK.

Raw biogas - derived from anaerobic digestion (AD) will be converted to biomethane suitable for injection into the national gas grid.

Such is the anticipated raw biogas input from the AD, upgrading units will need to be coupled in parallel to optimise an output of up to 5,000 cubic metres per hour of 98% pure biomethane. The model being supplied is the Totara +, the largest in the Greenlane® range.

Included in the service elements of the contract are a 3-year warranty, a guarantee of 98% system availability, and a monthly site visit by a CBG engineer.

The Greenlane water-wash process is proven in operation over the last 20 years and requires no heat and no chemicals. More 75 sites are operating successfully around the world, 30 of which employ the Totara model.

When the project is completed in late 2014, CBG will have six similar systems of various capacities installed in the UK - more than all other types of biogas upgrading units operational in the country put together, and more than any other single supplier.

Flow of biogas – Estimated 5,000 m³/hr
First gas to grid – Expected Q4 2014
Other Projects in 2014

• NWL Howdon
  – Northumbrian Water’s sewage works near Newcastle
  – 2,000Nm³/hr biogas – Water Wash

• Euston Estates
  – High Pressure LTS Connection project in Cambridgeshire
  – 7 bar main with remote compressors and injection to 42 bar grid – 1st project to use this model
  – 1,000Nm³/hr biogas – membrane plant

• Fraddon
  – Food waste, Cornwall, membrane – approved today

In total 18 projects being completed in 2014 and around 15 more expected to be completed in 2015
MARKET FORECAST AND STATISTICS
Feedstock Categories

REA forecast model categorises projects according to sectors defined by the Green Gas Grids Project:

1. Sewage Sludge
2. Agricultural
   a. Animal manure (slurry)
   b. Agricultural by-products and residues
   c. Crops for Energy
   d. Agricultural biomass is modelled as one sub-group as projects will often contain elements of all 3 streams
3. Industrial Food Processing waste
4. Food Waste (commercial, domestic, local authority)
5. Biodegradable waste (e.g. from an MBT plant or garden waste collected by local authority)
<table>
<thead>
<tr>
<th>Probability</th>
<th>Number projects in Category</th>
<th>%</th>
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<tbody>
<tr>
<td>Low</td>
<td>16</td>
<td>28%</td>
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<tr>
<td>Medium</td>
<td>9</td>
<td>16%</td>
</tr>
<tr>
<td>High</td>
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<tr>
<td>Definite</td>
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<td><strong>Total Projects</strong></td>
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</tr>
<tr>
<td>scmh Biogas</td>
<td>Number of Projects</td>
<td>%</td>
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<tr>
<td>------------</td>
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<td>----</td>
</tr>
<tr>
<td>0 - 400</td>
<td>4</td>
<td>7%</td>
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<tr>
<td>400 - 800</td>
<td>15</td>
<td>26%</td>
</tr>
<tr>
<td>800 - 1200</td>
<td>20</td>
<td>35%</td>
</tr>
<tr>
<td>1200 +</td>
<td>18</td>
<td>32%</td>
</tr>
<tr>
<td><strong>Total Projects</strong></td>
<td><strong>57</strong></td>
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</tbody>
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**% Projects by Biogas Flow Rate**

- 0 - 400: 7%
- 400 - 800: 26%
- 800 - 1200: 35%
- 1200 +: 32%
<table>
<thead>
<tr>
<th>Pressure Tier</th>
<th>Number of Projects</th>
<th>%</th>
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<tbody>
<tr>
<td>MP</td>
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<td>32%</td>
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<tr>
<td>IP</td>
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<tr>
<td>LTS</td>
<td>11</td>
<td>19%</td>
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<tr>
<td>TBC</td>
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<tr>
<td><strong>Total Projects</strong></td>
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</table>
Total subsidy in 2015 forecast to be around 200 million Euros
For around 0.7% of domestic customer gas demand
Biomethane to Grid Conclusions

• It has taken 6 years but UK regime is good:
  • Over 30 projects by end 2015 – very high confidence
  • Water wash and membrane leading market shares
• Majority of biomethane from waste feedstock
• Around 2 TWh in 2015
  • UK total gas demand 700 TWh
• Focus on reducing capital costs
  • Grid Entry Unit costs reduced by >50% in last 5 years
  • 7 active biomethane equipment providers in UK – competition
  • Membrane plants have potential to be significantly lower cost

UK biomethane market growing fast, delivering significant benefits and helping the UK to meet 2020 renewable energy targets