NATIONAL ENERGY FOUNDATION

Ace

Local United

Energy farms – anaerobic digestion

How to develop a community-led agricultural anaerobic digester

About this action pack

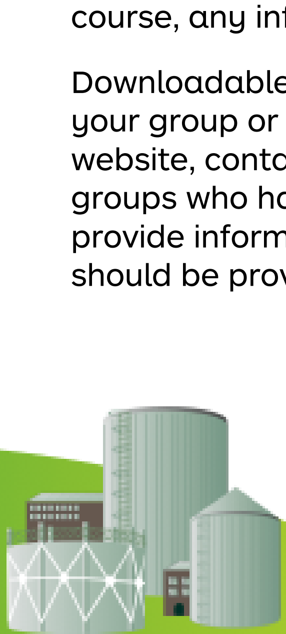
This action pack has been developed as part of a series produced by the Academy of Champions for Energy (Ace). Each pack has been written and reviewed by community activists with first-hand knowledge of what it takes to set up social enterprises to address the challenges of peak oil and climate change. Inside you will find practical suggestions and inspiration for setting up your own community initiative, helping those who are ready to take action to do just that.

This series of action packs was originally funded by NESTA and produced by Local United (www.localunited.net), a co-operative of social entrepreneurs which aims to speed up the rate at which good ideas are adopted by communities. These latest revisions have been produced by Ace, a sustainable energy initiative running in the UK, Ireland, France, Belgium and the Netherlands, funded by the INTERREG IVB NWE programme.

Ace aims to bring together 'Champions' of energy transition across the public, private and community sectors to share and disseminate information to increase uptake of renewable energy and energy efficiency measures. The focus is on using resources already available within our communities to build sustainable futures. This means citizens working together to find collaborative solutions which integrate energy transition into our everyday lives. Citizen engagement and community-led action are therefore central to this vision, and these packs aim to demonstrate how to build projects from the bottom up for the benefit of everyone. For more information about Ace visit www.aceforenergy.eu. For more guidance on citizen engagement visit www.aceforcommunities.net.

Each pack provides a useful 'how to' guide, illustrated by inspirational stories of what can be achieved when communities come together to act. Many of the packs contain technical advice, links to other information, copies of legal templates or lists of regulations all of which can help communities get their projects off the ground. Of course, any information provided is only as up to date as the day it goes to print.

Downloadable versions of the packs are available on the many partner websites. If your group or organisation would be interested in sharing the packs on your own website, contact the National Energy Foundation via ace@nef.org.uk. Community groups who have used the packs to support their own projects are also invited to provide information on how useful the packs have been, what other information should be provided or any other feedback which may improve future packs.



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2014

Foreword

The original pack was prepared by Keith Richardson to provide an overview of anaerobic digestion (AD). It was designed to inspire community groups to take action and used examples from CoRE (Community Renewable Energy Ltd) which was a social enterprise working with community groups to develop community energy projects. CoRE had obtained planning permission for two AD plants in Cumbria and was actively seeking funding for their development when the lead for these projects was incapacitated. Neither of the plants has proceeded. CoRE is now dissolved and the rights to the Cumbria AD projects are held by CoRE NW.

CoRE worked with all forms of renewable energy and had aspirations to franchise operations. This turned out to be a step too far; each of the franchises (Berwick CoRE, CoRE NW, and CoRE 50) is now independently run and CoRE is itself being wound-up. CoRE's one major success was obtaining planning permission for the Berwick Community Wind Turbine and its subsequent construction and commissioning by Berwick CoRE.

Introduction

Renewable energy is needed to meet decarbonisation and climate change targets. In many circumstances it can also be a means of generating sustainable incomes for communities.

To present there has been little engagement with energy from the wider community sector, beyond a focus on fuel poverty. In some areas joint oil-buying groups get significant support. Energy groups are, however, a growing sector with a range of potential.

The energy sector is likely to be accelerated by the new focus on 'social investment' as communities seek to take ownership of and manage local assets. The money from renewable energy systems (that is not linked to grant conditions) can be spent as the community desires.

The benefits of empowering community groups to take over power generation have been widely documented. As the Climate Change Action Alliance noted 'Evidence shows that the public sees local economic, social and environmental benefits from Community Energy.'

There is evidence, in particular, that starting with a well-planned community engagement programme well in advance of any planning proposal will help build active support and minimise opposition.

The Government's 'Community Energy Strategy' (January 2014) recognises the current and future potential for community owned energy generation as a distinct sector developing new renewable energy assets. The strategy sees potential for the sector to provide up to 3GW of electricity by 2020.

It recognises that support for the sector is required and is considering measures to encourage them to develop 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 experience in managing and delivering community led renewable energy projects.*
- *Very low levels of risk finance for community energy projects.*
- *Very high set-up and development costs (governance, planning, legal, co-ordination), which can be at risk until the project is built, operating and producing an income.*
- *A lack of replicable, well-tested, successful community energy project models.*

The Government's new 'Community Energy Strategy' goes some way to addressing these issues and the Community Energy Funds will assist with 'at risk finance'. However, to overcome these barriers communities need to work together, to share knowledge and to work collaboratively to offer a credible alternative to the private sector.

Community Energy Scotland and Community Energy Wales already exist as infrastructure support bodies. Community Energy England has been formed as a result of cross-sector discussions arising from the Community Energy Strategy Consultations. Community Energy

England's mission is to provide a network of Energy Practitioners to support community groups by sharing knowledge and expertise. www.communityenergyengland.org

What is anaerobic digestion?

Anaerobic digesters generate significant amounts of energy from agricultural materials (e.g. slurry and silage) and waste products from the food chain. The Coalition Government identified development of anaerobic digestion (AD) as an early win in 2010. The National Farmers Union (NFU), supported by the Government, set a target of 1000 farm based AD plants in the UK by 2020. In 2011 there were 15 AD plants in the UK. As of 2014, there are now 134 (www.biogas-info.co.uk). However, in Germany there are more than 5000.

Individual farms are rarely large enough to produce material to run a viable plant. So co-operative models, where a number of sources provide the feedstock, are one obvious solution. CoRE's pilot 1000kW plant in Silloth, West Cumbria would be a good example of farms co-operating to collectively supply sufficient feedstock for an AD plant. West Cumbria, and other areas such as Devon, Cheshire and North Yorkshire, is well suited to agricultural AD development because of large cattle and dairy herds, which produce substantial amounts of slurry. They have large herds because the areas are good for growing grass, which is a very high-energy feedstock for AD plants.

If we make general comparisons with other forms of renewable energy, AD is one of the more profitable technologies. Though not as profitable as wind it creates more jobs and is quicker to develop compared to wind or hydro turbines with similar generating capacities.

Agricultural AD is also suited to other areas utilising alternative, locally sourced feedstocks, e.g. beet tops, potato processing waste or abattoir lairage. Non-agricultural AD can be tailored to a range of waste streams, e.g. sewage, brewery or distillery spent grains or waste food.

AD plants not only produce electricity, but can also produce heat and fertiliser (from spent digestate). Where they are not producing electricity they can produce gas for the grid.

How does it work?

AD is one of the least understood forms of renewable energy, but in some ways it is the simplest and one of the oldest (there is evidence that the Babylonians used AD).

An AD plant can be likened to a stomach; it uses the same processes. Feedstock goes into the system and bacteria break down the organic materials in an oxygen free environment. This results in the production of methane and a liquid called digestate. In an AD plant the methane is usually used in large engines similar to petrol engines to produce electricity. In doing this, like any engine, they produce heat. Thus a 1000kW AD plant will not only produce 1000kW of electricity, it will also produce an equivalent amount of heat. The gas may also be pumped into the national gas distribution system. Either process is considered renewable energy because the CO2 released by burning the methane can be absorbed by the next generation of crops grown to feed the digester.

The other product of the basic AD process is digestate. More like compost than fresh manure, it is a better and more effective fertiliser than raw slurry as well as being less smelly! Around 80 tonnes of digestate are produced for every 100 tonnes of feedstock. Digestate is normally spread back on the land as a fertiliser (making the system nearly a closed loop).

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

The total foodstock envisaged for the 1000kW plant planned for Silloth, West Cumbria was 16,000 tonnes of energy crops (mostly grass silage because this is the most suitable local energy crop) and 14,000 tonnes of slurry and manures. Although this sounds a lot, all of the material would come from farms 2km or less from the AD plant.

Why should your community look at AD?

AD has a number of benefits compared to other renewable technologies:

- It is relatively profitable, comparable to wind and solar parks (large photovoltaic arrays).
- It takes significantly less time to take from concept to commissioning because the risk elements are more easily assessed. For example, it took nearly four years to compile all the evidence required for a planning application for the Berwick Community Wind Turbine against two for the planning application for the Silloth anaerobic digester.
- Anaerobic digestion is labour intensive – it is estimated that a 100kW AD plant will create up to 7 jobs and indirectly sustain double this number.
- Anaerobic digestion creates both heat and electricity and these can be harnessed locally to reduce a community's carbon emissions.

However, as with any low carbon solution, it is only suitable for locations with sufficient local natural resources. This is why wind turbines are in windy places (often hilltops) and most photovoltaic arrays face south. AD plants need a plentiful supply of suitable feedstock, good grid connection and an end user for the heat.

The benefits of AD may be categorised as follows:

Socio-economic benefits

CoRE's research showed that the plant at Silloth would create 2 jobs running the plant, 1.5 jobs managing the plant and developing others and 3.5 jobs on the 8 farms supplying feedstock. In addition we estimated that there would be knock-on support for another 15.5 jobs through the availability of low cost heat. One of the more surprising results of the research was that double the number of farmers' children would stay in farming.

Local jobs and skills would also have been created through the plant's construction and in local supply chains. Indeed one of the reasons why CoRE chose Biogas Hoechreiter to supply AD technology was because they would spend 60% of the capital costs locally. It can be seen that the construction of the plant has genuine economic benefits for the locality, as would the development of a local supply chain.

Cultural and community benefits

Agricultural AD

Many farmers are leaving the industry and a way of life that may have been in their family for generations is coming to an end. This is because of commercial pressures to keep prices low, a factor that continues to affect dairy farmers. Over the last two decades the number of dairy farmers has reduced by over 40% (from 35,104 in 1997 to 14,741 in 2011). At the same time dairy production has declined, consumption has increased.

The requirement to become more economic has driven the growth of larger herds and more intensive farms. Intensification usually increases the burdens on the natural environment. It is likely that AD plants can help farmers diversify, increase their income and reduce the impact that they have on the local environment.

Waste AD

Landfill Tax is a tax on the disposal of waste. It aims to encourage waste producers to produce less waste, recover more value from waste, for example through recycling or composting, and to use more environmentally friendly methods of waste disposal.

Landfill is a major problem associated with consumer society. The Tax has been levied since the mid-1990s on an escalating scale. One way to reduce waste being sent to landfill is to transform it into a more useful resource. AD accomplishes this and produces an income stream.

Environmental benefits

The main environmental benefits of AD are:

1. Reduction of CO_2 emissions from.

- Replacing heat and electricity produced from carbon based fuels
- Reducing methane released into the atmosphere from slurry
- Reducing the use of intensive synthetic petrochemical based fertilisers

2. Conversion to organic fertiliser.

Organic fertilisers put organic content back into the land, strengthening soils and supporting friendly soil supporting organisms. Although organic slurry is also used as a fertiliser there

are problems associated with its use. It is less efficient as a fertiliser than digestate, it smells, it spreads weeds and can spread diseases. It cannot be applied through the winter months in Nitrogen Vulnerable Zones because it can wash off the land and into rivers causing pollution and vegetation problems throughout watercourses.

3. Consistent energy production.
One of the complaints levelled at renewables is that they cannot produce a consistent base load for our energy needs. However an AD plant can operate at its rated generating capacity for around 90% of the year. For example, a 100kW AD plant will produce as much electricity (about 8m kWh) as a 3000kW wind turbine (and similar quantities of heat) over the course of a year. A 1000kW AD plant will supply 1700 households with electricity and 400 households with heat.

The food versus energy debate

It is true that an AD plant will need to be supplied with crops that could otherwise be used for food production, but this must be seen in context. The NFU's plans for 1000 AD plants will use only a small proportion of the land used for growing food. Indeed even this many AD plants will use less land than is used for golf courses or for keeping horses used for leisure. Traditionally farmers have used up to 25% of their land for energy, either to produce wood for heating or feed for horses and oxen.

Is an AD plant suitable for your community?

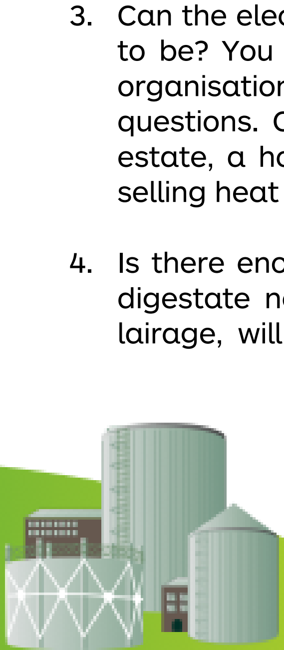
To assess the viability of setting up an AD plant the following questions need to be considered:

1. Is there enough locally available feedstock? Depending upon the nature of the feedstock this is likely to be in the order of 5000 tonnes to produce enough energy to feed a 250kW AD plant. This is the smallest size that will normally be deemed commercially viable, but it could be smaller or bigger depending upon the cost and availability of feedstocks. For example, if you have a large supply of free horse manure or grass from an airport, or are able to sell all the heat that you produce, then a 200kW might be viable.

2. Is there a suitable site to build the AD plant on? A 500kW energy farm will require at least an acre and it should not be in an area prone to flooding. There may also be both planning and regulatory considerations if it is adjacent to domestic properties.

3. Can the electricity and heat produced be sold? What are the grid connection costs likely to be? You will need to talk to the Regional DNO (Distribution Network Operator), the organisation with responsibility for managing the local supply, to answer these questions. Consider whether there is a substantial local heat user such as a housing estate, a hotel, a swimming pool or a greenhouse complex. AD can be viable without selling heat but it is much more commercially viable if an end user can be identified.

4. Is there enough land available to spread the digestate that will be produced? Will the digestate need additional treatment? Some feedstocks, e.g. waste food, sewage and lairage, will require pasteurising. Given that additional treatment may be required it



could be worth considering digestate as a marketable product and aiming to give it added value through on-going analysis and further processing, e.g. belt drying, ISO certification and bagging.

5. Is planning permission likely to be obtained? Some of the main issues are proximity to watercourses and homes, transport of materials on public roads and visual impact. AD can be seen as essentially a waste reduction process and it normally is not a source of controversy.

6. Can the necessary finance be raised? Prices start at around £1million, and a 500kW AD plant may cost double this. In terms of raising capital to build and commission the project there are a variety of funding sources: banks, equity investors, social investment funds, community share issues and so on. For more information on fundraising see Share Energy's wind turbine diffusion pack.

7. Could food waste be put through the AD plant alongside agricultural materials? Whilst this sounds like an ideal solution (food waste is usually high energy value and an ideal complement to slurry) in practice it can be far from simple because:

   - There is less food waste 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 such a long period.
   - As soon as any food waste involving meat or other such materials is used in an AD plant, the costs of running the plant increase dramatically. This is because of regulatory requirements, the need for increased reporting and pasteurisation of digestate, and so on. As a result, capital costs can increase by 50%.
   - It becomes much more difficult to utilise digestate. Although it is legal to spread pasteurised digestate produced from food waste on food producing land there is resistance from food retailers who are concerned about impacts on marketing and liability.

Finance

Construction costs

Energy farms will cost between £1-4million for 200kW-1000kW plants. Set out below are the indicative costs of building a 500kW plant with one concrete ring in ring plant (i.e. with an inner and outer tank) of 42m diameter. It is important to be careful when comparing quotes to ensure that all costs like feedstock storage facilities are included. It is possible to build cheaper systems with poorer quality equipment, using steel instead of concrete for example, but be aware that such cost reductions can reduce efficiency and life expectancy. They can also create problems with planning, as steel tanks cannot be built underground like concrete plants can. Note also that underground tanks are better at retaining heat and easier to feed.

Feasibility studies, permits, design, legal, health and safety, EIA, planning permission	200,000
Construction of plant and buildings	725,000
Equipment, CHP, mechanical and engineering, commissioning	900,000
Plant sub-total	**1,825,000**
Access roads, feedstock storage, services	160,000
Grid connection	100,000
Periphery sub-total	260,000
Total capital	**2,085,000**
3% Project contingency	52,000
TOTAL	**2,137,000**

Operational finance

Anaerobic digesters are eligible for several support measures:

- Feed in Tariff
- Renewables Obligation Certificates
- Renewable Heat Incentive

The introduction of these financial incentives means that AD generation is reasonably profitable, doubling the potential income from an AD plant over the past few years. A 500kW plant costing £2m can create a gross income of £700,000 p.a. (principally from the sale of energy and financial incentives). Costs will be around £425,000 p.a. (principally for feedstock and maintenance costs). This leaves around £250,000 p.a. to cover finance and management costs. These figures do not assume that all heat can be sold. If heat can be sold, profitability increases significantly. Low cost feedstocks also make a large difference to profitability. See the Appendix for more financial detail.

Raising finance

An AD plant would normally pay back its capital costs in between 8 and 12 years, depending upon its size, costs of feedstock and how much heat can be sold. This makes it a commercially viable proposition.

Typically, to finance any renewable energy system requires equity investment of at least 30% (money that is at risk and generates dividends based on the size of the 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 on renewable

energy schemes in general and in particular to less well known processes like AD. Currently most AD finance is coming from equity investors and grants. As more AD plants are built (and the process becomes more established) it should become easier to finance them.

Whilst capital to construct a scheme can be difficult to obtain perhaps the most difficult costs to cover can be those necessary to get the project to a point that is 'finance ready'. For most banks and investors this means:

- The plant is ready to be built. Planning permission has been granted, environmental permits have been obtained and the land has been secured (there is a long-term agreement or lease in place).
- Feedstocks are guaranteed. Unless there is a long-term agreement with feedstock suppliers continued financial viability cannot be guaranteed.
- 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 PPA (Power Purchase Agreement). For heat, investors will need to see contracts with end users. Such contracts will also need to be long-term to justify the capital costs of a heat network.
- Proof that the technology works, evidence of a reliable manufacturer and a fully worked up design and construction plan for the plant. This should be backed by guarantees and maintenance/insurance agreements with technology and equipment suppliers.

Assuming pre-construction costs of £200,000 (of which £120,000 will be spent on preparing and submitting an application for planning permission) how do you raise the money? This money is more difficult to raise as there is a risk that the plant won't obtain planning permission or will work out too expensive to be a viable proposition.

The work can be staged, for example:

- Pre-feasibility and feasibility studies
- Tendering of technology suppliers (with design and build included as options)
- Assembling the complete folio for planning consideration in stages
- Community consultation

This is, in any case, a sensible approach; chunking the project ensures that each element is of a manageable scale and is readily accomplishable. With the recent introduction of the Rural Community Energy Fund and the shortly to be launched Urban Community Energy Fund some of the funding is in place. There are also feasibility grants and development loans for AD available from the Government through WRAP.

Please note that any sizeable renewable energy scheme will involve substantial costs before it is finance ready. Indeed, as outlined earlier, other forms of renewable energy schemes (e.g. hydro or wind) can have longer development time scales and this can involve more expense in reaching financial readiness.

Community engagement

Research undertaken for the UK government (well before Community Energy schemes developed) suggest that at its best, community involvement can enable:

- Processes to be speeded up
- Resources to be used more effectively
- Product quality and feelings of local ownership to improve
- Added value to emerge
- Confidence and skills to increase for all
- Conflicts to be more readily resolved

On this basis, investing time in building communications and engagement is time well spent.

At the moment engagement takes many forms, including:

1. Communities hear about a project, take part in consultation, and perhaps find a way to offer support. There may be some limited benefits.
2. A project seeks engagement through a money-raising share offer, and the investors form a 'community of interest' around the project, even though many / most may not live nearby. As share-holders these investors receive benefit and there is a degree of ownership.
3. Project developers actively seek local engagement and local people / organisations can join an advisory or management group, with long-term community benefit and a greater degree of ownership.
4. A community-based organisation, such as a development trust or residents association (perhaps supported by an energy-focused agency) starts the process, raises the resources, designs and develops its own project and owns the assets: receiving the maximum benefit.

Community engagement and tapping into local concerns was important for developing the plans for the two AD plants in Cumbria. CoRE's initial involvement arose from a chance meeting with an Agricultural Sales person. In a conversation focussed on the number of dairy farmers leaving the industry the question 'What can be done to maintain their incomes in the current competitive dairy market?' was asked, to which the response was 'Have you looked at renewables?'.

This developed into a longer dialogue, the identification of a number of potential projects and discussions with a range of early partners. It was concluded that the resources already available to dairy farmers (including waste) could be harnessed to develop AD on a co-operative basis.

After bringing together a farmer's co-operative the wider community was consulted. This was not on a wide scale; it was at village hall level. Generally this was seen simply as farmers letting their neighbours know what they were doing. Locally the development of a new set of agricultural buildings that would reduce the smell of cow poo was seen as a good thing!

Legal structures

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

There are a range of models, the most common of which are:

- Company Limited by Shares
- Company Limited by Guarantee
- Co-operative (Industrial and Provident Society)

Marketing

Generally most of the electricity generated will be sold through the National Grid via 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 both the Feed in Tariff and the Renewable Heat Incentive are applicable.

The marketing of heat is much more complex than the marketing of electricity, as it can only be used close to source. In the UK 2km is generally thought to be the maximum distance from source. This is similar to Scandinavian countries where a single source is rarely connected to a loop larger than 5km. In addition to proximity, most heat user's demand varies considerably throughout the year.

It can be seen that heat distribution is itself a speciality within the renewable field. Establishing and linking businesses and communities with a mixed and varying demand requires a new sort of thinking. Instead of charging by kWh, one suggestion is providing a fixed heat level (anything over is then billed on top). This could apply equally to domestic, commercial and agricultural heat users.

AD is an ideal base generator (energy 24/7) 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) and it produces both heat and electricity.

Skills needed

A report by the Anderson Centre for the National Non-Food Crops Centre predicted that '*Assuming the UK policy of paying double ROCs starts in 2009* (which it did*) then...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 upon, communities and farmers need to have skills and expertise in the following areas:

- The technical and regulatory knowledge to obtain planning permission and other necessary permits.
- An understanding of the electrical 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 will require the production of detailed financial information.
- Expertise in constructing business models – joint ventures, co-operatives and partnerships will require business managers to act as honest brokers between members.
- In depth knowledge of AD. If a community is developing a wind turbine it is reasonably easy to obtain typical costs for a turbine and how much energy it will produce in a given area. However, this is not the case for AD because it is a less well-developed market. Estimating capital cost is much harder and assessing how much money it will make from a range of potential feedstocks is much more complicated. This type of knowledge tends to be jealously guarded. So a tame expert with industry knowledge is needed, or a relationship with an AD manufacturer.

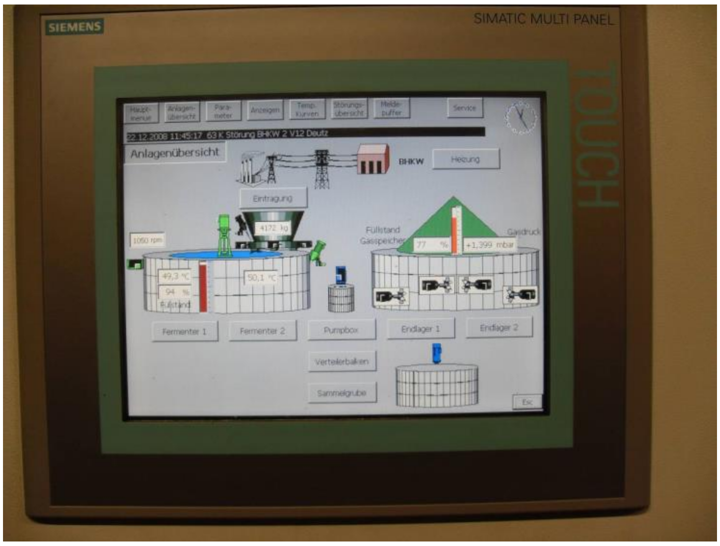
There are also cultural barriers in the UK to overcome:

- AD is largely seen as a chemical process and run by 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.

If a community is seriously thinking of embarking on this route then it may be useful to be thinking of developing a cluster of plants. To build up the knowledge necessary to commission one plant is a time consuming exercise and may not justify the returns from a single plant. However, a second plant may take half the time to go through planning and commission as links built up with financiers and banks, production of legal templates, and ancillary competencies based on experience all make it easier and cheaper to replicate development.

Running an AD plant

Running an AD plant is relatively straightforward and basically involves ensuring that the plant is fed continuously with the right balance of feedstock to maintain optimum operation. This can be done manually (usually in batches) or automatically (either continuously or in batches). The process needs to be monitored to maintain the right chemical balance. This may be undertaken through on-site or remote monitoring and analysis.



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

As well as feeding the plant, feedstock supplies need to be managed. They need to be checked for quality and energy values, they may need to be stored and they have to be recorded correctly so that fees or payments can be accounted properly. There are also regulatory requirements to meet, which for agricultural AD plants are not onerous (they are much more complicated for AD plants using food waste, sewage or lairage).
Staff requirements can be summarised as follows:

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

Most manufacturers and suppliers would be involved in monitoring the plant through telecommunications and provide the guidance on adjustments needed. In the main 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, half-time
3. Plant manager / back-up, half-time

There will be some need for flexibility in roles to ensure smooth operation and so cover can be provided for most of the day. Contracting with one of the farmers involved or with the farmer's co-operative could provide some of the above roles.

Support to develop AD

Developing an AD plant requires considerable time and financial resources. It may be possible to find these locally as set out above, or alternatively locals could learn them or the necessary skills could be bought-in.

An alternative to this is to work in partnership with an existing organisation or to seek support from them. As far as CoRE was aware they were the only social enterprise to have moved beyond the feasibility phase and obtained planning permission. However, other organisations are actively looking at this, such as Greener for Life (Tiverton, Devon), Share Energy (West Midlands) and the Scottish Agricultural Organisation Ltd (South West Scotland). There may also be local renewable energy support agencies such as the Centre for Process Innovation or Community Energy England.

A community group may 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 with an operating record in the UK.

Conclusion

AD presents a substantial opportunity for the UK and is particularly suited to community development; 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 AD and renewables Local United and Community Energy England are developing learning materials for short courses. Other organisations such as the Centre for Sustainable Energy may also be able to help.

The following provide useful reference material. We would particularly recommend the Anderson report as a detailed and valuable source. The report, together with other useful tools and information, can be found at http://www.biogas-info.co.uk. Please note that the AD Calculator is a spreadsheet for calculating financial viability that is very useful, but needs a fair degree of knowledge to use. Some of the key data to assess viability is not calculated by the spreadsheet (e.g. capital costs) and some of the base assumptions will need checking, as they are dependent upon the equipment being used.

Web based:

http://www.biogas-info.co.uk/ (Defra / DECC)

http://www.wrap.org.uk/content/anaerobic-digestion-1 (WRAP)

http://adbiogas.co.uk (Anaerobic Digestion & Biogas Association)

Reports and papers:

Biomass Task Force Report to Government, 2005

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

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

Outline Feasibility of Centralised Anaerobic Digestion Plants linked to Diary Supply Chain; AEA for Dairy UK, 2007

A detailed economic Assessment of Anaerobic Digestion Technology and its suitability to UK Farming and Waste Systems; The Anderson Centre for Biomass Projects for the National Non-feed Crops Centre (NNFCC), 2008

The quality of liquid and solid digestate from biogas plants and its application in agriculture, Dr. O Palm at 'The future for Anaerobic Digestion of Organic Waste in Europe.' ECH/ORBIT e.V. Workshop 2008

Briefing note: Anaerobic digestion of agricultural manure and slurry. Environment Agency, 2008

Anaerobic Digestion – Shared Goals, Defra, 2009

PAS110:2010 Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials. WRAP/BSI 2010

Focus on: Farm anaerobic digestion, Farming Futures, 2010

Anaerobic Digestion Strategy and Action Plan, Defra, 2011

Open Source Materials

Appendix: 500kW 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												
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

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