Local United

Energy farms – anaerobic digestion

How to develop a community-led agricultural anaerobic digester

Local United – diffusing practical initiatives in response to climate change and peak oil

Local United brings together and supports community activists who are setting up social enterprises to address the challenges of peak oil and climate change. We aim to speed up the rate at which good ideas are adopted by community groups motivated to build low-carbon economies.

Initially eight 'diffusion packs' have been produced which offer practical suggestions for setting up initiatives in the following areas:

Energy Farms	Community-led Food Initiatives
Community-led Hydro Initiatives	Sustainable Community loan Fund
Community-led Wind power	Community-led Reuse of Resources
Energy Performance Energy Services Company	Community-led Transport Initiatives

NESTA provided funding for the development and dissemination of these information packs which have been written and reviewed by people with first-hand knowledge of the community and climate action sectors they work in. Often the authors will have been involved in the conception of the project idea and in many cases they would now be regarded as experts in their fields. Biographies will soon be available on our websites

All of these packs are intended as on-going 'works-in-progress'. We are hoping that other groups working in these areas will add in their experience. In time they will build into a comprehensive library of good practice case studies. They will become a source of inspiration to community groups. They will provide information on motivational projects which have been carried out by other community groups and they will act as a directional tool to help communities who are ready to take action, to do just that.

These packs are offered to groups who are interested in setting up social enterprises in these areas. They can be downloaded from the many partner websites.

Of course, any information provided is only as up to date as the day it goes to print. Many of the specific examples have worked so well because of the people involved, the skills they possess or the resources that were available to them. Thus these examples will predominantly serve as an inspirational call to arms. However, many of the packs contain useful 'how to' guides, copies of legal templates or list of regulations, all of which may be useful to community groups wishing to set out on their own project. All of the packs contain notes or links on where to find more help.

Feedback on these packs is continually being sought. Community groups who have used the packs to support their own projects are very welcome, and indeed are invited, to provide information on how useful the packs have been, what other information we should be providing or any other feedback which may help us to improve these in the future.

Local United is keen to work with other groups and organisations active in these areas who may be interested in offering the diffusion packs through their websites. We are also actively seeking funding to follow up these packs with a mentoring/buddying system which will provide additional support to emerging social enterprises.

Energy Farms – Developing Cooperative Anaerobic Digesters

This pack is designed to provide an overview of Anaerobic Digestion. It is designed to inspire community groups to take action and uses examples from CoRE (Community Renewable Energy) which is a social enterprise that works with community groups to develop community energy projects. Much of what you find in this pack will be specific to what CoRE has done in the past and will show you how your community could emulate these projects.

Introduction

Renewable energy is needed to meet climate change targets and, in many circumstances can be a means of generating sustainable incomes for communities.

Government is increasingly recognising the need for communities to get involved in developing renewable energy and has introduced a number of measures, such as Feed in Tariffs (FiTs) to encourage communities and enable them to develop potentially profitable schemes. However, the number of community energy schemes in the UK is much fewer than in many European countries. This is a consequence of a number of factors:-

- *A lack of a clear financial driver to initiate community energy projects.*
- *Very high set-up costs (planning, legal costs, co-ordination), which are at risk before the project is built and operating.*
- *A lack of replicable, well-tested models for deploying community energy projects.*
- *A lack of finance for the apparently risky smaller community energy projects.*[1]

If we are to overcome these barriers communities need to work together, to share knowledge and to work collaboratively so they can replicate proven models and offer a credible alternative to the private sector. Community Renewable Energy operates as a social franchise (ie they work together under a common brand sharing knowledge etc) to enable this joint working, as do other social enterprises like The Green Valleys Trust and Energy 4 All.

CoRE works with all forms of renewable energy, but has developed a speciality in anaerobic digestions. We have produced this pack to share our knowledge of anaerobic digestion and more specifically, anaerobic digesters fed by agricultural materials – slurry, manure and energy crops.

Strategy

Anaerobic Digesters generate significant amounts of energy from agricultural materials (eg slurry and energy crops like silage) and food waste. The new coalition government has identified an opportunity to develop anaerobic digesters on a significant scale[2]. The National Farmers Union, supported by the government has set a target of 1000 farm based anaerobic digesters in the UK. At present there are fewer than fifteen such AD plants in the UK, but in Germany there are over 5000.

[1]Conclusions from a study by the Energy Savings Trust 2008 into the development of renewables at a community level

[2] The Coalition: our programmed for government 2010

If we make general comparisons to other forms of renewable energy, anaerobic digestion is one of the more profitable, though not as profitable as wind. It creates a lot of jobs and is quicker to develop compared to similar sized wind turbine or hydro schemes.

AD plants also produce heat as well as electricity. However, to be viable AD plants have to be quite large and thus require significant capital investments of between £1-5million.

Individual farms will often not be large enough to produce enough feedstock (any organic material apart from wood) run a viable plant. So here we will look at how an Energy Farm (as we call agricultural AD plants) can be set up with a cooperative of farmers providing the feedstocks in the form of energy crops (principally grass silage). In this example, the community is a farmers' cooperative working with a community organisation.

West Cumbria, and other area of the country such as Devon, Cheshire and North Yorkshire, is well suited to establishing Energy Farms because of large cattle and dairy herds which produce substantial amounts of slurry, which is an important feedstock for AD plants. They have large herds because the areas are good for growing grass, which is a very high energy feedstock for AD plants. CoRE's pilot 1000 kW Energy Farm, is in Silloth, West Cumbria and we have secured planning permission for it, together with a second plant near by, and are about to begin its construction in January 2012. These experiences will be drawn upon as examples for this document.

Agricultural AD is also suited to other areas of the UK which produce large quantities of agricultural by products, eg the tops from sugar beet or potato peelings but there is always a need for slurry or manure to provide the bacteria.

Culture and community benefits

Many farmers are leaving farming and a way of life that may have been in their family for generations. This is because of the low price paid for food and is a factor that has particularly affected dairy farmers. Over the last 11 years the number of dairy farmers has reduced by a third from 35,104 in 1997 to 20,122 in 2008. At the same time UK milk production has declined whilst consumption has increased.

The need to become more economic has driven the growth of larger and larger herds and farms and a more intensive form of agriculture. This intensification often increases the burdens on the local environment. It is likely AD plants can help farmers diversify, increase their income and thus reduce the need for intensification and reduce the impact they have on their local environment.

We will now look in more detail at the benefits of anaerobic digestion, but first we need to better understand what it is.

What is Anaerobic Digestion?

Anaerobic digestion is perhaps one of the least well understood forms of renewable energy but in some ways it is the simplest and one of the oldest (the Babylonians are thought to have first used the technology).

An anaerobic digester can be likened to a cow's stomach; it uses the same natural processes. Bacteria break down organic materials in an oxygen free environment (large concrete or steel tanks). This results in the production of methane and a liquid called digestate. Methane is used in large engines similar to petrol engines to produce electricity. In doing this, like any engine, they produce large amounts of heat. Thus a 1000 kW anaerobic digester will not only produce 1000kW of electricity, it will also produce a similar amount of heat. This is considered renewable energy because the CO_2 released by burning the methane in the engines is then absorbed by the crops grown to feed the digester.

The other product of an Energy Farm is the liquid digestate. More like compost than fresh manure; it is a much better and more effective fertiliser than raw slurry as well as being much less smelly! Around 80 tonnes of digestate are produced for every 100 tonnes of feedstock. This digestate is normally spread back on land as a fertiliser (making the system virtually a closed loop).

In general the amount of energy produced by feedstocks is related to their energy value. Thus a tonne of fat will produce far more energy than a tonne of protein as it has a higher calorific value (basically the fatter it makes you the more energy a material contains!). In addition, the drier a material the more energy it contains. Thus the solid content of milk whey (a liquid by-product from cheese production) is mostly protein, but it also has a lot of water so it does not produce much energy per tonne. Cheese, by contrast, has much less water and is made up of fat and protein so will produce maybe 25 times more energy per tonne. Slurry, because it is largely water and because the animal has done its best to extract as much energy as possible from it, has very little energy value. However, it and/or manure are necessary to provide the bacteria needed for the AD plant to function. Environmentally, its inclusion also has major benefits.

Thus in total the 1000kW AD plant planned for Silloth in West Cumbria will take in about 16,000 tonnes of energy crops (mostly grass silage because that is the most suited energy crop to the area) and 14,000 tonnes of slurry and manures. Although this sounds like a lot, all of the materials needed will come from farms 2km or less from the AD plant.

Positioning

Socio Economic benefits of Energy Farms
The CoRE approach brings together a cooperative of farmers to develop and supply an Energy Farm. This has the commercial scale to be viable, whilst allowing farmers to continue producing food, which is what most of them want to do. Supplying an Energy Farm can be very profitable and the extra income allows them to stay in farming and provide a long term future for their families. Crucially, it also provides a long-term, stable and reliable price for their produce.

Research for the pilot plant at Silloth shows that it will create 2 jobs running the plant, 1.5 jobs in CoRE managing the plant and developing others and 3.5 jobs on the 8 farms involved in the cooperative. In addition it is estimated that it will help sustain a further 15.5 jobs on

the farms and help create jobs through the availability of low cost heat. One of the more surprising results of the research was the fact that the supplying the Energy Farm would double the number of farmer's children staying involved in farming.

Local jobs will also be created in the construction of the plant and local supply chains. Indeed, one of the reasons why we CoRE chose Biogas Hoechreiter to supply the AD technology is that, although a German company, up to 60% of the capital cost of the plant can be spent locally principally on the construction of the concrete tanks need for the digester. Thus the construction of the plant is likely to have considerable local economic benefits, as will the development of the supply chain.

A cooperative approach also allows farmers to compete with large companies who are beginning to buy up land solely to produce energy crops to feed AD plants.

1 8 MW plant under construction

Environmental benefits

The main environmental benefits from AD are

1. Reduction in CO_2 emissions by, for example, 6,000 tonnes per annum for a 1000kW plant by
    - replacing heat and electricity produced from fossil fuels ,
    - reducing methane released into the atmosphere from slurry and the use of energy intensive fertilisers
2. An organic fertiliser - compared to slurry, digestate is a much better fertiliser, it has much less smell and it does not spread weeds and disease as slurry does. An AD plant has to be able to store 6 months worth of digestate. This reduces the need for farmers to build slurry stores.   This is of particular importance to farmers in Nitrogen Vulnerable Zones (NVZ) as they might otherwise have to spend up to £100,000 to upgrade their slurry storage capacity to meet NVZ regulations.
3. Consistent energy production, a 1000 kW AD plant will operate at 1000 kW over 90% of the year. Thus a 1000 kW AD plant will produce as much electricity (about 8,000,000 kWh) a

year as a 3000 kW wind turbine or wind farm as well as similar quantities of heat. Thus a 1000 kWh AD plant will supply 1700 households with electricity and 400 households with heat.

One the farmers summed up the overall impact of being involved in CoRE's AD plant. *"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 Food versus energy debate
It is undoubtedly true that AD plants will need land to grow crops that could otherwise be used for food production, but this must be kept in context. The NFU's plans for 1000 AD plants will use only a small proportion of the land area used to grow food. Indeed even this many AD plants will use less land than is used for golf courses or keeping horses used for leisure. Furthermore, farmers have traditionally used up to 25% of their land for energy, either to produce wood for heating or feed horses and oxen for motive power.

Why should communities look at AD?
AD has a number of benefits compared to other renewable technologies:

- It is relatively profitable and probably second only to wind.
- It takes relatively less time to develop because less time is needed to assess energy production, obtain planning and other permissions, for example it has taken about 2 years for CoRE to obtain planning permission and get to the position of being able to build their first AD plant. To get to this finance ready position for a wind turbine/s of comparable energy output (about 3000 kW) would take at least three years and a hydro scheme could take even longer. Furthermore, CoRE's second AD plant has taken half as long to develop and get to this position
- It generates large amounts of local employment both in its construction and running – CoRE estimate that a 1000kW AD plant will create about 7 jobs and sustain about 19 directly
- It produces heat and electricity meaning that it is possible to have a major impact on a community's carbon emissions.

However, AD, like any renewable technology, is not suitable for all areas. One would only develop AD plants where there are local sources of suitable feedstocks (ie with enough energy to be commercially viable). The location of the plant should also consider heat users as well the necessary connection to the Grid.

Operations

Service Delivery

Is an AD plant suitable for your community?

To assess the viability of setting up an AD plant the following questions need to be considered:-

1. Is there enough feedstock locally available, depending on the nature of the feedstock this is likely to be in the order of a minimum of 5000 tonnes to produce enough energy to feed at least a 250 kW AD plant ? This is the smallest size that will normally be commercially viable, but it could be smaller or bigger depending on the cost and availability of feedstocks? For example, if you have a large amount of grass from an airport or horse manure that is free or you can sell all the heat you produce, a 200 kW AD plant or smaller might be viable.
2. Is there a place where an AD plant could be built - a 500 kW Energy farm will require at least an acre and it should be in a suitable area ie not in an area prone to flooding etc?
3. Can the electricity and heat produced be sold – are grid connection costs going to be very high (this can only be properly understood by talking with your local District network Operator, DNO, the people who manage the supply line), is there a local heat user such as a swimming pool, a hotel or large greenhouse -AD can be viable without selling heat, but it is obviously better to do so?
4. Is there enough land available to spread the large amounts of digestate an AD plant produces on to?
5. Can planning permission be obtained? Some of the major issues are proximity to water courses and homes, transport of materials on public roads and visual impact. So far CoRE has gained two planning permissions, for the first there were two objectors and for the second there were none. So AS does not need to create a lot of local opposition.
6. Can the necessary finance be raised? Prices start at just over a £1million and a 500 kW AD plant will cost about £2million. In terms of raising capital to build the project, there are a variety of means of doing this through bank loans, equity investors, community share issues and so on. For more information on raising finance see the Share Energy's wind turbine diffusion pack.

At this stage it may be worth considering putting food waste into an AD plant alongside agricultural materials. Whilst this sounds an ideal solution (food waste is generally of high energy value and thus is an ideal compliment to slurry), in practice it is difficult for the following reasons

- There is less food waste available than one might expect.
- An AD plant is a long term commitment – it will operate for at least 25 years and it is difficult to guarantee supplies of food waste for more than a few years.
- As soon as any food waste involving meat or other such materials is used in the AD plant, the costs of running and building the plant increase dramatically. This is because of regulatory requirements, increased reporting, the need to pasteurise food waste and so on. As a result capital costs can increase by 50%.
- It becomes much more difficult to get rid of the digestate – although legal to spread digestate produced form food waste on food producing land, the products of the land (eg grain or meat) become harder to sell because of market concerns about food contamination.

Finances

Construction costs

Energy Farms will cost between £1-4million for a 200kW to 1000 kW plant. Set out below are indicative costs of building a 500kW plant with one concrete ring in ring plant (ie with an inner and outer tank) of 42m diameter. It is important to be careful when comparing quotes to ensure all costs like silage clamps (used to store crops) are included. It is also possible to build cheaper systems with poorer quality equipment, steel instead of concrete tanks and so on, but be aware that such cost reductions reduce efficiency and reduce life expectancy. They can also cause greater problems with planning as it is preferable to build concrete tanks under ground, which is not the case with steel tanks. They are thus better at retaining heat and easier to feed.

	Permits, design, legal, Health & Safety, planning permission	200,000
	Construction of tank and buildings	725,000
	Equipment, CHP, Mechanical & Engineering , commissioning	900,000
	Plant Sub-total	1,825,000
	Access roads, silage clamp, services, slurry store	160,000
	Grid connection	100,000
	Periphery Sub-total	260,000
	Total Capital Expend	**2,085,000**
3%	Project contingency	52,125
	Grand Total	**2,137,125**

Operational finance

Anaerobic digesters can obtain Feed in Tariff which results in an income of about 16p a kWh for AD plants up to 500 kW, and 14.5p a kWh for plants between 500 to 5000 kWh. Alternatively, double RoCs (Renewable Obligation Certificates) can be obtained, which will result in a sale price of about 16p kWh (but ROCs are not fixed in price like Feed n Tariff. With the proposed Renewable Heat Incentive, heat can generate about 6p per kWh (3p per kWh without it).

The introduction of these financial incentives means Energy Farms are reasonably profitable. A 500 kW plant will typically cost £2million, produce sales of £700,000, principally the sale of energy and financial incentives (ROCs or FiT), and a year with revenue costs of about £4250, 000 per annum, principally the price paid for silage and other feedstocks and maintenance of the CHP engines. This then leaves a profit in the first full year of operation of £250,000 (year 2). This assumes about 5% of the available heat is sold. If more of the heat can be sold, profitability increases significantly, low cost feedstocks can also make a large difference to profitability. Appendix 1 provides more financial detail.

Raising finance

An Energy Farm will pay back its capital costs in between 4 to 8 years depending on its size and costs of feedstocks and how much heat can be sold. This makes it a commercially viable proposition.

Typically, to finance any renewable energy systems requires equity investment of at least 30% (money that is at risk and generates dividends based on the size of profits) and bank loans of 70% (money that is less at risk and for which interest is paid). However, the current financial situation has meant that banks are less willing to make loans to renewable energy

schemes in general and in particular to less well known processes like AD. CoRE had to raise all their money from equity investors and a small amount of grant. As more AD plants are built, however, it should become easier to finance them.

Whilst capital to construct a plant is difficult, perhaps the most difficult costs to cover, as with any renewable energy scheme, are those necessary to get the project to a point that it is 'finance ready'. For a bank and most investors, this means

- The plant is ready to be built – planning permissions and environment agency permits have been obtained and the land has been secured (ie there is a long-term agreement or lease in place).
- Feedstocks are guaranteed – usually this means for at least 5 years and involves supply agreements with farmers or others supplying the plant
- Evidence is available that the heat and electricity predicted in the finance model can be sold - for electricity this is relatively easy and involves working with an energy trader to secure a Power Purchase Agreement. For heat, investors will need to see contracts with end users. Ideally, such contracts will need to be for number of years, probably at least five, to justify the capital costs of distributing the heat.
- Proof that the technology will work – evidence of a reliable manufacturer and a fully worked up design and construction plan for the plant. Also guarantees and maintenance/insurance agreements with technology and equipment supplier.

To make an Energy Farm finance-ready will cost about £200,000, about £120,000 of which will be spent obtaining planning permission. This money is more difficult to rise as there is a risk that the plant won't obtain planning permission or will work out too expensive to build. CoRE, raised this money from grants and from people working at risk – ie they were sufficiently committed to the project that they worked unpaid on the assumption that they would get paid when the plant was built or have a small stake in it.

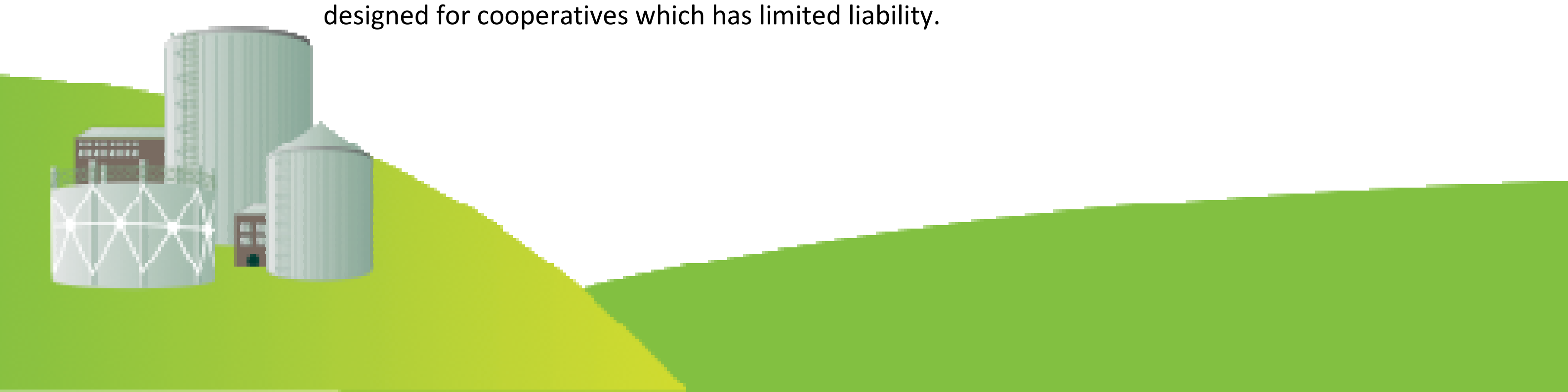
Of course, not all of this money has to be raised up front as the work can be done in stages, but before embarking on the project the ultimate goals need to be clearly set out. CoRE, admit that 'had we realised {what was required} we would probably have sought more of the finance from the farmers involved'.

Please note that any sizeable renewable energy scheme will involve substantial costs before it is finance ready. Indeed, as outlined previously, other forms of renewables eg hydro or wind, can involve even more expense to become finance ready and certainly more time.

Legal structures

Like any large project, it is sensible to set up a separate legal entity to run and operate it, commonly known as a JV (Joint Venture). This is not only prudent (it reduces risk to the organisations involved) it is also practical as it provides a means of governing the operation and distributing the profits if more than one organisation is involved.

CoRE set up a company limited by shares which will be owned by them, private investors and the farmers through an Industrial and Provident Society (IPS). An IPS is a legal structure specifically designed for cooperatives which has limited liability.



As part of their membership agreement that they need to sign before they can join the IPS, farmers will agree to supply a certain amount of feedstocks to the AD plant. They can also invest up to £20,000 through the IPS in the Energy Farm and have the opportunity to invest more directly in the JV (and thus become private investors).

In the future CoRE will look to set up a Community Share Scheme so that members of the local community can invest in the Energy Farm too. Other organisations, like Low Carbon West Oxford and Sheffield Renewables, are developing similar schemes.

CoRE will use its share of the profits from the AD plant to support other communities to develop renewable energy systems.

Operation

Running an AD plant itself is relatively straightforward and basically involves ensuring that the plant is fed continually with the right balance of feedstocks to maintain optimum operation. In the case of the Silloth AD plant the technology provider, Biogas Hoechreiter, will remotely monitor and analyse regular samples to maintain the right chemical balance in the plant.

As well as feeding the AD plant, supply from the farmers needs to be managed and the input materials tested for energy values (CoRE uses a bonus system to encourage farmers to maximise the energy value of the crops they supply) also payments to farmers need to be administered. There are also regulatory functions which for agricultural AD plants are not too onerous (they are much more complicated for AD plants involving food waste), managing the supply of feedstocks and general administration of the business.

CoRE estimate that 2 full time staff will be needed to carry out this work on site and a half time post within CoRE. CoRE will have responsibility for operating the plant on behalf of the JV and have a contract to do so. This enables them to develop economies of scale, eg through the sale of power through their Energy Supply Company and managing feedstocks, as they are intending to build a cluster of AD plants.

Marketing

Generally, most of the electricity generated will be sold through the National Grid through what is called a Power Purchase Agreement. This ensures payment of the current market value of the electricity (AD plants currently get about 5p kWh). In addition to this, as set out above, the Feed in Tariff will be applicable.

The marketing of heat is much more complex as it can only be used close to the Energy Farm –2km is generally thought of as the maximum distance. In addition to proximity, most heat user's demand varies considerably through the year. This makes heat distribution complicated, though CoRE are developing expertise in the distribution of heat from AD systems and establishing district heating systems to businesses and houses. They are also developing relationships with companies that might wish to locate next to an AD plant and make use of the low cost heat such as tomato growers or crop driers.

AD is an ideal base generator for any community seeking to generate renewable energy and substantially reduce its carbon footprint. It will reliably produce power (unlike most other forms of renewables) 24/7 and it produces both heat and electricity.

Biogas plant in an urban environment

Skills needed

With Feed in Tariffs, ROCs, and the forthcoming Renewable Heat Incentive, the potential income from an AD plant has doubled in the last few years. However as we have seen, finance to develop and build what will potentially be a profitable business is difficult to obtain. There are also cultural barriers in the UK to overcome:

- AD is largely seen as a chemical process and run by industrial chemists who do not relate easily to the agricultural world.
- Farmers are much less likely to be part of co-operatives in England compared to Scotland - never mind other parts of Europe.
- AD is also often wrongly perceived to be another form of incineration and is poorly understood by regulators and the general public.
- It is often very difficult to obtain information on the performance and cost of AD plants. CoRE has done this by developing a close relationship with a German AD manufacturer.

A report by The Andersons Centre for the National Non-Food Crops Centre predicted *'Assuming the UK policy of paying double ROCs starts in April 2009* (which it has) *then the table below shows how UK operators will potentially be able to make even more money from AD than the Germans. This indicates that the dramatic explosion in numbers of sites experienced in Germany over the last four years is about to happen in the UK."*

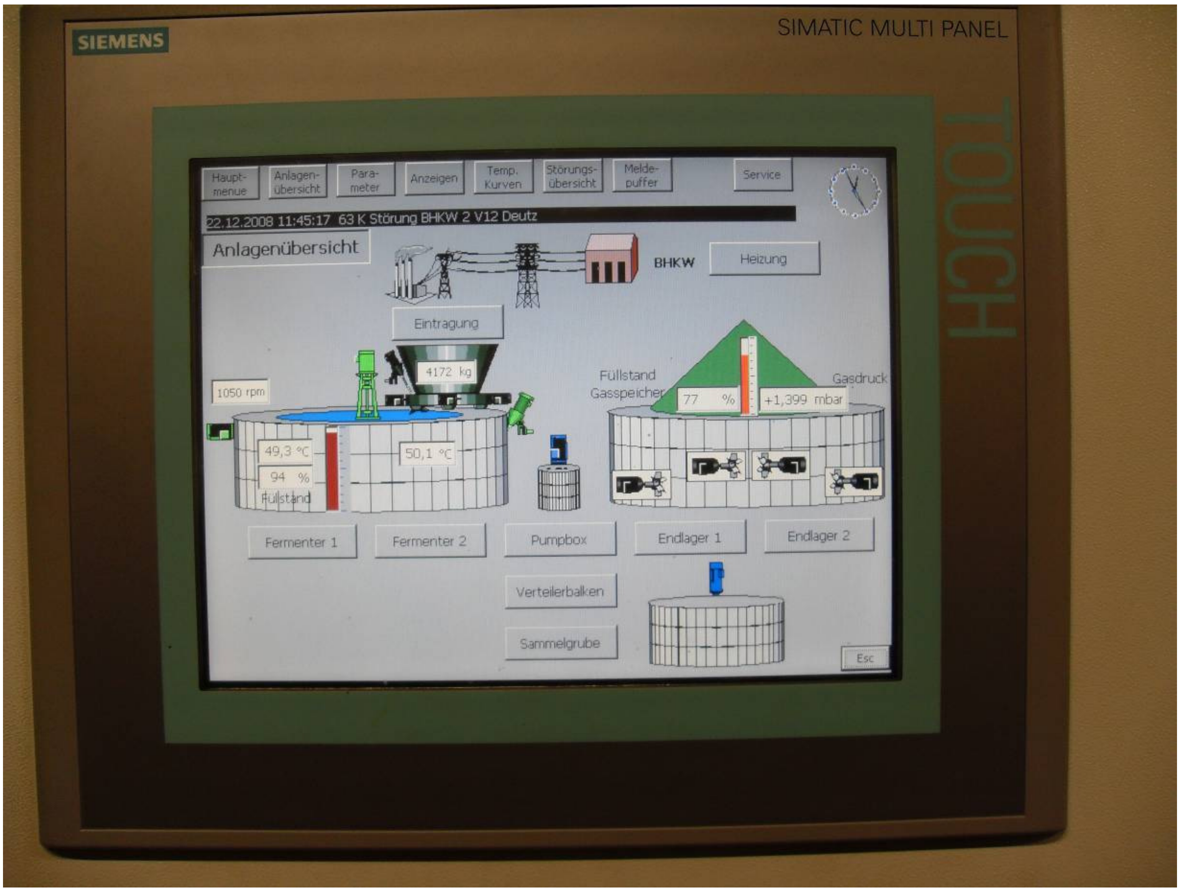
From 'A Detailed Economic Assessment of Anaerobic Digestion Technology and its Suitability to UK Farming and Waste Systems', 2008.

If this opportunity is to be capitalised on, communities and farmers need to have skills and expertise in the following areas

- The technical and regulatory knowledge of AD to obtain planning permissions and other necessary permits
- An understanding of the electricity generating industry and in particular renewable energy
- An understanding of agricultural processes and the agricultural industry more generally – communities need to be able to talk to farmers in their own language
- Expertise in raising finance – AD plants require substantial investment. To raise the money required will require the production of detailed financial information.
- Expertise in developing cooperatives – this will often require someone to manage the Farmers Coop who preferably is not one of the farmers so they can act as a honest broker between the Coop members
- In depth technical knowledge of AD - the AD market is very new in the UK. Thus if a community is developing a wind turbine it is reasonably easy to obtain typical costs for a turbine and estimates how much energy it will produce in a given area. This is not the case for AD because it is a much less well developed market. Thus estimating capital costs is much harder and assessing how much energy is available from different feedstocks is much more complicated. This type of knowledge is jealously guarded. So a tame expert with industry knowledge is needed, or a relationship with an AD manufacturer.

If a community is seriously thinking of embarking down this path then it may be useful to be thinking of developing a cluster of plants. To build up the knowledge necessary to build one plant is a time consuming exercise and probably not justified by the returns one plant can make. Thus CoRE's first plant at Silloth took twice as long and cost twice as much to obtain planning permission for compared to their second plant at Kirkbride. In addition to this, they also developed links with financiers and banks, produced agreements and developed other competencies in developing the pilot plant which are making subsequent plants much easier and cheaper to develop.

Running an AD plant



1 Part of the AD plant control system that can provide a graphical display of many of the functions of the plant and its operation.

The staff requirements are for the following activities

1. Twice a day putting solid material into the automatic feeder
2. Ensuring deliveries of feed stocks are made in such a way as to keep the plant in continuous operation and congestion on the site is minimised. There will be on average six vehicle movements a day (for a 1000kW plant) but there will be variations eg when silage is being cut
3. Enforcing, monitoring and keeping up with health & safety requirements and regulations
4. Monitoring overall functioning of the digester
5. Inspection and maintenance of AD plant and servicing of CHP unit
6. Taking and administering of monitoring samples from the digestate
7. Overall management of inputs and liaison with supplying farmers
8. Managing sales of energy and billing for heat used
9. Recording quantities of inputs supplied by farmers and making payments
10. Financial management of the company

Most manufacturers, like the supplier, Biogas Hochreiter, would be involved in monitoring the plant though telecommunications and provide guidance on adjustments needed. In large part the AD plant will run automatically, with surprisingly little staff involvement. However, staff need to be available to respond to any changes in the plant.

Overall, the above would require the equivalent of two staff:
1. Administrator/plant operator half time
2. Plant Operator/maintenance full time
3. Plant Manager/back-up half time

There will need to be some flexibility in roles to ensure a smooth operation and cover can be provided for most of the day. Some of the above roles can be provided by contracting with one of the farmers involved in the farmer's cooperative.

Support to develop AD

Developing an AD plant will require considerable time and financial resources. It may be possible to find this locally together with the necessary skills as set out above or for people to learn them or buy them in.

An alternative to this is to work in partnership with an existing organisation or seek support from them. As far as we are aware CoRE is the only social enterprise to have moved beyond the feasibility stage and obtained planning permission. However, other organisations are actively looking at this, such as Greener for Life at Tiverton in Devon, ShareEnergy in the West Midlands and the Scottish Agricultural Organisation Society Ltd. There may also be local renewable support agencies like The Centre for Process Innovation in the North East (they can work outside of the North East as well).

A community group may also be able to get support from commercial organisations. Choosing an AD manufacturer is difficult as there is little comparative information on different products, a large number of manufacturers and very few operating in the UK.

Rob Skinner of CoRE NW talking to a group of Silloth farmers

In conclusion

AD presents a huge opportunity for the UK and is particularly suited to community development as it is profitable, creates jobs and can be a means of greatly reducing a community's greenhouse gas emissions. However, like most forms of renewable energy, it is complicated to implement.

Further information

If you wish to find out more about CoRE's work on AD and renewables, the training we provide or become a member of the CoRE Network go to www.core .coop. Membership of the CoRE Network is free. CoRE is a social franchise and is happy to work with any community to develop community owned renewable energy systems. It currently operates in the North of England but is happy to discuss possible joint working with people from others parts of the country.

The following provide useful reference information; we would particularly recommend the Anderson Report as a detailed and valuable source. It, together with other useful tools and information, can be found at http://www.biogas-info.co.uk/. Please note there is a spreadsheet for calculating financial viability which is very useful, but needs a fair degree of knowledge to use.   Some of the key data required to assess viability is not calculated by the spreadsheet (eg capital costs) and some of the base assumptions are not very accurate and highly dependent on the equipment being used.

Biomass Task Force Report to Government, 2005

Livestock's long shadow: environmental issues and options; Livestock, Environment and Development (LEAD), Rome 2006

UK Biomass Strategy: Economic analysis of biomass energy; Energy Technologies Unit, DTI, 2007

BioReGen series: *Commercial Assessment of Anaerobic Digestion Technology for Biomass Projects;* by Juniper for Renewables East, 2007

Outlines Feasibility of Centralised Anaerobic Digestion Plants linked to Dairy Supply chain; AEA for Dairy UK, 2007

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Documents Available

CoRE NW can make available the following documents (some documents are only available to groups wishing to work with CoRE as they are commercially sensitive).

- Financial models that meet bank and finance requirements
- AD feasibility studies
- Farmer supply agreements
- IPS cooperative structures for farmers
- Pricing schedules and bonus arrangements
- Memorandum of Understanding and Exclusivity Agreements
- Social economic impact assessment of agricultural AD plants
- AD development process
- Gas production assessments
- Planning documentation
- Environmental Agency Permitting models

Open Source Materials

Appendix 1 500 kW AD plant summary finances

The following is a financial model for a 500 kW plant receiving Feed in Tariff and selling about 5% of the available heat. We have assumed inflation of 3% per annum based on historical figures and energy price inflation of 6%.

Summary for 10 year bank loan pay back, no grant, 30% equity

Income	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*	*Year 7*	*Year 8*	*Year 9*	*Year 10*	***Total 10 yrs***	***Total 25 yrs***
Electricity	610,445	690,121	717,615	746,341	776,360	807,738	840,542	874,845	910,722	948,254	7,922,984	27,826,380
Heat	9,586	10,651	11,153	11,681	12,236	12,821	13,436	14,084	14,765	15,483	125,895	469,222
Total income	620,030	700,772	728,768	758,022	788,597	820,559	853,979	888,929	925,487	963,736	8,048,878	28,295,601
Expenditure											0	
Cost of input materials	267,024	305,594	314,761	324,204	333,930	343,948	354,267	364,895	375,842	387,117	3,371,581	10,787,532
Staff Costs	25,000	25,750	26,523	27,318	28,138	28,982	29,851	30,747	31,669	32,619	286,597	677,229
Interest and loan	226,838	238,414	228,690	218,966	209,242	199,518	189,794	180,071	170,347	180,623	2,042,503	2,042,503
Maintenance	32,346	42,346	43,616	44,925	46,273	47,661	49,091	50,563	52,080	53,643	462,543	1,113,705
Biological & chemical support	14,519	16,132	16,616	17,114	17,628	18,156	18,701	19,262	19,840	20,435	178,403	424,269
General admin, permits, legal costs etc	46,000	55,363	57,024	58,735	60,497	62,312	64,181	66,106	68,090	70,132	608,439	1,456,056
Total expenditure	**611,726**	**683,598**	**687,230**	**691,262**	**695,707**	**700,577**	**705,885**	**711,644**	**717,867**	**744,569**	6,950,066	**16,501,293**
Profit	8,304	17,174	41,538	66,760	92,890	119,982	148,093	177,285	207,620	219,167	1,098,813	11,794,308