Biogas from AD – Strategic CHP Options

1. Background

This note aims to provide an update on the initial work undertaken to date to assess the potential of biogas export from the Norfolk County Council PFI Reference Project to assess the combined heat and power (CHP) application from the anaerobic digestion plant and sets out the further work that is to be undertaken.

The incorporation of heat use within the reference project has been limited to the requirements of the digestors only. It is recognised by the County Council that further application of the heat or biogas requires assessment to evaluate the environmental and economic impacts, whilst highlighting the technical challenges that may be considered in taking the project forward.

2. Biogas production

Based on the waste data flow model developed for the County Council, an MBT-Anaerobic Digestion plant treating 180,000 Tonnes of municipal solid waste has an estimated gas yield of 10.5 millions meter cubic of biogas. Biogas is primarily constituted of carbon dioxide (CO_2) and methane (CH_4). Methane has a calorific value of 10kWh/m^3 and constitutes approximately 55% of the content of the biogas, depending on the feedstock of the AD process. Smaller amounts of water, hydrogen sulphide (H_2S) and ammonia (NH_3) are also present in the biogas. It is necessary to operate a gas scrubbing stage for most uses of the biogas due to the corrosive properties of sulphurous acid (H_2SO_3) created during combustion. It might be necessary to lower the moisture level of the biogas as well.

3. On-site CHP

A majority of large scale anaerobic digesters in the UK run a combined heat and power (CHP) unit to burn the biogas produced. This process converts approximately 35% of the energy content of the methane in electricity and 52% in heat, the remaining being losses. One main advantage of running a CHP unit on-site is to reuse some of the electricity and heat produced to run the AD process itself. This operational energy demand is known as the parasitic load. Based on similar installations it is estimated the parasitic load of the AD plant would be between 10-20% of the electricity produced and 20% of the heat produced. In most cases it is quite difficult to find end-markets for the remaining heat generated on site, due to transport issues and low demand at proximity of the site. Thus only the electricity output generates revenue via a grid connection or a private wire. It is estimated the power revenue could range from £40 to £55 per MWh (depending on market fluctuations) and the heat will have a value of £5 to £15 per MWh if sold. There is still potential to find users at proximity and build a local heat network, but heat demand would have to be assessed. Another important source of revenue will be the double Renewable Obligation Certificates (ROCs) the electricity produced and exported to the grid or consumer would be eligible for under the new legislation expected by April 2009. At current prices, this would mean additional revenue of between £70-£90/MWh.

4. Off-site CHP

The sale of biogas to an industrial or manufacturing client (Palm Paper Mill) is a possible option. The paper mill is a high energy user, both in terms of electricity and heat (heat requirements: 11 bar 150 °C 6 t/h; 4 bar 150°C 94 t/h). This would take full advantage of the energy potential of the biogas, if using a CHP unit. Following Enviros contact with the Environment Agency, it was confirmed that the client would have to apply for an environmental permit (which replaces PPC permits as of April 2008) for the combustion of the gas. However, for a large scale activity such as the paper mill, it is likely that this will be a simply variation to the existing EPC as the combustion of the biogas would not be considered a WID regulated process.

The transport of the gas would involve additional costs however. A land assessment will be required to determine to the additional capex for the civils and installation to the plant.

The industrial client would be eligible for double ROCs under the upcoming legislation, if the CHP unit is run solely on biogas. If a mix of fuels is used, the operation would be classified as co-firing and thus be eligible only for ½ ROC (and only until 2016 – this is discussed further below). The revenue potential from selling the biogas to this kind of heat intensive industry is expected to be higher, as the gas would be sold for its full energy potential rather than solely its electricity potential.

Following initial contact with Ofgem, it has been confirmed that the supply of biogas would have to be via private pipe network for the electricity produced to be eligible for ROCs. Further clarification and confirmation from Ofgem on this option is required from Ofgem.

5. Co-firing (Gas Fired Power Station)

One option considered for the biogas is to export it to a power producer for co-firing in the adjacent gas fired power station. The main technical issues associated with this option are the logistics of the gas (and associated costs – gas clean up), and the quality requirements of the power station. The gas logistics issue remains the same as for off-site CHP as a private heat network would have to be constructed for the electricity produced to be eligible for ROCs.

It is expected that the biogas would not need to be upgraded to grid standards, but this would very much depend on the specifications of the power company. From a financial aspect, co-firing is eligible only for ½ ROC, and thus likely to reduce the revenue potential for power produced. It is also important to note that energy producers have a cap on the quantities of co-fired ROCs they can use to meet their renewable obligations. The quotas are 10% until 2011, and 5% until 2016, after which co-firing will not be eligible for ROCs (unless further developments are made to the RO and banding post 2013). In terms of economic benefits this options is dependent upon the value that the power company places on the biogas in terms of energy and meeting their obligation for renewables.

We believe further discussions should be made with Ofgem to investigate this initial decision as we believe that the efficiencies from biogas to power station application could outweigh on site CHP and as such the benefits from ROCs should remain at the proposed 2 ROCs. The philosophy of the banding for 2 ROCs is to stimulate the uptake of AD, which we believe will be reduced if the co-firing 'rule' exists in this model. Our initial discussion with a power company looking into the potential of AD has indicated that this has the potential to provide a good opportunity to meet their Obligation requirements, however the concern over the ROCs issues remain.

6. Injection in to Mains Gas Network

The injection of gas sourced from biomass into the mains gas pipe network is something which is being done in Europe, but not in the UK. We are aware that BERR has commissioned work to look into the landfill gas application for Biogas Liquification Process and the possibility of injection into the gas mains, but as yet results have not been published.

In order to inject biogas into the national gas grid, it has to be upgraded to biomethane with similar specifications to standard grid gas. This involves removing the carbon dioxide, a thorough scrubbing process, and pressurisation. Currently there are no known suppliers of this type of technology in the UK, but an integrated unit can be sourced from a number of European suppliers.

The European legal framework to promote the existing grid for gas from sources other than natural gas, including biogas currently exists. It states:

"Member states should ensure that, taking into account the necessary quality requirements, biogas and gas from biomass or other types of gas are granted non-discriminatory access to the gas-system, provided that such access is permanently compatible with the relevant technical rules and safety standards. These rules and standards should ensure, that these gases can technically and safely be injected into, and transported through the natural gas system and should also address the chemical characteristics of these gases" - European Directive 2003/55/EC

It is our understanding that the work being undertaken by BERR is addressing these issues, however any answer is unlikely to be established before the decisions on technology are made.

Under current legislation, feeding gas produced from renewable sources into the grid is not eligible for ROCs. Incentives, such as ROCs, may be proposed in the future for gas injection into the grid – for example in a Renewable Heat Obligation or Heat Incentive Initiative. This is supported by National Grid and other economic actors. BERR confirmed its support for this option in its *UK Renewable Energy Strategy Consultation* and is currently working in collaboration with Ofgem on the legal, technical and regulatory requirements to introduce biomethane into the grid. It is understood these developments might be taking place on a medium-term timescale.

7. Initial Conclusions

With regards to the discussion above, the different options have to be assessed in more detail against financial, technical and contextual feasibility criteria. Revenues generated from the biogas will be dependent on the future fluctuations in the energy prices and value of the ROC. Taking into account current RO legislation, it seems injection into the National Grid is not a beneficial option in today's policy framework, even though it would appear to be the optimum in terms of energy use. Co-firing has also limited advantages, mainly because it would generate only ½ ROC and only until 2016.

Thus the two most favourable options would seem to be CHP on-site or off-site. On-site CHP is the most straight forward solution, and has the advantage to provide the energy requirements to run the AD process and plant heating requirements, and be eligible for double ROCs for its electricity output to the grid. However the potential market for the export of heat would have to be identified. Off-site CHP at an industrial/manufacturing site offer the advantage to combine double ROC and a better use of the energy generated (heat) – further work on modelling the heat demand and heat production from the facility is required as it is highly unlikely that the biogas will provide 100% energy needs to a paper mill. The main issue is the technical and financial feasibility of a private pipe to carry the biogas and its application.

8. Our On-going Scope of Work

8.1 CHP Incineration

Whilst the initial work to date has focussed upon the reference project of MBT with AD we cannot exclude the technology option of incineration. We have developed an initial model for CHP feasibility, which will be applied to an incineration CHP option to evaluate the plant performance in terms of energy output (power and heat) based on the available waste and its energy content. This model will be used to show the impact of varying heat output from the incinerator and its impact on power generation. We will incorporate the data received from Palm Paper Mill to assess the advantages and disadvantages both environmentally (carbon savings) and economically.

The operating performance of the CHP plant will be benchmarked against the CHP Quality Assurance Scheme to define its performance in terms of it being "good quality" CHP. The financial performance of the plant will be modelled to assess the impact of operating in power only model and at increasing levels of heat extraction (CHP) in line with the paper mill requirements. The financial assessment will use estimated power and heat values.

As part of the financial assessment, the impact of power and heat price variance will be assessed, and ROCs implications taken into account where appropriate.

This financial assessment will allow an initial decision to be made on the potential additional benefit from operating in CHP mode.

The results of the initial assessment and which will provide an early indication of the benefits to the heat user and authority will be presented by the second week of August.

8.2 Biogas

The first stage engagement with the regulators has been made to address the permitting and ROC issue. Further engagement is required with the power and paper company to discuss the potential dedicated heat/biogas requirements for direct injection onto the gas boilers.

As part of the ongoing developments for the heat offtake (heat options) there is a requirement to have further engagement between Norfolk County Council and the business park developers and Police Authority to assess the potential of heat export to their new infrastructure. To inform the feasibility of the CHP there is a need to pull together quantitative and qualitative information from these sites – as has been achieved with the Palm Paper Mill. This would include where possible:

(a) Heat demands for the site, e.g. space heating and process heating.
(b) Current or future heat supply, e.g. hot water, steam, direct gas fired heaters.
(c) Duration of heat demands, weekly and annual basis.
(d) Current energy tariff.
(e) Review the heat generation and supply infrastructure.
(f) Identify potential connection options for heat supply and possible need for modification.

8.3 Next steps for Biogas/Heat Offtake

In accordance with instruction from Norfolk County Council and in order to build a stronger information base to back decision-making we are undertaking the following actions that will build on the technical and financial assessment of the options available:

(a) Assess in more detail the potential energy revenues (e.g. price per MWh of exports to the grid or to a private consumer).
(b) Assess potential opportunities for a 'private pipe' arrangement with a consumer.
(c) Assess the costs associated with a 'private pipe'.
(d) Review and cost up the technical requirements for biogas/natural gas export (scrubbers etc).
(e) Approach potential consumers for first discussions (Police / new business park).
(f) Assess heat load and demand at proximity of the AD plant.
(g) Assess the technical feasibility and associated costs of a private gas pipe network for off-site CHP.
(h) Assess the feasibility of on-site CHP associated with a private wire and/or a private heat pipe for off-site use.
(i) Address the commercial Issues associated with the heat offtake (market price risk, contract duration etc).
(j) Provide economic payback, indexation and additional capital and operational costs.