Making the most of a sustainable future. Biomethane and a Smart Sustainable Energy Infrastructure.

agriAD Ltd

Sept 2016
<table>
<thead>
<tr>
<th><strong>Project SPV</strong></th>
<th>Bridge Energy Ltd</th>
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</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>500kW on-farm AD</td>
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<tr>
<td><strong>Primary Energy</strong></td>
<td>Electrical generation</td>
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<tr>
<td><strong>Promoter</strong></td>
<td>agriAD Ltd</td>
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<tr>
<td><strong>Location</strong></td>
<td>Banbridge, Co. Down, Northern Ireland</td>
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<tr>
<td><strong>Feedstock</strong></td>
<td>Grass silage, slurry, poultry litter</td>
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<td><strong>Technology</strong></td>
<td>Williams Industrial Services</td>
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<td><strong>Investment</strong></td>
<td>£3.5m</td>
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<td><strong>Lead Funder</strong></td>
<td>UK Green Investment Bank</td>
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<td><strong>Project Status</strong></td>
<td>Operational; OFGEM ROC Accredited.</td>
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<td><strong>Phase 2</strong></td>
<td>Biogas upgrading to biomethane; 1,000,000m³</td>
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The Bridge Energy AD site is located in Banbridge, County Down, Northern Ireland. The project involves the conversion of grass silage, slurry, and poultry litter into biogas, which is upgraded to biomethane. This biogas is then used to generate electrical power for Tesco filling stations and the electrical distribution networks. The project also includes a 280-unit housing development under construction, and a route of dedicated electrical grid connection of 3MW and potential gas distribution pipeline. The project is supported by the UK Green Investment Bank and is accredited by OFGEM ROC.
Figure 4: Net margins after full economic costs 2010-2014 for milk production in selected EU countries

Note: Country name indicates the typical farm herd size

Source: IFCN
AD Projects currently operational or under construction in NI

- 55 to 60 no AD Projects
- ~£150m investment
- At least £75m spent locally
- £15m/yr of feedstock for 20yrs
- £7m/yr in operational services for 20yrs
- 1000 construction jobs
- 150 operational jobs
- 100m litres of imported diesel displaced per yr

- £90M to upscale from biogas to biomethane
- 1000 construction jobs
- 150 operational jobs
- 100m litres of imported diesel displaced per yr
- 30MW el generation capacity
- Potential for biomethane
- ~£1.5m per plant to upgrade
- 1.8m litres of diesel displaced per plant upgraded
NI’s Bio-methane Feedstock Potential

Waste from food chain
500,000 tonnes of food waste generated annually in NI
Can displace ~10% of current diesel consumption with bio-methane

Feedstock from grass silage
1 hectare (Ha) of grass produces bio-methane equivalent up to 4,500 L of diesel
20% diesel displacement requires ~2% of total grass and crop land in Northern Ireland

Total Impact: £300-400M to NI Economy
Savings of £100-200M switching to Dual-Fuel technology (using natural gas or bio-methane)
Using locally produced bio-methane rather than imported gas retains further ~£200M in NI
Weakness;
Electrical grid saturation.
Potential major capital expenditure required.
Opportunity;
Is there a smarter way of doing this?
CASE Proposal; Biomethane and a Smart Sustainable Rural Energy Infrastructure

How the electrical grid was designed

- **Electrical Grid Unbalanced**
  - Net import
  - But grid designed to do so

- **33kv**
  - **11kv**

- **Load Demand**
  - **Load Demand**
  - **Load Demand**
  - **Load Demand**
How the electrical grid operates currently

Biomethane and a Smart Sustainable Rural Energy Infrastructure

**Electrical Grid**

Unbalanced

Net export; Grid not designed to do so

**33kv**

**11kv**

**Wind turbine 225kW**

Variable generation

**AD 500kW CHP**

Constant generation

**Wind turbine 225kW**

Variable generation

**Load Demand**

Generation greater than demand

Wind blowing

Generation greater than demand
Biomethane and a Smart Sustainable Rural Energy Infrastructure

How the electrical grid needs to operate now;
Balance generation and demand by creating load at the local grid level. Smart energy infrastructure.

**Electrical Grid Balanced**
- 33kv
- 11kv

**Wind turbine 225kW**
- Variable generation

**AD 500kW CHP**
- Constant generation

**Wind turbine 225kW**
- Variable generation

**Load Demand**

**Biomethane for transport**

**Biogas upgrading and biomethane compression**

**Additional load created. Demand balances generation**

Wind blowing
Biomethane and a Smart Sustainable Rural Energy Infrastructure

How the electrical grid needs to operate now;
But balancing of the local electrical grid is difficult to achieve with variable generation.

- Electrical Grid
  - Unbalanced
    - Net import;
    - Increased demand on transmission network

- Wind turbine 225kW
  - Variable generation

- AD 500kW CHP
  - Constant generation

- Wind turbine 225kW
  - Variable generation

- Load Demand

- Biomethane for transport
  - Additional load created.
  - But demand greater than generation

Wind not blowing

Biogas upgrading and biomethane compression
Biomethane and a Smart Sustainable Rural Energy Infrastructure

How the electrical grid needs to operate now;
Need to balance variable generation with smart on demand generation.

Electrical Grid Balanced

- Wind turbine 225kW
  - Constant generation
  - On demand 225kW CHP
- AD 500kW CHP
  - Constant generation
- Wind turbine 225kW
  - Constant generation

Load Demand
- Biogas upgrading and biomethane compression
  - Additional load and generation created.
  - Demand balances generation
  - Biomethane for transport
Biomethane and a Smart Sustainable Rural Energy Infrastructure

Biomethane as an energy carrier; Why compress air when you can compress energy

On demand electrical generation from biomethane CHP

Biogas upgraded to biomethane

Cow slurry

Biomethane for on farm heat

Biomethane for transport of milk

Milk

Biomethane for transport of dairy products

Biomethane for farm vehicles

Energy Crops

Biomethane for process heat to dry milk

Food processing waste

SCHOOL BUS

Biomethane for rural public transport
Innovate UK Proposal
Innovation in Infrastructure Systems

Belfast Harbour Biogas Site

Belfast Harbour Commission
Planning approved
Central location
70kt of feedstock/yr
Up to 2MW electricity
Or
4 million cu m biomethane
7 million litres of diesel displaced
Belfast Harbour Biogas Project

Food waste

Organic waste streams

Invasive species

Biomethane for transport, domestic heating, on demand electricity & industrial process heat

Belfast Trust

Queen’s University Belfast

Belfast City Council

Belfast Harbour

Translink

Biomethane for council vehicles

Biomethane for public transport

Biomethane for fleet vehicles and transport

Biomethane for industrial CHP and process heat

Biomethane for domestic heating

Biomethane for transport, domestic heating, on demand electricity & industrial process heat

Food waste

Biomethane for Irish Sea ferries

Food waste

Food waste

Biomethane for transport, domestic heating, on demand electricity & industrial process heat

Biomethane for industrial CHP and process heat

Biomethane for fleet vehicles and transport

Biomethane for public transport

Biomethane for council vehicles

Biomethane for Irish Sea ferries

Biomethane for transport, domestic heating, on demand electricity & industrial process heat

Biomethane for transport, domestic heating, on demand electricity & industrial process heat

Biomethane for transport, domestic heating, on demand electricity & industrial process heat
Belfast Gasworks

Belfast Gasworks provided light and fuel to the city since its inception. The first recorded use of gas in Belfast was in 1810, with the installation of gas lights at Clifton House.

1821 – John and George Barlow of London, owners of the Belfast Gas Company, obtained a contract with the Belfast Corporation to provide gas for the town. The contract states:

‘Gas light to be equal to that supplied to the town of London, and to be installed in the main streets and other parts of the town as may be required.’

The installation of gas lighting was seen as a significant improvement over the previous gaslight, which was oil-based. The new gas lighting was cleaner, brighter, and more efficient. The process of gas production involved the extraction of coal gas from coal and the use of a retort to produce the gas. The gas was then cleaned and delivered to the houses and streets of Belfast.