Blackdyke Industrial Estate Energy Farm Feasibility Study Interim Report Draft 1

On behalf of

CORE north west

April 2009

Cumbria County Council

Northwest Regional Development Agency

Solway Coast Area of Outstanding Natural Beauty

defra Department for Environment Food and Rural Affairs

The Hub "The next level"

CONTENTS

1. INTRODUCTION

The Solway Plain in West Cumbria is one of the most productive dairy areas in Britain. To maintain incomes, dairy farmers have increasingly intensified the milk production process. By so doing they are placing particular burden on the local environment. This is due principally to the spreading of slurry and farmyard manure (FYM) on the land.

The dairy industry is also facing severe economic problems, which have forced an increasing number of dairy farmers to leave the industry. Indeed over the last 11 years the number of dairy farmers in the UK has declined by a third and milk production levels are at their lowest since 1971 despite the market for milk products growing

One way of dealing with slurry and transforming a rising business cost into an income stream is through the creation of renewable energy and a high quality biofertiliser through anaerobic digestion technology.

This report sets out the interim findings of a feasibility study carried out by Windustry into establishing an anaerobic digester as the key component of the Blackdyke Industrial Estate Energy Farm (BIEF). It focuses on the viability of such a plant and its impact. The BIEF is planned to be the first of a cluster of Energy Farms, which are being developed by Community Renewable Energy North West (CoRE NW) in partnership with local farmers.

The study has been funded by funding from the North West Regional Development Agency, Solway and Coast AONB Sustainable Development Fund, EnviroLink and the Hub, a local social enterprise development agency.

2. WHAT IS ANAEROBIC DIGESTION?

Anaerobic digestion is a process that rots down most organic materials in a contained oxygen-free space. It transforms them into biogas, which consists of about 60% methane, and a nutrient rich liquid fertiliser commonly known as digestate.

The biogas is normally used in a gas Combined Heat and Power (CHP) engine to create heat and electricity but can also be used to power vehicles or more simply burnt to create heat. In our case it will be used in a CHP engine with the electricity being sold to local end users and/or to the national grid. Heat is will be sold to local heat user.

Sales of electricity benefits from the government's renewable energy incentive, Renewables Obligation Certificates (ROCs). As a consequence the income received for electricity generated by anaerobic digestion is greatly increased compared to conventional non-renewable generation and is worth almost three times as much. There are at present no incentives for renewable heat production, but they are scheduled to come into force in 2011.

The Environment Agency has produced protocols for anaerobic digestion, which means that if they are followed the resulting digestate can be described as an accredited product and not a waste. This will make it much easier to sell and use digestate.

Digestate is easier to apply to land and is a much more effective fertiliser than slurry and thus reduces demand for expensive chemical fertilisers.

We will set out in more detail the AD system we will use later in this report.

3. THE NEED FOR ANAEROBIC DIGESTION

One of the first modern anaerobic digesters in Europe was built in West Cumbria in the village of Blennerhasset over 130 years ago. However, since then the UK has been slow in developing farm based AD plants, there being only three registered to receive financial incentives (ROCs) for the production of electricity, whilst in Germany there are about 4,000 AD facilities benefiting from a renewable feed-in-tariff.

However, this situation is changing and there are four main issues that are driving the development of farm based AD. They are

1. Global warming/Climate Change
2. Government Policy on Renewable Energy
3. The need to deal with slurry more effectively
4. Economics

3.1 GLOBAL WARMING / CLIMATE CHANGE

Anaerobic digestion reduces greenhouse gas emissions in three ways.

Firstly it greatly reduces the emissions of greenhouse gases. Slurry and other manures rot down when left or applied to fields. This processes results in the release of methane, carbon dioxide and other gases, which contribute to global warming. Indeed methane is a 22 times more potent green house gas than carbon dioxide. By containing the process by which slurry and manures are fermented, the methane released is captured and burnt in an engine to produce electricity and heat and the methane is converted into CO_2 and water. This process reduces the impact of the methane released from slurry by converting it to CO_2 and by reducing the need for fossil fuels to be used to generate energy.

Secondly, the AD process is carbon neutral in the way all other forms of biomass like wood are. CO_2 is absorbed by plants that are either fed directly into the AD process as an energy crop or indirectly to animals resulting in the production of slurry and FYM. The AD process turns the energy crops and slurry into biogas the combustion of which produces CO_2 which in turn is absorbed by plants that form the feedstock for the AD process and the cycle continues. Thus as with other biomass such as wood, the carbon is recycled and this is why AD is considered to generate power from renewable resources. Overall there is little net increase in the amount of carbon released to the environment compared to fossil fuels.

Finally, the digestate that results from the AD process is highly effective bio-fertilisers (especially compared to the application of slurry) and typically provides for 80% of a farmers fertiliser needs. Thus it reduces the need for industrial manufactured fertilisers, whose production and transport is extremely energy and carbon intensive.

3.2 GOVERNMENT POLICY

In principle the government have recognised this potential of anaerobic digestion to tackle climate change and has stated that:

“We are working to facilitate a much greater uptake of anaerobic digestion by local authorities, businesses and farming.” (Defra 2009)

David Milliband MP summed up the value of AD when Minister for the Environment. He stated, “Anaerobic digestion shows that sometimes it is much easier to solve three problems together than three separately:

– AD helps us to meet the need for more renewable energy
– it helps us to mitigate methane emissions form agriculture, and
– it helps divert other kinds of organic waste, especially food waste, from landfill or incineration.” (David Milliband MP, Annual NFU Meeting 2007)

As we have seen the biogas or biomethane that results from the AD process can be used for a variety of purposes and several policies are of relevance. The use of renewable electricity, or more precise, the use of renewable fuel sources like biogas to generate electricity, is well supported by the Renewables Obligation Order and its latest amendment which came into force on the 1st April 2009. Furthermore the Renewable Transport Fuel Obligation has recently been launched to support the use of biofuels including biogas in vehicles. No similar incentives yet exist for the production of heat from biogas. However, the government has stated its intention to introduce such a financial incentive by 2011.

Renewable heat is a particularly important issue because as of 2006 only 1% of heat produced in the UK is produced from renewable resources. It is estimated that the UK market for renewable and waste heat in the UK will potentially be between 37TWh and 87TWh by 2020, equivalent to between 5% and 12% of the current UK heat requirement. It is generally regarded that a lack of defined targets and policy measures for increasing the use of renewable heat are the key reasons for the UK’s current low contribution from renewable heat.

The UK currently produces 100 million tonnes of organic waste, 90% (by weight) comes from agriculture. The government estimates that if all this waste were used in anaerobic digestion, it would produce up to 7.5% of the renewable energy the government has pledged the UK to produce by 2020. It is therefore a potentially major source of energy and a significant player in the government’s strategy to tackle climate change (Defra 2009).

The government has also sought to make the digestate that results from the AD process more usable by providing more favourable regulatory frameworks for its use. England has come in line with Scotland and produced a draft guideline for a quality control mechanism for digestate production and classification, the PAS110, published by WRAP and the Environment Agency (EA).

The EA has also recently revised how it classifies AD digestate produced from agricultural manure and slurry. Where the only waste feedstock to an AD plant is agricultural manure and slurry, the digestate output is not considered waste, as long as it is used in the same way as the original untreated manure and slurry would have been. This interpretation is also valid, if manure and slurry is mixed with other, non-waste feedstock such as crops grown specifically for AD. Furthermore Defra officials at a seminar they held “Guidance for Farmers in Nitrate Vulnerable Zones”, on 27th January 2009 described such digestate as ‘nitrate immune’. This meant it does not need to be included in calculations that assess the amount of nitrogen being applied to land within NVZs.

3.3 SLURRY USAGE AND MANAGEMENT

The application of slurry to fields is problematic in a number of ways. The main problems associated with were identified by David Chadwick and John Laws (Laws and Chadwick 2002)

Loss of fertiliser value – traditional application techniques mean that up to 80% of the nitrogen value is lost due to evaporation of ammonia because the slurry sits on the surface. Further losses of nitrogen are made in the storage of the slurry.

Restriction on application of slurry – cows avoid grazing on grassland that slurry has recently been applied to. Applying slurry to grass being cut for silage production too close to harvesting can seriously reduce the quality of the silage. In general application should be made at least six weeks before harvesting to maximise the quality of the grass.

Spreads disease and weed – application of slurry potentially spreads disease, as the slurry never reaches a temperature sufficiently high to kill pathogens, at present this is a particular problem due to the spread of TB. For the same reason, it also tends to spread weed seeds, particularly docks, which thrive in the conditions created by slurry. This increases the use of herbicides and reduces the productive value of grazing land

Pollution and release of greenhouse gases - overall agriculture is responsible for 80% of ammonia emissions. Ammonia contributes to global warming and causes local damage (e.g. in water courses) and more widespread ecological damage due to acidification of soil. Phosphates from run off also pollute watercourses. The uncontrolled decomposition of slurry also results in the release of methane and other greenhouse gases.

Odour – slurry creates a strong smell when applied that is both unpleasant and a nuisance to those living close to it. It consequently inhibits tourist developments.

Storage –some farmers will need to spend considerable sums to ensure they have five months storage capacity, which could mean considerable costs due to NVZ regulations outlined above.

Run off – Slurry application can cause serious problems for watercourses. The solids and chemical nature of slurry means the nitrogen it contains is poorly absorbed by soil, when it is applied much of the nitrogen can flow into streams and other water courses causing severe nitrate pollution problems. This problem is one of the main drivers for the NVZ regulations.

The environmental problems caused by applying slurry and fertilisers to the land have led to the introduction of regulations to protect Nitrogen Vulnerable Zones (NVZs). Within such areas, fertilisers and slurry can only be applied at rates which the crops can absorb the nutrients and at certain times and conditions. The most significant impact of the legislation is that slurry cannot be applied during the winter months. To cope with this closed period (the winter, when most dairy cows are producing slurry in barns) the farmer must have sufficient storage capacity to cope with 22 weeks production of cow slurry (and 26 weeks for pig and poultry slurry). This is a considerable amount given each cow produces about a third of a tonne of slurry per week. As a result the capital cost of providing slurry storage could be as much as £100,000 for a large herd.

Only two of the farms we are working with will come into the NVZ area, but it is likely that the area will be extended in the next few years.

3.4 ECONOMIC IMPACT

The final driver is the economic benefit, in terms of the income that AD plants can generate. This income can benefit farmers and help them diversify and the local economy.

In our case farmers will jointly own the AD plant and will benefit economically in three ways

1. Fertiliser saving - slurry is transformed into a much more useful and usable fertiliser (the digestate) that can meet 80% of a farmers fertiliser needs. This saves farmers from purchasing chemical fertiliser and given it costs around £40 a tonne can result in substantial savings
2. Income from sale of silage – the AD plant will purchase energy crops and the principal crop in the Blackdyke area will be silage. We estimate that this will increase farmer's income, compared to renting the land out, by about 100% and provide a long-term reliable income.
3. Income from shared profits – all farmers will have a stake in the AD plant and share in the profits it generates depending on their level of involvement (e.g. how much feedstock materials they supply and how much money they invest in the plant).

With funding provided from the Solway Coast AONB we researched the impact on twelve of the 15 farmers involved in the BIEEF. This research found that the economic impact of being involved in the AD plant would be:

1. Increase farmers' income by as much as £20,000 for those who wish to supply silage. The average increase of all participating farmers is ca. £16,300 and £196,000 for all twelve farmers surveyed per annum. Share of dividends is likely to increase this amount on average by £10,000 per year.
2. Double the number of farmer's children who are expected to stay in farming from five to twelve.
3. Create sustainable farms and make farming less arduous as one farmer put it "Creating sustainability for the family and farm, allowing us to carry on farming"
4. Chemical fertiliser use would decline to possibly a fifth of the current usage
5. Increase employment on farms from 21.5 to 25, an increase in 3.5 full time equivalents and safeguard 19.5 jobs by substantially increasing the income of farmers
6. One farm that would otherwise have been sold within six months will continue in operation.
7. Increased usage of currently underused land

One farmer summed up the overall impact of being involved in the AD plant very succinctly:

"Improving land environment – spreading when conditions are right. Putting (fertiliser) on land that requires it at the right time instead of having to get rid of it (slurry) when store is full on to land that does not need it and in the wrong weather destroying the soil. It will help us improve soil structure and get better yielding crops and improve income."

The AD plant can also benefit the local economy more generally by providing a source of low cost, low carbon heat and electricity. Indeed, CoRE NW has been looking at ways of using heat and other outputs from the AD process to develop other economic activities. Funding has been received to look at how this might be done to support local tourist and food production enterprises. One key way of doing this will be a proposed low carbon Eden of the North. It will use heat, CO2 and digestate from a cluster of AD plants including BEIF in a hydroponicum (a glass house with plants growing in a liquid medium, in our case digestate) to grow all year round vegetables and other food plants and be a significant tourist attraction. Other green tourist activities can also be linked to the AD plant and its production of renewable power.

Overall, it is clear that AD can provide a means of dealing with the severe decline of the UK dairy farmers by increasing and diversifying their income. It can also have significant benefits for the local economy.

We will now look in more detail at the viability of establishing and running the Energy Farm.

4. THE VIABILITY OF THE ENERGY FARM

The success of our Energy Farm will be affected by a range of issues, some of which are about how an AD plant is operated, the legal structure, the most appropriate taxation regime and so on. Such issues can be addressed by utilising best practice as set out in literature produced by the National Non-Food Crops Centre (NNFCC), BioReGen, the Renewable Energy Association (REA) and various other parties and we will deal with them in our final report.

However, as a first step we have to assess the practical viability of an AD plant and identify a suitable site. To do this we have identified a sequence of seven key factors or criteria to judge these factors against which are set out below in order of importance.

1. Availability of feedstock that will produce sufficient biogas to ensure a profitable operation primarily from the sale of electricity.
2. Long-term commitment to supply feedstock ('security of supply').
3. Availability of grid connection at a reasonable price.
4. Planning consent and environmental permit: a location where an appropriate technological solution can be developed that can potentially attain the required permissions and permits. This means a site has no significant adverse environmental effects (e.g. odour, noise, visual intrusion, spillages) which can't be mitigated against.
5. The ability to distribute the resulting digestate within a relatively close area, preferably to those who contributed input materials in the first place.
6. Access to local domestic/commercial/industrial users of electricity and heat so that the maximum amount of energy can be utilised and a higher financial value can be created for all parties involved.
7. Integration of local farmers and professionals in the supply and value chain, through co-ownership and/or agricultural contracting, maintenance and administration work.

4.1 AVAILABILITY OF INPUT MATERIAL

From the outset of our capacity study we had to come to terms with

- the geographical range of sourcing input materials, and
- the type of input materials, the key decision being whether to include Category 3 waste (like animal by-products, sewage sludge or food waste) or not.

We agreed to investigate for sources of input materials within a range of 2-3km from the identified plant location, then within a wider area of 5km, then of 10km and finally within an area of ca 15km or 10 miles.

Secondly we categorised the potentially available plant feedstock by increasing regulatory requirements and pre-treatment or post-treatment costs:

- animal slurry and manure
- vegetable and fruit waste
- landscape maintenance, i.e. certain lignin-free green cuttings
- energy crops including grass and clover silages, straw
- organic waste before it enters the manufacturing process, like rejected milk, milk whey, pot ale, brewers' grain, DDGS
- industrial organic waste (food manufacturing)
- commercial organic waste (catering, supermarkets, out-of-date food)
- household organic waste (waste collections)
- sewage sludge and sewage cake

After the initial identification of potential plant feedstock we were considering:

- biogas yields from the various substrates,
- their suitability in combination with other materials,
- potential income streams from gate fees,
- environmental benefits and
- other socio-economic benefits.

Starting from a sustainability angle we looked into the strengths and weaknesses of the Silloth area and immediately realised the enormous potential the food industry and the agricultural sector and in particular the dairy industry provided. After meeting several players in the food waste industry we realised that access to the larger volumes of food waste was barred by long-term waste contracts. Furthermore we were conscious that such materials would require more expensive and time consuming permissions to be attained. Given that ore research found large and reliable sources of feedstocks from agriculture, we concluded that the best solution was, at least for the pilot plant, to focus on agricultural materials, slurry, manures, milk whey and silages.

We are aware that agricultural AD plants have lower biogas yields compared to, for example, some types of food waste. But as there are AD plants based on either mostly slurries or mostly silages successfully operating in other European countries there is no practical reason against this approach.

As a social enterprise, our business model tries to include environmental and social benefits as desirable goals, despite the poor financial recognition they receive in the UK, and this in particular lead us to take in more slurry, which has a relatively low gas producing potential, but provides major environmental benefits, than would be considered on commercial grounds. However, we were also aware that if we took in all the slurry that was available, we would produce a significantly less profitable AD plant that may not be able to satisfy the needs of investors for capital payback. Many investors seek to have their capital repaid within the period of the first Power Purchase Agreement for renewable electricity, which is typically for five years. We thus had to balance our environmental aims with the need to be commercially viable and limit the amount of slurry we received to 75% and increase the more energy intensive silage feedstocks. Even by doing this, to be fundable we will probably still need a small capital grant of around £500,000.

We then focussed our efforts on farmers and assessing how likely it was that they would commit to long-term supply agreements. We indentified 15 farmers interested in being involved in the development of the BIEF, 13 have been engaged for over three months and have been met with on at least three occasions. Two additional farmers have become involved in the last month. It must be borne in mind that for farmers any involvement with an AD plant is very new and will require significant changes to their way of working and farming.

In terms of assessing the likelihood of farmers entering into long term agreements to supply materials, we can split the farmers into two groups: those supplying slurry and manure and those supplying (sometimes in addition to slurry) energy crops, usually grass silage. We can then get a better understanding the decision making process each group needs to go through

In both cases, farmers will receive back almost as much digestate as they supply feedstock. Thus a farmer supplying 1000 tonnes of slurry will receive back about 900 tonnes of digestate. Farmers are agreeable to do this.

For those supplying slurry, the key question for them to answer is whether or not the additional cost of transporting slurry to the AD plant and digestate back to their farm is worth the benefit they will receive in terms of the increased fertiliser value and usability of digestate. In most cases this will be a short journey of less than 2km. As such it will carry some costs in extra time and transport fuel. On the other side it will save time and costs because of the increased fertiliser value of the digestate (due to it being more easily absorbable) and its ease of use (slurry cannot be applied to land which cattle are grazing on or which is likely to be cropped within five weeks whilst digestate can be). The AD plant will also have capacity to store five months of digestate production, which means farmers in the NVZ area will not need to build increased storage capacity for slurry.

Of the farmers with slurry available (9 out of 15) all felt that supplying the AD plant with slurry and FYM was beneficial to them and agreed in principal to supply slurry.

For those supplying silage or energy crops the question is more straightforward, is the income they will receive greater and more secure from supplying the AD plant than what they are currently doing with the land, which in most cases was renting it to other farmers. Farmers will get at or near the long-term market rate for their crop as the AD plant can afford to pay this for silage which produces relatively large amounts of biogas. Additionally they receive in return digestate that they may have to transport or pay to have delivered, but will still reduce their fertiliser bills, enhance soil structure and thus increase overall profitability as we have outlined.

Our interviews identified enough arable farmers willing to produce at least 12,500 tonnes of grass silage annually. There was indication that some farmers might wish to take the opportunity to shift from dairy production to producing energy crops thus diversifying their income.

Interviews with farmers has provided in principle commitments to supply the following amounts of materials:

Farmer	Slurry (tons)	Silage	Manure	Chicken litter
A	0	4400	0	1100
B	0	900	0	0
C	0	1000	0	0
D	1670	0	0	0
E	0	0	3500	0
F	0	1000	0	0
G	0	600	0	0
H	3000	0	500	0

I	1670	0	0	0
J	1660	0	0	0
K	3000	0	0	0
L	0	1000	0	0
M	0	2600	0	0
N	0	0	0	0
O	0	1000	0	0
Total tonnes	**11000**	**12500**	**4000**	**1100**

Looking at the energy and thus income this amount of materials will produce using Biogas Hochriter's gas production models and the capital cost of setting up the plant of £3.1 million (see appendix 1 for more details) shows that payback of capital can be achieved in 6 years or 5 years with a grant of £500,000 without any equity investors. The pay back period could be further reduced by the introduction of equity stakeholders. After this period the plant will be generating substantial profits of around £500,000 per year. It is thus in our opinion commercially viable.

Energy 4 All have assessed the viability of the plant in terms of engaging local investors as per their successful model for funding community owned wind farms or turbines. They found that the profitability of the AD plant is sufficient to make their model work and thus provides another funding option. They have also concluded that the Internal Return on Investment is favourable at 12%.

4.2 SECURITY OF SUPPLY

In order to achieve a long-term commitment of all involved farmers and their supply delivery we have, as stated above, met frequently with farmers and organised a public meeting with them to which all 23 people turned up and all 15 farms were represented.

Farmers have expressed their commitment to being involved and we are developing supply agreements for them to sign up to.

However, our main strategy for gaining the buy-in of farmers is to make them joint owners of the AD plant. The ownership structure, which we shall outline in more detail in our subsequent report, involves the plant being owned by a cooperative of farmers as an Industrial and Provident Society, the family who own the land where the AD plant will be developed (who are also farmers and major contributors of silage) and CoRE NW. The major stakeholders will be the Farmers Coop and CoRE NW.

We believe that the fact that the farmers will jointly own the plant and will share in the profits it generates will provide a greater commitment to the project which will be more effective at maintaining a continuity of supply than contractual arrangements.

As the capital costs will be being paid off in the first four years, profits and dividend payments to farmers will naturally increase over time, providing a further incentive for farmers to be involved as a long-term commitment.

The other consideration in the supply security is the long-term price for energy crops. Looking at the last 10-year price average we identified grass silage as the least fluctuating crop. Whilst discussing alternative crop to grass silage we discarded the cultivation of rapeseed, maize or maize silage for two reason simultaneously: unfavourable climate conditions and extreme price fluctuations.

4.3 GRID CONNECTION

We have observed that there are low voltage and a high voltage electricity lines and various types of transformers close to our proposed location, which will be able to provide, one way or the other, the grid capacity we require.

We have submitted a request for a connection survey to United Utilities to clarify the situation.

4.4 SITE LOCATION: PLANNING AND TECHNOLOGY

The AD plant will be located on the Blackdyke Industrial Estate to the Southwest of Silloth. In term of regulatory factors and its environmental impact we have developed a range of proposal that we believe will mitigate against any environmental impacts and indeed bring environmental benefits.

The proposal will include the following key elements:

- two ring-in-ring tanks (42m diameter, 6m high), comprising an outer segment (digester) and inner segment (storage),
- engine building (contained in the corner of the existing on-site hangar inc two gas engines),
- liquid reception tank,
- additional digestate tank (replacing an existing dilapidated tank),
- silage clamp with bund,
- pipe work, and
- electrical grid connection, placed below ground

The site is slightly constrained and to fit in the three AD tanks required means will mean their size will need to be limited to a maximum size of 42m diameter. This means, given the feedstock we intend to use, digester will be just under 1000 kW. This is a relatively small output from this size as it allow for a relatively large amount of slurry compared to other higher energy feedstock such as silage.

Negotiations have begun with family that own Blackdyke Farm and they have signed a Memorandum of Understanding with CoRE NW and long-term cooperation agreement, which covers the expected time till plant commissioning.

The deciding planning authority will be Cumbria County Council. We, together with our environmental consultants, Enviros, had a pre-application meeting with one of their lead officers. The main consultees in the planning process are:

- Cumbria County Council,
- Allerdale Borough Council,
- Highways Agency,
- Solway Coast AONB,
- Environment Agency,
- Natural England,
- Silloth Parish Council,

We have discussed several potential planning and regulatory impacts and partly assessed their mitigation on the environment. Our final report will set these strategies out in detail, but here we will provide an overview to demonstrate that key regulatory and planning issues can be dealt with

From an **environmental health** perspective the issues that need to be considered in are:
Odour:
Odour can occur from:
- the transport of input material to the site's storage facility
- their on-site storage (silage clamp for solids, no open-air storage for liquids like slurry)
- their transfer from storage (silage clamp) to the feeder at the digester
- the pick-up of digestate

Odour does normally not occur from:
- from the actual process as the anaerobic tanks are by definition totally sealed
- from biogas, as it is completely odour-free (gas in households has actually enriched with odour particles to make it smell able)
- from the storage of processed material, ie digestate, as it is contained in sealed tanks (so that the final portions of gas can be collected)

It is worth mentioning that digestate is considered to have an odour that is 80% less detectable by humans compared to slurry.

Noise:
Noise can occur from transport, transfer of material and operation of equipment (stirrers, feeder). The AD plant is optimised to reduce noises from these sources within the AD plant and noise form these sources is minimal. However, the CHP engines are comparable to diesel engines in their noise output and we have minimised noise from these sources by the construction methods used in building the engine shed and by placing it within one of the hangars The development of a sustainable transport policy and site layout shortening vehicle routes and minimizing transport movements on site will reduce the noise impact from transport.

Pest control:
In the absence of food waste on site we do not expect we will need to set up additional pest control methods over and above those already in place on what is a working farm.

The **visual** and **landscape impact** of the AD plant can be categorised as follows:
The impact of **agricultural practices**: can be mitigated by a crop/grass selection using indigenous plants such as grass (excluding rye grass).

The impact of **infrastructure**: can be mitigated mainly by site selection – the Blackdyke Industrial estate is designated as an industrial estate. The hangars shield most of the visual impact of the AD plant. Additionally hedgerows will be planted to mitigate any further visual impact on the neighbourhood.

Keeping farmers in business, helping them to continue working in traditional ways will mitigate the impact on **the cultural landscape** and indeed be beneficial. We expect the increased income farmers will receive will enable them to keep their farmhouses and other building in good shape and for them to restore currently dilapidated agricultural buildings.

Criteria for location of the AD plant
Our criteria for site assessment were threefold:

1. THE PROPOSED SITE INFRASTRUCTURE CAN ACCOMMODATE OR 'ABSORB' THE PROPOSED AD PLANT

There are a large number of pre World War 2 large military aircraft hangars in the area which means that rather than being located in open fields, the AD plant will be close to two hangars. The nearest hangar is ca. 100m x 50m wide and ca. 10m in height. The digesters are located close to the front of the hangar. The hangar's height exceeds that of the AD tanks by 4m, which are 6m high. Thus the plant be smaller than existing structures and hidden by them.
Existing structures can also be used to house some of the required infrastructures of the AD plant:

- The engine room can be placed inside the hangar, thereby reducing the footprint, the noise impact and the visual impact of the Ad facility.
- Two existing storage tanks at the rear end of the hangar can be used as surplus digestate storage tanks, thereby repairing and refurbishing the partly neglected tanks.
- A dilapidated office at the front of the hangar will be refurbished and used as the Energy Farm office.
- The dilapidated building at the site entrance can be used as a future visitor centre to highlight AD technology in a farming environment, thereby not interrupting the ongoing farm business.
- The chicken litter clamp can be moved from outside into the hangar and by so doing its odour impact will be reduced.

2. THE PROPOSED SITE IS A REASONABLE DISTANCE FROM RESIDENTIAL DWELLINGS.

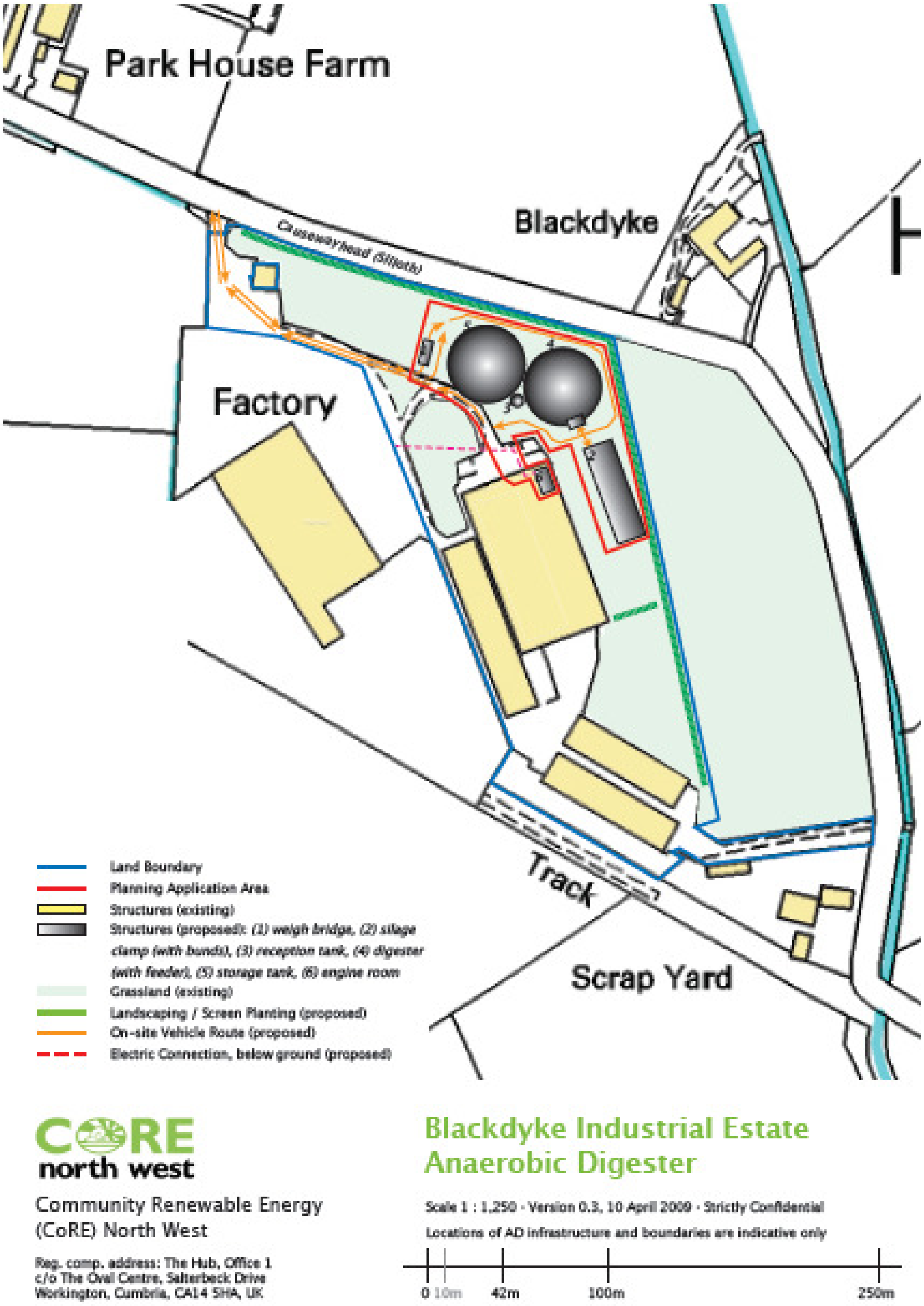
Direct view of the proposed AD location are partly obstructed by trees, hedges or the hangars.

3. CURRENT SITE ACTIVITY IS IN KEEPING WITH PROPOSED AD PLANT

Despite being designated as an industrial estate and there being a prefabricated concrete slab manufacturer and scrap yard on the Estate - the proposed site is currently largely in agricultural use: broiler chicken are kept in four chicken sheds, producing ca 1150 tons of chicken litter a year. Grain is stored inside the hangar. The surrounding grassland is used for grazing cattle.

There is only one household close to the site and there is good road access.

Overall we and Enviros have concluded that there are no major planning or regulatory issues that can not be overcome.



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4.5 DIGESTATE DISTRIBUTION

Farmers have agreed to receiving back similar quantities of digestate to the amounts of input materials they provide.

However, slurry providers are unlikely to want as much digestate back as they provide slurry and growers of silage may require more digestate to fertilise their grass than they supply in silage. The exact amounts will need to be determined as the project develops...

4.6 ENERGY SALES

Access to local domestic/commercial/industrial users of electricity and heat so that the maximum amount of energy can be utilised and a higher financial value can be created for all parties involved.

Our financial projections are based on heat initially being sold to the three chicken sheds on the site and there is the potential to sell a small amount of additional heat to the concrete fabricator and to use the heat for cooling the chicken sheds in the summer. Electricity could also be sold to these two end users.

However, these end users are unlikely to use anything more than a small proposition of the available energy resource. Most of the electricity will thus be sold to the grid and we will have to develop or attract additional heat users.

As outlined previously, one possible development we are working on is a proposal for an Eden of the North and there are also possibilities of using heat to dry crops.

4.7 WEALTH CREATION

As we have seen the AD plant will greatly benefit the farmers involved economically and nearly all profits will be retained for local benefit. Being a social enterprise, we are keen to ensure these benefits are shared by the local community and others. It is therefore hoped that a proportion of the profits will be used to benefit local community activity. There is also the possibility of local people investing in the Energy Farm and sharing in the profits directly.

Profits will also be used to develop other community owned renewable energy schemes. Key amongst these will be a cluster of Energy Farms that will not only benefit other farmers but also strengthen the operation of the BEIF by enabling a concentration of AD management and development skills.

We have also chosen a German technology provider, Biogas Hochriter, who are keen to support the development of local supply chains and which can provide significant opportunities for this development. Because of this and the fact that the plant is mainly constructed of concrete, 60% of the capital costs for the plant can be spent locally. We are keen to develop relationships with local suppliers who can be involved in building further plants in Cumbria and beyond.

Finally, as outlined previously, funding has also been secured to look at the possibility of developing low carbon enterprises that will benefit from the availability of renewable heat and electricity. Talks have already been had with local food producers and tourism businesses as well as the agencies that support them. This will effectively be a phase 2 development of the site.

5 IN CONCLUSION

Our research to date has shown that the Blackdyke Industrial Estate Energy Farm has the potential to be economically, socially and environmentally viable and to provide significant benefits for those involved and the local community. In particular, the Energy Farm has the potential to provide a model for halting the decline of the UK Dairy Industry and as a means of tackling climate change. A model we hope to exploit by developing a cluster of up to five Energy Farms in the area and other beyond.

Our final report will build on this work and set out in more detail the practical operation of the Energy Farm.

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APPENDIX 1 FINANCIAL PROJECTIONS

Blackdykye Industrial Estate Summary Capital Costs	£
AD plant and other equipment	2950000
Interest charges pre commissioning on capital	98714
Pre commissioning staff and running costs	109750
Total capital costs	**3158464**

Blackdyke Industrial Estate Energy Farm summary profit and loss budget

Year	1	2	3	4	5	6	7	8	9	10	**Total**
Income											
Electricity Sales	1,023,239	1,136,932	1,136,932	1,136,932	1,136,932	1,136,932	1,136,932	1,136,932	1,136,932	1,136,932	**11,255,628**
Heat sales	12,000	24,000	113,693	113,693	113,693	227,386	227,386	227,386	227,386	227,386	**1,514,012**
Digestate Sales	0	9,533	19,067	28,600	38,133	38,133	38,133	38,133	38,133	38,133	**286,000**
Total income	**1,035,239**	**1,170,465**	**1,269,692**	**1,279,225**	**1,288,759**	**1,402,452**	**1,402,452**	**1,402,452**	**1,402,452**	**1,402,452**	**13,055,640**
Operating Costs											
Staffing costs	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	**700,000**
Silage 12,500 ton (£25/ton)	281,250	312,500	312,500	312,500	312,500	312,500	312,500	312,500	312,500	312,500	**3,093,750**
Maintenance	50,000	50,000	50,000	50,000	50,000	60,000	300,000	50,000	50,000	50,000	**760,000**
Other	56,065	56,340	56,340	56,340	56,340	56,340	56,340	56,340	56,340	56,340	**563,125**
Total Operating Costs	**457,315**	**488,840**	**488,840**	**488,840**	**488,840**	**498,840**	**738,840**	**488,840**	**488,840**	**488,840**	**5,116,875**
Operating profit	**577,924**	**681,625**	**780,852**	**790,385**	**799,919**	**903,612**	**663,612**	**913,612**	**913,612**	**913,612**	**7,938,765**
Finance costs and repayments											
Repayment of capital	345,000	470,000	605,000	655,000	710,000	373,464	0	0	0	0	**3,158,464**
Outstanding capital	2,813,464	2,343,464	1,738,464	1,083,464	373,464	0	0	0	0	0	**8,352,320**
Interest repayment @ 7%	221,092	196,942	164,042	121,692	75,842	26,142	0	0	0	0	**805,755**
Total finance & repayment costs	566,092	666,942	769,042	776,692	785,842	399,606	0	0	0	0	**3,964,219**
Net profit before tax after interest & capital repayment	**11,832**	**14,684**	**11,811**	**13,694**	**14,078**	**503,507**	**663,113**	**913,113**	**913,113**	**913,113**	**3,972,059**