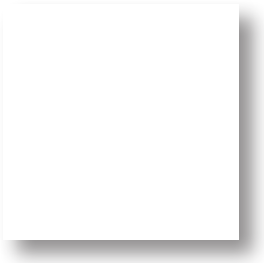
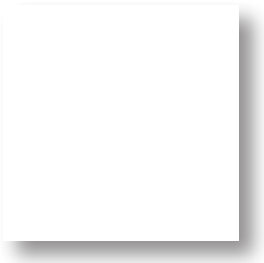
Hit the gas:

how to get the anaerobic digestion sector moving

Thomas Brooks and Quentin Maxwell-Jackson





CENTREFORUM

About the authors

Thomas Brooks joined CentreForum in January 2011, and is the author of 'Pathways to prosperity: making student immigration work for universities and the economy' and 'Taxing decisions: the debate between tax credits and personal tax allowances'. He studied PPE and previously worked for Sierra Leone's Ministry for Foreign Affairs and International Cooperation.

Quentin Maxwell-Jackson is a research associate with CentreForum. He was until 2011 a senior partner at KPMG where he led the Public Services Consulting, Central Government Advisory and Consumer and Industrial Markets practices. He has considerable experience of financing major infrastructure programmes, including nuclear power. He is the author of another CentreForum report – 'Getting better value from Public Sector Research Establishments' and was for some years editor of 'Public Governance', the journal of the Public Governance Institute.

Acknowledgements

The authors would like to thank Charlotte Morton and Matt Hindle of the Anaerobic Digestion and Biogas Association (ADBA) for their advice during the preparation of this report. CentreForum acknowledges the financial support of ADBA in the preparation of this report. However, the views expressed are those of the authors.

The authors would like to express their thanks to all those in the anaerobic digestion sector, Defra, WRAP and DECC who participated in the interview programme.

Contents

Executive summary

Anaerobic Digestion – huge potential blocked by barriers

Anaerobic Digestion (AD) is a process which breaks down organic compounds – including waste – to produce renewable energy and nutrient-rich organic fertiliser. AD currently produces about 1.3 TWh of energy in the UK per year – enough to power 300,000 homes.

AD has the potential to generate over 11 TWh of energy by 2020, powering more than 2,500,000 UK homes - an increase of more than 800% over current levels. AD can make a significant contribution to the UK's renewable energy commitments, but only if barriers are removed.

The key barriers are:

- Gaining access to finance and feedstock
- Lack of confidence in tariff levels remaining constant
- A perception that government is opposed to further expansion of AD from purpose grown crops (PGCs)
- The high costs and stringent regulatory requirements which must be met in order to connect to national grids
- Absence of a mature market for digestate

This report sets out the benefits of AD, describes each of the barriers and recommends actions to remove or lessen their impact.

AD benefits

AD has several advantages over other forms of waste treatment and renewable energy generation because:

- AD produces biogas which can be used to generate electricity and heat or, converted to bio-methane, injected into the gas grid or compressed or liquefied for use as a transport fuel
- Bio-methane is one of the few renewable options for fuelling Heavy Goods Vehicles (HGVs)
- AD produces 24 hour energy, unlike other renewables such as solar and wind, which are dependent on climatic conditions
- Since AD generates a gas, it can be stored, unlike electricity
- AD diverts food waste from landfill and captures its energy efficiently
- AD produces nutrient-rich renewable fertiliser
- Digestate displaces greenhouse gas (GHG) emissions from producing inorganic fertilisers
- AD produces fewer air and solid emissions than incineration, landfill, pyrolysis and gasification
- At just 11g CO2/kWh (compared with average 500g CO2 for energy from incineration), AD is a low carbon energy

AD – the Opportunity

There is a huge potential for AD to grow as an energy source and waste treatment system in the eight years to 2020. On the basis of recent government studies, we estimate that there is the potential for expansion from 1.3 TWh today to 11 TWh by 2012.

However, this vision for AD will not be achieved rapidly, let alone by 2020, unless several barriers and brakes to development are removed.

Barriers

The key barriers to achieving this growth, and our suggested solutions, are summarised below:

- **Obtaining financing –** many AD schemes have struggled to secure financing. AD schemes' small size rules out non-recourse project finance, and the significant risks inherent in operating an AD plant generally mean that they have to be funded with a significant proportion of equity with any debt fully secured on assets. AD's risks are more daunting at the pre-commissioning stage than once a plant is up and running successfully, so when sufficient AD plants are operating funding will become easier to obtain. In the meantime, the Waste and Resources Action Programme (WRAP) loan fund and the UK Green Investment Bank proposal to provide equity funding for AD will help to bring more schemes into operation. The Anaerobic Digestion and Biogas Association (ADBA) should build on the experience of its Finance Forum to produce a succinct guide for developers and potential funders about AD's key financial risks and how they can be managed, as there still remain unrealistic expectations amongst some potential developers about financing AD schemes.
- **Feedstock supply –** Waste treatment AD plants often struggle to secure long-term supply contracts for feedstock. Source segregation of waste feedstock can help provide a larger and more secure feedstock supply: it minimises waste in the first place (as consumers and businesses become aware of their level of food wastage), and it improves the quality of other recyclable materials by removing contamination. Only 13% of households in England have the benefit of separate food waste collection, whereas in Wales 82% are covered. The government should move to ban all food waste to landfill in England by 2020. There should also be financial support to local authorities to facilitate switching to

split-body collection vehicles if the current fleet is not due to be changed for some time.

- **Confusion about government support –** There is a widespread perception that government policy on AD is not coherent, consistent or stable. There is lack of confidence in the stability of financial incentives such as Feed in Tariffs. A system of pre-accrediting AD schemes at financial close to fix applicable tariffs for the subsidy period would provide greater certainty for developers. The incentives relating to gas grid injection also need amendment, so that Renewable Heat Incentive (RHI) support is expanded on a sliding scale to plants up to 1 MW. Also, given the benefits of using bio-methane for HGV fuel, the Renewable Transport Fuel Obligation (RTFO) should be amended, so that AD biogas producers are able to claim RTFO support for injection of gas to the grid which is extracted elsewhere in the network for conversion to vehicle fuel.
- **Government appears opposed to purpose grown crop (PGC) AD –** Using PGCs for AD has several advantages, including the relative technical simplicity of AD plants treating PGCs, the virtuous cycle in which digestate returns nutrients to the land growing PGCs, and a simpler digestate regulatory regime. Energy yields per hectare are also high compared to other forms of bioenergy. However the government appears concerned that supporting PGCs may promote monoculture, divert incentives from waste AD, harm the environment and compromise the UK's food security. None of these concerns stand up to scrutiny at the level of PGC AD we envisage. AD has particular advantages over alternative crops because PGCs for AD recycle nutrients, do not tie up land for long periods and support longer crop rotations. Concerns about monoculture and pollution/habitat loss can be addressed by adopting a code of conduct for farmers growing energy crops and incorporating an assessment of compliance in

the proposed pre-accreditation process for tariffs.

- **Cost and regulatory complexity of making grid connections –** Injection to the gas grid is the most efficient use of biogas, but only two plants are currently connected. This is because of stringent gas quality regulations and the often exorbitant costs of connecting to the grid. Amendments to the gas regulations, already being contemplated, such as increasing the amount of oxygen bio-methane may contain and relaxing the stringent accuracy requirements on calorific value measurement would make a major difference, as would introducing functional specifications for grid connections to standardise connection requirements and open them up to competition.
- **Under-developed market for digestate –** Although the AD digestate market has a potential value of over £200 million a year, for most AD plants digestate is currently viewed as a cost. Defra and WRAP have recognised the need to help the market develop, and we welcome the initiatives they have taken. It would further help if regulations were amended so that farm co-operatives could spread waste co-digested with on-farm waste as long as both were pasteurised. More education about the benefits of digestate amongst farm end users and major supermarket buyers is also needed.

Conclusion

AD has the potential to produce 11 TWh of energy by 2020 whereas currently it is producing 1.3TWh - a more than 800% expansion in eight years.

The government must act to ensure that it delivers the expansion it pledged in 2010 in the Coalition Agreement.

Government's six priorities should be to:

- Phase out organic waste to landfill by 2020
- Promote source segregated collection of Municipal

Solid Waste (MSW) and Commercial and Industrial (C&I) Waste

- Introduce accreditation of AD schemes at financial close to fix all tariffs
- Encourage bio-methane injection to the grid
- Encourage use of bio-methane to fuel Heavy Goods Vehicles
- Ensure that the WRAP loan fund and Green Investment Bank have sufficient funds to support AD development

1 - Introduction

Anaerobic Digestion – huge potential

Anaerobic Digestion (AD) is a process which breaks down organic compounds – including waste – to produce biogas and nutrient-rich digestate. AD is important because biogas is a renewable energy which helps the UK to meet its commitments to the Climate Change Act 2008 and the EU Renewable Energy Directive.[1]

When AD uses waste feedstock it diverts material from landfill; a priority as we have a dwindling number of suitable landfill sites and are committed to complying with the EU Landfill and Waste Framework Directive.[2] Currently around 7 Mt of food waste is sent to landfill in the UK each year, a rate which the EU categorises as a 'midrange' level.[3]

The Prime Minister has stated that he will lead the 'greenest government ever' and in 2010 the Coalition pledged:

> "We will introduce measures to promote a huge increase in energy from waste through anaerobic digestion."[4]

1 The Climate Change Act states that greenhouse emissions must, by 2050, be cut to 20 per cent of 1990 levels. The EU Renewable Energy Directive states that 15 per cent of UK consumer energy must come from renewables by 2020.

2 The EU Landfill Directive stated that biodegradable waste must be reduced to 35 per cent of 1995 levels by 2020. The Waste Framework directive states that 50 per cent of household waste should be recycled by 2020 – AD outputs are counted towards these if they meet end of waste criteria.

3 DECC, Defra, 'Anaerobic Digestion Strategy and Action Plan', p. 19. 'Midrange' definition comes from European Commission – Use of economic instruments and waste management performances – 10 April 2012.

4 The Coalition: Our plan for government, May 2010.

The UK currently has a total of 222 AD plants, which produce more than 1.3 Terrawatt hours (TWh) of electricity a year.[5] Government studies have shown that this capacity has the potential to increase very significantly to 11 TWh by 2020, enough to power about 2,500,000 homes, which is roughly 10% of the UK's households.

But significant barriers to AD reaching its 2020 potential remain, including:

- access to finance and feedstock
- lack of confidence in tariff levels remaining fixed
- a perception that government is opposed to further use of purpose-grown crop plants
- the often unreasonably high cost of connecting to national grids
- the lack of a mature market for digestate

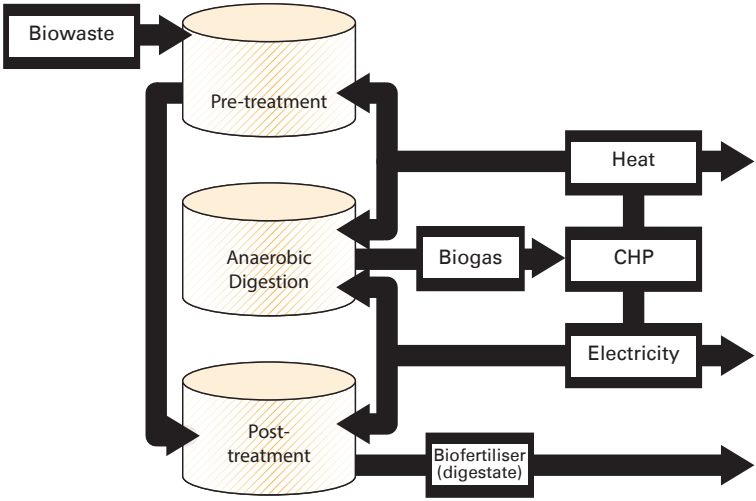
What is anaerobic digestion?

AD is a treatment process that breaks down organic material with microorganisms in the absence of air. It has been used in the UK to process sewage sludge for over 100 years, but its full potential for treating other materials including food and farm wastes and purpose-grown crops has only been recognised in the past decade. AD produces energy at all hours of the day and regardless of weather conditions, unlike other renewable sources such as wind, solar and tidal energy.

The AD process creates two products – biogas and digestate - as shown in Figure 1.

5 WRAP, Anaerobic digestion infrastructure in the UK: September 2011, p. 5.

Figure 1: Anaeurobic digestion plant configuration



A renewable natural biogas comprised mostly of methane and carbon dioxide is emitted.[6] It is extremely versatile and can displace the use of non-renewable natural gas. Biogas from AD can be used for:

- Direct combustion – combined heat and power (CHP) generators convert biogas into electricity which can be transferred to the national electricity grid and provide heat for local use.
- Injection into the grid – biogas can be processed to produce bio-methane which can be compressed/ liquefied to make HGV fuel or injected into the national gas grid where it can be stored with natural gas. Only two UK plants currently inject to the grid, largely because of regulatory burdens and tariff issues.

Both of these options create clean, renewable energy from the biogas produced by AD.

6 Biogas is around 50-70 per cent methane and up to 30 per cent carbon dioxide with other trace impurities.

AD benefits

AD has several advantages over other forms of waste treatment and renewable energy generation because:

- AD produces biogas which can be used to generate electricity and heat or, converted to bio-methane, injected into the gas grid or compressed or liquefied for use as a transport fuel
- Bio-methane is one of the few renewable options for fuelling Heavy Goods Vehicles
- AD produces 24 hour energy, unlike other renewables such as solar and wind, which are dependent on climatic conditions
- Since AD generates a gas, this can be stored, unlike electricity
- AD diverts food waste from landfill and captures its energy efficiently
- AD produces nutrient-rich renewable fertiliser
- Digestate displaces greenhouse gas (GHG) emissions from producing inorganic fertilisers
- AD produces fewer air and solid emissions than incineration, landfill, pyrolysis and gasification
- At just 11g CO2/kWh (compared to average 500g CO2 for energy from incineration), AD is a low carbon energy

AD creates a residual nutrient-rich digestate which accounts for around 90% of the original feedstock's mass. The digestion process preserves nitrogen and releases other nutrients contained in the organic compounds of the feedstock, including phosphates.

Digestate is a renewable fertiliser which can displace greenhouse gas (GHG) emissions associated with the creation of conventional inorganic phosphate fertilisers. This is not insignificant – currently 1.1 per cent of the UK's total GHG emissions derive from fertilisers made with fossil

gas.[7] When produced in close proximity to agricultural land, digestate also saves transportation costs associated with commercial synthetic fertilisers. In liquid form, it also penetrates through to crop roots unlike granular fertilisers which rely on rain or irrigation.

The Waste and Resources Action Programme (WRAP) estimates that digestate from household food waste AD could have an annual value of £50m, but the market is immature and disposing of digestate is currently a cost for most plants.

AD in the UK today

AD is a diverse sector, with industrial, farm-based and commercial plants processing waste and non-waste feedstock. The following AD plants currently operate in Britain:

	Plants
Sewage sludge plants	146
Food waste	49
Farm plants	27
Total	222

Source: Figures from www.biogas-info.co.uk/index.php/ad-map.html

Water treatment is long-established and accounts for around two-thirds of the UK's 222 AD plants. There are 76 non-water plants, which represents a significant increase from just two in 2005. Overall, the UK's current AD infrastructure has a capacity to process 5 million tonnes of feedstock, creating 1.3 TWh a year - enough electricity to supply 300,000 homes.[8]

To put this in context, last year solar installations produced less power than AD at just 0.3 TWh (after an eightfold increase due to FiTs). AD produced more than four times as much.

Prevention and avoidance must be the priorities in waste management, but for unavoidable food waste the government recognises that AD "is the best currently available treatment option".[9]

7 DECC, Defra, 'Anaerobic Digestion Strategy and Action Plan', p. 21.
8 Houses of Parliament Offices for Science and Technology, 'Anaerobic Digestion', Number 387, September 2011.
9 DECC, Defra, 'Anaerobic Digestion Strategy and Action Plan', p. 10.

AD can use waste food that has been segregated from other household waste. If done at source this has the additional benefit of reducing the volume of waste food produced as businesses and households become more aware of the large amounts of avoidable waste food they are producing.

AD energy potential by 2020

What is the potential for renewable energy produced by AD by 2020?

There are various official estimates. The DECC/Defra *Anaerobic Digestion Strategy and Action Plan (2011)* concluded that "the forecast potential for AD deployment for electricity could reach between 3-5 TWh by 2020." This was based on an analysis of studies into feedstocks arising mainly from food and animal waste.

The Committee on Climate Change (CCC) considered the potential for biogas from the full range of AD feedstocks (including energy crops). The Committee pointed out[10] that two figures are relevant – the energy potential of the gas produced, and the efficiency with which it is turned into final energy. The CCC quoted recent studies by DECC and SKM[11] which estimated that available and potential feedstocks could support production of 20-21 TWh of gas energy by 2020, on the assumption that some of the barriers to AD development were lifted.

DECC and SKM made different assumptions about the efficiency with which this gas would be converted into usable energy. DECC's National Renewable Energy Action Plan (NREAP) assumed that most of the gas produced would be used to generate energy locally, and estimated a final energy yield of 9 TWh. SKM made the assumption that most of the gas would be used for grid injection – a much more efficient way of producing usable energy – and estimated a

10 Committee on Climate Change, The Renewable Energy Review, May 2011, p. 126. The Government is aiming for 227 TWh of renewable by 2020.

11 www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/uk_action_plan/uk_action_plan.aspx DECC's National Renewable Energy Action Plan (NREAP) and SKM (2011) Analysis of the Characteristics and Growth Assumptions Regarding AD Biogas Combustion for Heat and Bio-methane Production and Injection to the Grid.

final energy yield of 15 TWh. This would account for nearly 7% of the government's renewable energy target of 227 TWh.

If the measures outlined in this paper are taken, we consider that the total usable energy produced from AD by 2020 could realistically be in the range 9-15 TWh, as the DECC and SKM studies showed. Given the likelihood that most conversion of gas to energy will be done through local electricity generation rather than directly into the grid in the run up to 2020, we consider it realistic to aim for the lower end of the estimated range - 11 TWh of final energy from AD by 2020.

However, as the SKM forecast showed, significantly more final energy is derived through injecting AD produced bio-methane into the grid or using it as a transport fuel than through local electricity generation. Greater encouragement of more efficient uses of AD biogas by government, as we recommend below in this paper, would make it realistic to aim for the top end of the CCC forecast.

There is thus a huge potential for AD to grow as an energy source and waste treatment system in the eight years to 2020 - from the 1.3 TWh produced today to at least 11 TWh by 2012.

Government support

The production and usage of biogas from AD can be encouraged by government incentives. The power of incentives is nowhere more clear than in Germany, where the government encouraged the use of energy crops for AD through the Renewable Energy Act 2010 (EEG). This created a base tariff for renewable energy with additional payments for energy from crops; the Act precipitated a huge growth in AD infrastructure, and Germany now has more than 7,500 plants producing 20 TWh annually, primarily in the form of electricity from bioenergy crops. By contrast, Sweden has different energy needs and has encouraged the production of transport fuel from the biogas produced at its 173 plants.[12]

12 Houses of Parliament Offices for Science and Technology, 'Anaerobic Digestion', Number 387, September 2011.

The role of AD can clearly vary; elsewhere in Europe, countries such as France and Italy have large-scale plants for municipal waste, whereas Denmark's AD industry is based primarily on farm-based waste.[13]

The government has sought to support AD in three main ways: though tariffs for energy production, loans and grants for the development of plants, and creation, jointly with industry, of a 'Strategy and Action Plan' for AD.

There are four mechanisms used to subsidise the production of energy with AD: Feed in Tariffs (FiTs), Renewable Obligations (ROs), the Renewable Heat Incentive (RHI) and the Renewable Transport Fuel Obligation (RTFO). The key elements of each are outlined in Table 1 (overleaf). Only one tariff can be claimed, except where CHP is used, in which case RHI can be claimed for heat used and FiT for the electricity.

The government has also sought to support AD infrastructure development while complying with State Aid requirements. WRAP has a loan fund of £10m to support AD development over a period of four years, with the objective of removing 300,000 tonnes of food waste from landfill. UK Green Investments, the precursor to the Green Investment Bank (GIB), is also looking to invest to correct market failures where it perceives a lack of investment in viable AD projects. These two initiatives complement each other, as WRAP provides debt while the GIB will offer equity investment.

The government has also sought to make clear its support for AD and to work with industry to remove some of the barriers it faces. In 2011 Defra published a National Waste Review and an associated AD Strategy and Action Plan. The Strategy and Action Plan confirmed that AD should play an important role in the government's commitment to a zero waste economy. The paper did not set specific targets for AD, but included a series of actions to remove some of the obstacles to wider AD deployment.

13 DECC, Defra, 'Anaerobic Digestion Strategy and Action Plan'.

Table 1 – Government incentives

	Feed in Tariffs (FIT)	Renewable Obligations (RO)	Renewable Heat Incentive (RHI)	Renewable Transport Fuel Oblication (RTFO)
Role	To encourage deployment of new low-carbon electricity generation on a small scale (below 5MW).	To promote deployment of large-scale renewable energy generation. ROCs are sold on a market to energy suppliers.	To help drive a seven-fold increase in renewable heat over the coming decade, which will help shift it firmly into the mainstream.	To promote use of biofuels for transport in the UK. All fuel suppliers who supply at least 450,000 litres of fuel a year are obligated.
Government department	DECC	DECC	DECC	DfT
How funded	Socialised to consumers	Socialised to consumers	Through central government revenue	Socialised to consumers
For	Electricity	Electricity	Heat or gas injection	Processed bio-methane at point at which duty charged
Rate	2012-13 kW <250: 14.7p 250–500: 13.6p >500: 9.9p	AD receives 2 ROCs / mW which are worth a guaranteed price of £38.69 each but generally between £40 and £50 depending on market conditions.	7.1p / kWh for biogas injection to grid or combustion (up to 200kW).	Market mechanism with guaranteed buyout and duty incentive for 30p per litre for fuel suppliers.
First in operation	2010	2002	2012	2008
Timescale	FIT payments guaranteed for 20 years once accredited. Scheme is budgeted to 2020.	The RO will close to new generation on 31 March 2017. Existing schemes will continue to receive full lifetime support in the "vintaged" scheme after 2017.	Non-domestic scheme launched in November 2011. Not budgeted beyond 2015.	Incorporated into renewable energy directive.

Technology

The basic AD process is well established and has been used in the UK for over a hundred years. The Committee on Climate Change describe AD as a mature technology that is already widely used.[14]

Some specialist AD technologies are relatively young, particularly for front-end treatment of waste feedstocks. While Britain is lagging behind other countries in injection technology, in many respects it is leading the way in waste treatment. This represents a genuine opportunity to develop technology for an area of expertise which can be exported, much as we look to Germany currently for gas injection products. Taking a lead now will create jobs in design and manufacture.

Accreditation schemes have been established to support development of renewable energy technology, and these could help with front-end AD processes. The Microgeneration Certification Scheme (MCS) approves technology producing renewable heat and technology such as solar PV, wind and biomass. The Solar Keymark has also been developed to certify solar technology at a European level in an attempt to promote development and reduce trade barriers.[15] The need to demonstrate quality to the accrediting agency would create a driver for technology suppliers to raise standards and, in particular, help Britain take the lead in front end waste technology.

Non-AD treatments – pros and cons

The alternatives to AD for organic wastes are:

- **Landfill** – gas is recovered from landfill, but it is not efficient in capturing all the gas produced and the gas is of low quality. The UK is also running out of space for new landfill sites, so food waste should not be sent to landfill.

14 Committee on Climate Change, Bioenergy Review, December 2011.
15 Their websites are www.microgenerationcertification.org and www.estif.org/solarkeymarknew

- **Incineration** – the process generates energy, but also creates ash rather than the nutrient-rich AD digestate, thus losing the nitrates contained in the feedstock. An advantage of incineration is that material does not need to be source segregated, which reduces costs. But burning damp food waste is less efficient at recovering energy from food than AD.
- **Composting** – captures and retains nutrients as AD does with digestate but, unlike AD, does not extract the energy.

The table below compares the different options.

	Compost	Incinerator	Landfill*	AD
Outputs	Compost	Electricity, heat, ash	None	Biogas, digestate
Nutrient recovery	Yes	No	No	Yes
Typical gate fee / tonne	£43	£73	£76	£43
Waste taken	Garden, food	Any	Any	Food, farm, garden
Reduces emissions	Yes	Reduces methane but emits carbon dioxide	No	Reduces methane and carbon dioxide significantly
Saleable product	Yes	Yes	No	Yes
Energy recovery	No	Yes	No	Yes
Average plant output	N/a	20 – 60 MW	N/a	100KW – 2MW

*The landfill figures assume that landfill gas is not recovered.

AD and incineration have the advantages over composting of recovering energy. However, where food waste is segregated, AD recovers more energy than incinerators, as well as preserving nutrients and having a lower gate fee.

Appropriate use of AD

AD is the optimal treatment for food and garden waste products in many, but not all, circumstances. It is ideally suited for medium and wet food wastes, for which it not only offers the most energy efficient production but also creates a nutrient-rich digestate. Although incineration can process most food waste, it is inefficient at incinerating moist food, which requires burning off water content and produces less energy than AD per Mt of waste.

An important factor is the distance which the feedstock must travel to reach an AD plant. There is a point where the fuel needed to transport feedstock and digestate cancels out the carbon and economic benefits of AD. Thus AD is a localised treatment which works best when it is close to where waste or other feedstocks are produced. This also means that AD plants are generally relatively small – between 100KW and 2MW. Of course, the same point about taking account of feedstock travel distances also applies to other treatment options, such as incineration.

It makes environmental sense to locate plants beside industrial sites or large settlements. In rural areas the carbon and economic cost of transporting feedstock from a large catchment area may be too high. In these situations it may be optimal to compost waste locally or transport food with other waste to an incinerator.

The method of feedstock collection is linked to the issue of how far feedstock is transported for treatment. If separate food waste collections occur on top of normal residual waste, this may nullify the benefits of AD. Similarly, where joint collection of food and garden waste is employed, composting may be the preferred treatment. However, where source

segregation does occur, AD is the best treatment provided that there is a plant within 100 kilometres or so.[16]

AD is also suitable for treatment of purpose grown crops (PGCs) grown as part of good farming practice crop rotation. When managed in a normal manner, PGCs can be used for AD by farmers who need to manage their soils, while also creating energy and providing them with fertiliser. There are also circumstances where PGCs can be combined with farm-based slurries and local food waste to make AD a viable treatment for local commercial or municipal waste.

16 Exact distances will vary for different feedstocks. This figure is described by the Office of Fair Trading in relation to sewage sludge feedstock. See OFT, Organic Waste: An OFT market study, September 2011, p. 37.

2 - Financing AD projects

Obtaining financing is a major barrier

Many AD schemes have struggled to secure financing. This is because project finance is generally not viable, AD has inherent risks which are not yet well enough understood to provide potential funders with confidence, and many developers appear to be over-optimistic about the type of financing which is realistic for AD projects.

Financing is thus a major barrier to the faster development of AD in England. What can be done about it?

Non-recourse project financing is unsuitable for AD

AD schemes are very small compared to some other projects in the green energy sector such as wind, hydro or nuclear. AD projects typically have a financing requirement of £3-8m for schemes generating 500 kW to 2MW.

Non-recourse project finance - where debt and equity are secured on project cash flows rather than on assets or credit worthy parent guarantees - has been used in other parts of the waste/energy sector; for example to build and operate incinerators. It can be an attractive form of finance, since a high proportion of debt relative to equity can significantly reduce financing costs.

However, non-recourse schemes have to be large. This is because funders require assurance that project cash flows will be secure. This leads to high due diligence costs, for example scrutinising feedstock contracts, the Power Purchase Agreement (PPA), government incentives/subsidies and digestate sales contracts.

It is not generally desirable to transport feedstock and digestate over large distances because this offsets the ecological benefits of AD (and indeed other treatment options). So the general pattern of AD deployment will be a large number of geographically dispersed small plants. Only in a few cases where large supplies of feedstock are generated in one place – such as in sewage slurry treatment or some forms of C&I waste – is it viable for projects to be larger, and even then no AD schemes reach the £40m plus threshold above which non-recourse project financing makes economic sense.

Unfortunately there is no magic wand which will make AD projects suitable for non-recourse project finance. They are simply too small to be funded in this way.

AD Risks

The relatively small size of AD schemes is not the only factor relevant to their financing. Risk is also central.

AD is inherently more risky than some other forms of green energy generation, such as wind or solar. All such projects carry planning, construction, PPA/offtake, government incentive and technology risks, but AD carries some additional risks:

- **Feedstock –** there are two related sets of risks, and funders will need confidence that they are managed via appropriate contracts, or that the local feedstock market is sufficiently developed and understood:
  - *Securing feedstock* **–** AD plants need a sufficient guaranteed quantity of suitable feedstock in order to operate, whether wastes, purpose grown crops or a mixture;
  - *Gate price/feedstock costs* **–** there are risks associated with gate price fluctuations for waste, and the cost/opportunity cost of purpose grown feedstocks.

- **Operating risks –** AD is a relatively complex process technology, and operators need to understand how to manage the risks of the plant in operation. Plants which treat a large proportion of waste feedstock have greater operating risks than those using purpose grown feedstocks because of the diverse nature of waste feedstocks, and because waste feedstocks require pre-treatment (e.g. de-watering or de-packaging) before they enter the digestion process. Funders will need confidence that operators have sufficient experience and track record to manage operating risks.
- **Digestate risks –** The market for digestate is immature, and currently digestate disposal is often treated as a cost rather than revenue for AD schemes. It is likely that as the market develops there will be potential revenue streams from digestate, and funders will need assurance that customers exist for the digestate and confidence that digestate pricing is well founded.

Funders will need to understand how each of these specific AD risks will be managed and mitigated, together with the myriad other risks common to renewable energy projects.

The large number of risks involved in AD projects mean that funders need specialist teams which have invested sufficient time and resources in understanding and valuing them. The same applies to their advisors. AD schemes are too small to justify investing in the steep learning curve required to understand AD for a single project.

Funding AD projects

Their inherent risks mean that AD schemes have to be funded with a significant proportion of equity, usually significantly more than 50%, and often over 95%.

Equity is frequently provided by a single major shareholder (e.g. farming business, water company, Venture Capital Trust (VCT) or Enterprise Investment Scheme (EIS)), often

in partnership with other equity investors (e.g. farmers, private individuals). VCTs will generally expect their equity investments to be backed with a first charge over assets.

Returns from AD, given the current FiT scheme, are relatively low. Leverage often does not improve an AD project's financial viability given high due diligence costs and the impact on Gate Fees/Feedstock Costs and PPA/Offtake of having to fix long term contracts.

Relatively low equity returns mean that AD equity investors are usually either operating a complementary business (e.g. water treatment, farming, food processing) or, as with the VCTs/EIS schemes, secure a charge on real assets to cover the full amount of their funding, and are therefore prepared to take a lower overall return.

Where debt is provided this is often in the form of a finance lease (e.g. for the CHP generators) or senior debt secured on assets (e.g. farmland). There always needs to be a significant proportion (>50%) of equity.

Currently, the main types of funding include:

- **Farm Based Schemes –** In these cases AD is an adjunct to the other activities on the farm, helping to deal with wastes and slurries whilst generating an income for the farm business. These schemes are bankable provided that they are well thought through in terms of their key risks, and there are sufficient free assets (or suitable non-AD cash flows) on which to secure the debt. Some farm businesses object about the level of due diligence required by banks, given that the debt they require will be fully secured on farm assets. However, banks understandably take the view that they are not in the "pawn-broking" business, and need to understand that each AD scheme is viable.
- **Venture Capital Trusts (VCTs) or Enterprise Investment Scheme (EIS) –** these are generally farm based AD projects using only or mostly purpose

grown feedstocks. VCTs generally provide a mixture of equity and debt, all of it secured with a first charge over land assets.

- **Ancillary schemes –** these are AD projects which complement the equity investor's main business, which might be water treatment, farming or food processing/packaging where there are extant feedstocks (e.g. sewage sludge, farm slurries, waste vegetable matter). These projects generally have 95% plus equity funding, with possibly a small amount of debt in the form of finance leasing or senior debt.

Thinly capitalised start up companies, or on-farm projects which are not well thought through, or do not have asset headroom, will not secure funding.

Removing Funding Barriers

AD projects do get funded, but overall numbers are small. No funders yet have more than half a dozen or so funded schemes on their books, at the most.

We have seen that the key barriers affecting AD funding are the schemes' small size, which rules out non-recourse project finance, and the large number of risks inherent in operating an AD plant.

There is no doubt that AD's risks are more daunting at the planning and pre-commissioning stage than once a plant is up and running successfully. Once sufficient AD plants are operating, it will be easier for potential funders to understand AD's risks. The industry has not yet reached this critical mass, and needs further impetus if AD is to become more widespread and contribute to achieving England's 2020 and 2050 emissions targets, and energy and food security.

What is needed is better understanding of AD's key risks, and their impact on funding. This should involve both an education process – predominantly of developers – and support from government to help more viable projects to get up and running, and so demonstrate that AD risks can be managed.

Education about understanding the risks of AD

We understand that many of the successful planning applications for AD which have been made in England have been initiated by small, thinly capitalised start up businesses. Many of these are still understood to be seeking some form of non-recourse project funding (because they have few assets). This will not work for AD, as we have seen.

Action 1: Build on the expertise and experience of the ADBA Finance Forum to produce a succinct guide for developers and potential funders about AD's key financial risks, and how they can be managed (ADBA).

Government support

While the AD industry is at an early stage of development, it is appropriate for the government to provide support and encouragement to help viable projects get funded and built.

WRAP has a £10m loan fund which can provide loans of up to £1m to AD projects on commercial terms. WRAP is able to make use of its understanding of the key AD risks, especially feedstock and technology risks, to provide debt funding where commercial investors would not be prepared to take the risk, given the immaturity of the AD industry.

At present WRAP's fund is under-subscribed, but it should be increased if warranted by demand from AD developers.

We also understand that the UK Green Investment Bank (UKGIB), when it is formed later this year, will have equity funding available for suitable AD projects, under the management of a commercial fund manager. This equity funding will complement the WRAP loan fund in helping viable AD projects to be funded.

Once the AD industry matures, and risks are better understood, government support can be phased out. It should also be possible for AD schemes part financed via WRAP and/or UKGIB to be refinanced once they are operating successfully, so recycling funds to other projects.

3 - Feedstock

AD plants need a constant supply of suitable feedstock, ranging from maize and other purpose grown crops and grasses, slurry and sludge through to food and drink waste.

AD plants using food and drink waste face significant challenges in securing sufficient feedstock[17]. Food and drink waste falls into two categories: municipal solid waste (MSW) and commercial and industrial (C&I) waste.

MSW feedstock is a central element of the current capacity gap, but local authorities are facing budget constraints and are deterred by the capital costs of investing in new waste collection vehicles[18], or converting existing vehicles. This creates a 'market failure' in lack of investment for segregated collection, complicated by the way that waste collection is contracted out by local authorities and the fact that life cycles of vehicles vary. The cost of buying a new split-body collection vehicle is around £30,000 higher than a conventional collection vehicle, but each vehicle can save up to £22,500 per year in lower gate fees for the biodegradable elements of segregated waste.[19] So while it is not sensible to replace new conventional collection vehicles with split-body equivalents, it makes sense to do so when they reach the end of their natural seven to ten year lifecycles.

17 Obtaining feedstocks in the farm and water sectors is relatively simple because a supply usually exists under the control of the AD operators or owners.

18 Split-body collection vehicles cost around £160,000 compared to £130,000 for conventional, single-body machines.

19 This occurs when food waste is diverted to AD or IVC, based on assumption that each vehicle collects waste 250 days per year, and on median gate fees / tonne for food waste – currently £43 for both AD and IVC but £76 and £73 for landfill and incineration respectively. Each vehicle is able to collect 2.5 to 3 tonnes of food waste per day; this represents a potential saving of up to £22,500 per year in gate fees.

Fewer than half (14) of London's 33 boroughs currently offer segregated food collection. The GLA estimates that blanket segregated collection of food would remove more than 900,000 tonnes of waste from landfill each year. This would save 400,000 tonnes of carbon dioxide and would reduce collection and disposal costs by £9 million a year.

Segregated collection is important in both MSW and C&I sectors for three reasons.

First, it shows households and firms just how much food and other waste they are producing. This has a behavioural effect of reducing total waste produced as users realise the volume of waste food they are producing and seek to minimise wastage. Waste avoidance is about eight times better than AD in carbon terms.

Second, segregated collection also improves the quality of the recycling of other products such as plastics, papers and metals by avoiding contamination – which results in higher recycling values - and promotes recycling.

Third, it encourages best use of food and garden waste that arises, both in environmental and economic terms. Segregated food can be sent to AD which has considerably lower gate fees than incineration and landfill and is preferable environmentally.

Collection of segregated MSW food waste has increased consistently from a level of around zero households in 2005 to 3.25 million in 2011. This represents encouraging progress, but is nonetheless low given that there are 26 million households in the UK.

Rates of segregation vary significantly across different regions of the UK, with 82% of households in Wales receiving separate food waste collection compared to just 13% of households in England.[20] Low food waste segregation

20 Houses of Parliament Offices for Science and Technology, 'Anaerobic Digestion', Number 387, September 2011, p. 3.

increases the amount of waste sent to landfill, which is considerably higher in the UK (50%) than the average for the whole of the EU (40%).[21]

The government has sought to use landfill taxes as a tool to reduce waste to landfill, but it is clear that more is needed to encourage greater source segregation. A ban on food to landfill, similar to those imposed on batteries and WEE products, is now needed to accelerate the spread of source segregation. This should be done progressively with a sufficient lead-in time to allow households, firms, local authorities and waste companies to adjust. Equally, however, it is essential that landfill rates are reduced not only to avoid fines in 2020 from failure to meet the EU Landfill Directive, but also because the UK will run out of new landfill sites by 2020.[22]

The Scottish government has committed to a ban on all biodegradable materials to landfill by 2020, including compelling medium and large firms to segregate food waste by 2013 and all firms to segregate by 2015.[23] This approach has also been adopted in other European countries including Denmark, Germany and Sweden.

Action 2: Government should ban all food waste to landfill in England by 2020 (Defra-led).

For MSW, councils and their waste providers should be given incentives. There are already clear economic benefits in the medium term of segregating food collection, but in a period of central and local government austerity central government should consider supporting local authorities to meet the cost of split-body vehicles. This could be done with the proceeds from planned increases in the landfill tax. Alternatively, the government could support adoption of source segregation with a fund similar to DCLG's £250 million Weekly Collection Support Scheme which focuses on the environmental benefits of the segregation of waste.

21 www.defra.gov.uk/environment/waste/
22 A Grice, ' UK Warned it will run out of landfill sites in 8 years', Independent, 8 July 2010.
23 Natural Scotland, Policy Statement: Zero waste regulations, October 2011.

Action 3: DCLG should make provision for financial support to local authorities switching to split-body collections (DCLG).

4 – Government's role

Four departments

Four government departments share responsibilities for AD as a policy area.

AD creates renewable energy and mitigates GHG emissions (DECC) and is a form of waste management and landfill avoidance (Defra and WRAP). Further, it is affected by issues of local authority refuse collection (DCLG) and can make a serious contribution to renewable fuel for HGVs (DfT). So it is a challenge for government to be completely 'joined up' and consistent on AD.

Indeed, there is a widespread perception in the AD industry that government policy is not coherent, consistent or stable.

Providing comfort on future tariff levels

Government incentive tariffs can be claimed once an AD plant has been constructed and is ready to operate. They are then fixed for an agreed period and rise in line with inflation.

AD development schemes can take as long as five years to plan and complete. There is thus a concern that tariffs might be lowered before a scheme is completed, which would probably affect financial viability, often after considerable investment has already been made. There are also concerns that the introduction of capacity triggers could suddenly change tariff levels.

Confidence in the future rate of tariff payments from AD can be affected by what has happened in other sectors. In

October 2011 the government unexpectedly announced that it was more than halving the FiT for solar PV because the demand had been three times higher than expected.[24] There are also concerns that the FiT for onshore wind could be cut significantly in the near future.[25] A lack of confidence in the stability of government tariff rates has spread to AD.

DECC understandably needs to manage tariffs to ensure that it does not overspend its budget as it did with solar PV, and it is proposing to use capacity triggers to do this. Nevertheless, confidence in tariff levels at AD scheme planning stages remains low in many cases.

The government should act to address these concerns, which can significantly hinder the development of AD schemes. A system of pre-accreditation for AD tariffs has been proposed, and we support this initiative. It would allow developers of an AD scheme to apply for tariffs at the planning stage and receive a clear indication of the rate of payment they would be likely to receive upon completion on a particular date.

There is some debate about the best point at which to provide pre-accreditation. We support doing so at financial close, which is the point at which all substantive components of a scheme have been finalised, and where there is a high degree of certainty that the scheme will proceed to completion. In advance of financial close DECC would need to provide developers with a clear indication of the tariff level they should expect, given DECC's visibility of the AD pipeline, and the position in relation to capacity triggers.

In order to ensure that only live schemes are pre-accredited, scheme developers would need to demonstrate that they were proceeding to completion in accordance with a small number of agreed milestones in order to retain pre-accreditation.

There are clear advantages of this to AD developers and to the government. AD developers would find it easier to secure funding if they could be confident of tariff levels. The

24 The FiT was reduced from 43p to 21p / kWh. See DECC, 'Barker: Boom and bust for solar must be avoided, 31 October 2011.

25 D Carrington and T Helm, 'George Osborne demands massive cuts to windfarm subsidies, Guardian, 2 June 2012.

government would have visibility of what level of realistic demand exists for tariffs in the pipeline, and thus the likely point at which capacity triggers would come into effect.

The government is already working on a system of pre-accreditation for ROCs, and should work as quickly as possible to roll this out for AD tariffs.

Action 4: Introduce a system for pre-accrediting AD schemes to fix applicable tariffs at financial close (DECC).

Assessing total environmental benefit

The landfill tax drives waste from landfill to the cheapest alternative rather than necessarily the best environmental choice. There is a risk that existing incentive structures do not do enough to promote the most carbon efficient use of AD feedstock or the biogas it subsequently produces.

Some in the AD industry have suggested that tariffs do not always promote the right behaviour. FiTs, for example, do not encourage plant operators to reduce pollution or their carbon footprint but instead pay them to maximise gas outputs.[26]

Some have proposed a carbon metric which would recognise the lifecycle carbon benefits of the AD process, and offer developers better environmental incentives and the opportunity to compare the carbon benefits of different technology options.

The current system of ROCs and FiTs has different rates for different technologies, but these reflect variations in cost and maturity of technology more than carbon or indeed other benefits such as energy and food security. Tariffs fail to recognise the carbon 'waste miles' of the feedstock, the efficiency of gas conversion into HGV fuel or electricity, and how much carbon these outputs offset. A carbon metric, it is

26 For example, it doesn't help small farm based AD plants treating slurries, despite environmental impacts. See A. Bywater, 'A review of AD plants on UK Farms', Royal Agricultural Society of England, March 2011.

argued, would include these factors, as well as the benefits of using digestate as a substitute for fossil fuel-based fertilisers.

The Scottish government established a carbon metric to determine best treatment of waste, defining it in terms of carbon savings rather than by weight or volume. For example, the metric shows that textiles should be a priority for recycling because of the intense production process used to make them.

The Environment Agency's Waste and Resources Assessment Tool for the Environment (WRATE) similarly compares the environmental, as well as the financial, impacts of different municipal waste management systems. It is based on the resources used and transportation of waste.[27]

However, we take the view that whilst metric or WRATE systems are useful for local authority operational decisions, using them as the basis of tariffs would be unduly complex and costly. It raises a variety of questions about how large volumes of data – particularly for merchant plants – would be processed, particularly if tariff rates were linked to 'live' data on, for example, feedstock types and transport miles.

The *UK Solid and Gaseous Biomass Carbon Calculator,* developed for Ofgem, EA and DECC, is an established tool for calculating carbon intensity and GHG saving of solid biomass and biogas used for electricity and heat generation.[28] This can be used to provide detailed information on the carbon intensity of particular schemes.

We agree that it is important not to incentivise those AD plants which rely on feedstocks and digestate being transported long distances, cancelling out the other environmental benefits of AD, unless there are demonstrably no other options with lower overall carbon emissions. There is therefore a need to take account of the benefits of a particular AD scheme compared with other treatment options in the locality, assessed on a like for like basis.

27 Environment Agency WRATE: www.environment-agency.gov.uk/research/commercial/102922.aspx.

28 www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/FuelledStations/bbcc/Pages/bbcc.aspx

A simple way to do this would be to include a step in the tariff pre-accreditation process which would assess typical feedstock and digestate transport miles, and provide assurance that these were consistent with the planned environmental benefits of the specific scheme, and better than local alternatives on a like for like carbon basis. The Ofgem carbon calculator could be used to provide information on carbon intensity as part of this step. In Chapter 5 we propose a similar new stage in the pre-accreditation process for purpose-grown crops (Action 7).

Action 5: Introduce a step in the tariff pre-accreditation process for assessing the total environmental benefits of proposed schemes, taking account of feedstock/ digestate miles in the light of other local options, compared on a like for like basis (DECC/Defra).

Incentives for gas grid injection

The RHI is the only direct incentive for plants to inject bio-methane into the grid, which is one of the major potential benefits of AD because it is the most efficient and carbon saving use of the gas[29], and it can be stored.

The heat element is only offered to plants with a heat output below 200 kWth, including parasitic heat used by the plant itself. This is far smaller than commercially viable plants and effectively restricts the tariff to exhibition plants. It should be expanded to support plants up to 1MW, using a declining scale as FiTs do.

Action 6: Expand the heat element of the RHI to 1 MW (DECC)

The Renewable Transport Fuel Obligation (RTFO) is designed to promote use of biogas upgraded to bio-methane for renewable fuel. However, it can only be claimed at the fuel's duty point, which means that it is not possible for an AD plant to inject bio-methane into the national grid and sell the

29 "Bio-methane to the gas grid ... will have an advantage over electricity generation in the future when the electricity grid has been decarbonised, and injection to the gas grid provides flexibility to use the bio-methane as a transport fuel elsewhere." Carbon Trust Biogas from anaerobic digestion Technology Update

equivalent gas to a fuel converter. The AD plant would have to compress and dispense bio-methane fuel on site, which is not always economically viable for smaller scale AD plants.

The RTFO should be amended to offer credits to plants injecting bio-methane into the grid, which could be sold to firms converting gas into fuel. This would create a better incentive to use AD bio-methane for transport fuel via the gas grid.

Action 7: Amend the RTFO scheme so that AD plants can claim certificates for bio-methane injection which can be used to claim RTFO at larger compression centres (DfT).

5 - Purpose grown crops

Purpose grown crops – an environmentally friendly opportunity

Purpose grown crops (PGCs) such as maize, grass sileage, wildflower mixes and beet can be digested alone or co-mingled with various waste feedstocks to boost calorific content or balance moisture levels. The NFU has argued that the government should set a target of 1,000 farm-based AD plants by 2020, all of which would be financially and environmentally beneficial.[30] Today there are only 27 farm-based plants, so this represents a major opportunity.

However, government seems equivocal about supporting PGCs as AD feedstock. DECC's recent comprehensive FiT review, for example, warned that it may in future cease support for crop-only plants by exploring controls such as "limiting future eligibility for FITs to plants that treat wastes".[31]

This chapter explains the benefits of PGCs, before addressing the government's concerns, demonstrating that some are unfounded while others can be easily overcome.

Benefits of purpose grown crops

PGCs such as maize make good break crops to support the growing of primary crops including cotton, soybeans or legumes in agricultural rotation cycles. Crop rotation is a standard farming practice and increases yields by improving

30 NFU, Anaerobic Digestion (biogas) – an NFU Vision, October 2009.
31 DECC, 'Feed-in Tariffs Scheme Consultation on Comprehensive Review Phase 2B: Tariffs for non-PV technologies and scheme administration issues, 9 February 2012.

soil quality and reducing the prevalence of soil-born diseases. It also helps to balance nutrients such as nitrogen, which reduces the need for artificial fertilisers. Rotation and the use of break crops is already an important part of good farming practice. AD can provide an end market for such crops and multiply their benefits.

A major advantage of using PGCs for AD is that the digestate produced can be used to return nutrients to land, minimising transport costs and substituting the use of fossil fuels. When PGCs are used for AD, individual farms or co-operatives generally have control over the supply of their feedstock. Another benefit of using PGCs is that the Environment Agency allows plants using crop-only or co-mingled crops with on-farm manure or slurry to spread digestate without a permit.

Crop-only AD is a simpler process than waste AD because feedstock is homogeneous and requires minimal front-end processing. This means that both capital and management costs are lower than for waste plants[32]. A 500 KW plant using CHP with energy crops typically costs around £2.2 million to construct, whereas a similar plant operating with waste is likely to cost around £3.8 million. Greater simplicity offers not just cost reductions but also a more reliable digestion process.

PGCs are also beneficial when co-mingled with wastes including food, manure and slurry. In particular, wet wastes may require crops to increase dry matter content, which makes digestion more efficient. PGCs can also balance feedstock nutrient composition to make digestion more consistent for bacteria and to increase biogas yields. There are also likely to be circumstances where food waste alone does not provide a sufficient volume of feedstock to make an AD plant viable, but supplementing it with PGCs may do so. In this way PGCs can enable waste food to be sent to AD where it would otherwise go to compost, incineration or landfill.

32 Although feedstocks are a cost in the absence of gate fees

Government concerns

The government's primary concerns appear to be that tariff support for PGCs may promote monoculture and divert incentives from waste AD. It is also concerned that excessive use of PGCs could harm the environment and compromise the UK's food security.

Risks of promoting monoculture are frequently raised as a concern, although the government's latest review of tariffs recognises that AD crop monoculture is unlikely with existing tariff infrastructure.[33]

The concern that tariffs may make PGC plants too popular and claim incentives at the expense of waste AD plants implies that waste AD is viewed as preferable because it both treats waste and creates energy. DECC has stated:

> "we want the limited public funds available to drive greater and wider uptake of waste feedstocks, with crops being used to support this growth where it is required and it makes sense to do so."[34]

This is puzzling because FiTs are designed to support renewable energy rather than waste management. FiTs support wind and solar technology, neither of which treat waste. Incentives are also available for other forms of bioenergy, such as miscanthus, and the government has recognised the need for bioenergy. Where break crops are grown and used for AD, they produce green energy and reduce carbon emissions, so should be supported in the same way as wind, solar and other forms of bioenergy.

The third concern is over pollution or habitat loss through growing PGCs; however AD crops are no different from other crops, and can be controlled in the same way.

33 DECC states that: "with the current policy framework and FIT rates, only a modest increase in the use of these crops is likely as agricultural based AD plants mainly utilise manure, slurry and residue feedstocks, co-digested with crops. We are reassured that stakeholders agree the current framework is unlikely to lead to the creation of new large scale monocultures of crops which do not support our environmental objectives." DECC, 'Feed-in Tariffs Scheme Consultation on Comprehensive Review Phase 2B: Tariffs for non-PV technologies and scheme administration issues, 9 February 2012.

34 DECC, 'Feed-in Tariffs Scheme Consultation on Comprehensive Review Phase 2B'.

There is clearly a need for a set of criteria on achieving sustainable land use, which would apply across all forms of bioenergy, including farming, forestry and other land uses. This could usefully draw on the Ofgem *Biomass and Biogas Carbon Calculator*[35], developed for ROCs, to compare overall carbon benefits.

In the meantime, DECC has announced plans to work with stakeholders to produce a voluntary code of practice for AD operators using PGCs.[36] Doing so would clarify issues for farmers, highlight existing best farming practices and help to alleviate collective concerns about the environmental impacts of PGCs.

There is an opportunity to build the code of conduct into the pre-accreditation of AD schemes for tariffs, which would ensure that feedstock comes from a sustainable source. Pre-accreditation would require evidence that the code of conduct would be implemented by that scheme.

Action 8: Proceed with plans to develop a code of conduct for farmers growing energy crops, and incorporate an assessment of compliance with the code in the new pre-accreditation process for tariffs. (DECC/Defra).

Food supply and PGCs

The final concern over PGCs relates to PGCs replacing food crops and driving up food prices. Of course, many PGCs (e.g. maize) are themselves food and can be switched from AD to food production when market prices make this attractive.

PGCs for AD have particular advantages over alternative energy crops because AD recycles nutrients, AD PGCs do not tie up land for long periods (as woody biomass does), and support longer crop rotations.

35 www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/FuelledStations/bbcc/Pages/bbcc.aspx
36 DECC, 'Feed-in Tariffs Scheme Consultation on Comprehensive Review Phase 2B'.

Conclusion

In conclusion, responsible rotation and production of feedstock from break crops is an environmentally friendly and sustainable method of producing renewable energy from AD, which compared with other forms of bioenergy is productive and supports food production.

PGCs can improve biogas yields when mixed with wastes and make waste treatment plants viable where they may otherwise not be.

Crop-only AD plants should not be discriminated against simply because they do not treat waste. Rather, they should be considered on their own merits as renewable sources of energy much like wind, solar and other forms of bioenergy, which receive tariffs despite not treating waste. In this light, the government should review its stance on the use of PGCs and publicly back it to boost confidence.

Action 9: Government to review its policy on PGCs for AD and confirm that, with a code of conduct and sustainable land use criteria for all forms of bioenergy, it will continue to support PGCs for AD with tariff incentives (DECC, Defra, WRAP, EA).

6 - Gas grid connections

Advantages of bio-methane injection to the grid

AD produces renewable biogas. Most UK AD plants currently use CHP units to convert it into electricity, which has established incentives and fewer regulatory complexities than gas injection. Yet the potential for biogas to contribute to 2020 renewable energy targets rests not only on the quantity of gas produced but also on the efficiency with which it is converted into final energy.

Injection to the grid, together with producing compressed bio-methane (CBM) or liquefied bio-methane (LBM) on site where this makes economic sense, is the most efficient use of biogas.

CHP plants which fail to use heat locally may only extract 40 per cent of gas energy, whereas modern domestic boilers using gas from the grid can extract more than 90 per cent of its energy. The grid also offers access to a far larger market for potential buyers than local use as it reaches 80 per cent of UK homes.[37] There is also the potential to inject bio-methane into the grid and extract it elsewhere for conversion into CBM or LBM.

Despite the significant advantages of gas injection, only two plants in the UK are currently connected to the grid, with another two plants to follow this summer.[38] Even then, the UK's bio-methane injection levels will be considerably

37 DECC – 'Bio-methane into the Gas Network: A guide for producers', December 2009.
38 The two existing plants are Didcot Sewage Works and the Adnams Brewery in Suffolk. Plants are due to connect this summer in Poundbury and Stockport.

lower than other countries such as Germany - which has 60 plants connected to their grid - Switzerland, Holland and Sweden. This is due in significant part to the relative youth of British injection incentives - the RHI only began paying for bio-methane injection in January 2012. The RTFO must also be amended to support compression and liquification of bio-methane from the grid.

The main barriers to greater injection are strict regulation of gas quality and the often exorbitant costs of connecting to the grid. Problems with the incentives for gas injection are discussed in Chapter 4 and technology issues are discussed in Chapter 8.

Regulation

For biogas to be injected into the national grid, it must be upgraded into bio-methane.[39] It must also comply with regulations on odour, water content and oxygen concentration. The purification process can be completed with a number of different technologies including membrane separation, water scrubbing, selexol absorption and cryogenic separation.

The relevant gas regulations are enforced by the Health and Safety Executive (HSE). They are based on North Sea gas composition and require less than 0.2 per cent oxygen, whereas biogas may contain up to 5 per cent oxygen. There has been concern that high levels of oxygen and water in bio-methane could increase pipe corrosion in the grid, but HSE has recognised that the 0.2 per cent limit could safely be increased and is considering raising it to 1 per cent.[40]

There are also regulations to ensure that consumers get a fair deal from bio-methane. Gas is sold by volume, so it is important that bio-methane has as much energy content as natural gas. Calorific value (CV) is used to determine the energy of gas, but the equipment used to measure this

39 Biogas is converted from 50-70 per cent methane, 20-25 per cent carbon dioxide and other trace impurities to above 97 per cent methane,

40 Based on final testing by Wales and West Utilities. EMIB p. 7.

very accurately can be too expensive for small plants.[41] To address this, it has been suggested that cheaper equipment with an accuracy of +/- 0.5MJ/m^3 could be used which would be more affordable for smaller plants.[42]

The government recognises the regulatory burden on AD and has pledged to "work with regulators to enable Anaerobic Digestion plants to benefit from reduced regulatory burdens and faster permitting, including whether it is appropriate to amend regulations which apply to bio-methane injection to the grid."[43]

The UK's two plants that currently inject have been given exemptions from the usual gas regulations and instead have their own specific version. Similarly, two more plants which will go online in the summer have also received exemptions. We support the HSE's initiative to produce a standard exemption for bio-methane injection as a priority, allowing the market to spread.

Action 10: Produce a standard exemption template of regulation specifically for bio-methane injection which raises the oxygen allowance to 1 per cent as soon as possible (HSE).

Connection

A major barrier confronting AD operators who wish to connect to the gas grid is that capital costs of grid connection are often unrealistically high, with quotes ranging from £ hundreds of thousands to over £1 million.[44] Costs are not only very high but also vary significantly across the country. The fundamental problem is that there is not sufficient incentive for gas distribution networks (GDNs) to offer a competitive price for grid connection.

41 When the CV is not high enough, propane can be blended in to supplement it. RHI is paid for the renewable bio-methane content but not propane.
42 Review Group Report, Energy Market Issues for Bio-methane (EMIB), Summary and Recommendations.
43 DECC, UK Renewable Energy Roadmap, July 2011, p. 7.
44 A Bywater, 'A review of AD plants on UK Farms', Royal Agricultural Society of England, March 2011, p. 24.

We recognise that there are technical issues which drive up connection costs. Issues arise not only about how far a plant is from the existing grid and compression stations to push it across the grid, but also about levels of local demand.

At the heart of the problem is the fact that GDNs still have insufficient incentive to assist or conduct proper due diligence estimates for the cost of connection. Ofgem has a competition and connections group designed to oversee grid connections and has introduced a requirement for distribution network operators to produce a quote accuracy review scheme.[45] However, these have not been effective enough, and more drivers are needed to guarantee a more reasonable and consistent approach.

The situation in Germany is effectively the opposite; energy companies must connect sustainable energy plants to the national grid free of charge. The associated costs are passed back to consumers, as is done by the UK government with FiTs, ROCs and RTFCs.[46] This approach is unlikely to be palatable at the present time with rising domestic energy costs, but it raises questions of how we can get a fairer deal for small UK biogas producers.

The planned shift from cast iron to plastic piping will help reduce regulatory concerns, and the adoption of 'smarter networks' will enable two-way power. Nevertheless, Ofgem recognises that significant and immediate barriers remain and is in dialogue with DECC about grid connection issues. Currently GDNs have different specifications about how much connection machinery they control and how much the AD plant does.

The idea of a 'Functional Specification' has been raised, which would set out exactly what AD plants must do to be able to connect to their local GDN and give them a choice of where the gas entry point – where responsibility is handed to

45 Ofgem, New standards for network connection services.
46 Having said this, in Germany plants only receive the tariff and no additional market price for electricity produced.

the GDN - should be.[47] This would lead to a more consistent approach across the country and increase the confidence of AD operators who could put out to tender a contract to provide the technology they needed before the gas entry point. This would open the process to competition and reduce prices.

It is also worth considering other options, such as promoting co-location of waste AD plants with sewage plants to make use of existing gas infrastructure. Moreover, the use of 'dirty pipes' to transport gas from several AD plants to one end processor for injection would promote economies of scale. However the immediate focus must be on ensuring that networks have incentives to offer a reasonable connection service.

Action 11: Introduce a functional specification for grid connections to standardise connection requirements and open them up to competition with other gas distribution networks. (Ofgem)

47 Review Group Report, Energy Market Issues for Bio-methane (EMIB), Summary and Recommendations, p. 5.

7 - Market for digestate

Digestate market under-developed

WRAP estimates that digestate derived from avoidable household food waste alone has a potential value of £50m a year.[48] Scaling this up to include other food waste, slurries, manures and sludge, the AD digestate market could have a potential value of £200 million a year.[49]

The market for digestate, however, is currently under-developed and based on ad hoc local relationships. In order to sell digestate to farms, AD operators must pass an accreditation process – the Publicly Available Specification (PAS) 110 - or pay roughly £1/tonne for an EA waste permit.

For some farm plants the amount of land available for spreading is the primary limiting factor and the lack of a digestate market means they cannot accept additional waste feedstock.[50] For most AD plants digestate is viewed as a cost, particularly when they are in planning stages, because it is almost impossible to sell digestate in advance without a sample, let alone PAS110 accreditation. It is a problem particularly for waste but also for PGCs, because most of the environmental benefit is not represented in prices.

Benefits

Digestate helps reduce reliance on industrially produced sources of nitrogen. This leads to greenhouse gas (GHG)

48 Opportunities for quality digestate products to contribute towards the UK's fertiliser needs.
49 This is based on Carbon Trust figures of feedstock supplies. See Carbon Trust, 'Biogas from anaerobic digestion', technology update, Appendix p. 7.
50 A Bywater, 'A review of AD plants on UK Farms', Royal Agricultural Society of England, March 2011. p. 21.

savings against emissions associated with mining, production and transportation of inorganic fertilisers. Transport emission savings can be large because the voluminous nature of digestate means that it is only financially viable if transported short distances – it is almost by definition a localised solution unless de-watered. When digestate is accredited by PAS110 it gains End of Waste (EoW) status and can be classified as recycled and counted towards revised Waste Framework Directive targets.[51]

Technical benefits also exist. The AD process converts nitrates in feedstock into ammonium which is more readily available for uptake by crops. Moreover, digestate in liquid form penetrates through soils to crop roots whereas granular fertilisers require rainwater to spread nutrients into the earth. Having said this, pellets are easier to transport long distances and cheaper to spread.

Lack of market

Despite the benefits of digestate, the market is neither stable nor mature and those who can dispose of it most easily are generally farmers rather than a natural private sector market. Demand for digestate should grow naturally as the AD sector itself matures and oil-based fertiliser prices continue to rise. The government recognises, however, that it must give further impetus to development of a market because of the benefits digestate offers. WRAP, in particular, has worked to create and nurture the budding market by creating PAS110 and funding research into further uses for digestate.[52]

While focusing on what the government can do, it is also important to recognise that practical problems also exist, most of which lie largely beyond the government's control. For example, conventional fertilisers are less bulky and cheaper to spread than digestate which costs around £4/tonne to spread. There is also an inherent tension in municipal waste AD between the need for plants to be near

51 Digestate that does not meet EoW criteria still has GHG benefits, but is not counted towards recycling targets.
52 WRAP, New WRAP trials seek to develop end markets for digestate, 21 May 2012.

an urban source of feedstock and the need for digestate to be near farmland.

Regulation

Digestate from AD can fall under four different areas of regulation:

- Sewage sludge – light touch regulation for sludge to farmland through the safe sludge matrix supported by the EA. [53]
- PAS110 and the Quality Protocol (QP) – accreditation with requirements for pasteurisation and control of feedstock, which reduces need for testing at the back end. It is the only standard for demonstrating a quality digestate but currently very few plants are accredited.
- Permits - cost £600 each (roughly £1/tonne) and cover the EA's costs of regulating the spreading of non-PAS110 accredited digestate.
- On-farm manures and slurry - can be spread without PAS110, permits or animal bi-products testing on farm. Co-operatives can also spread on-farm wastes from others in the group on the condition that they have been pasteurised.[54]

PAS110 and the QP

WRAP developed PAS110 to "remove a major barrier to the development of AD by encouraging markets for these digested materials."[55] Plants must have the specified process in place to remove pathogens and show that their output meets the requirements on three consecutive inspections.

53 The Environment Agency, Spreading Sewage Sludge on Land, www.environment-agency.gov.uk/business/sectors/130187.aspx

54 This PAS includes a reduced range of test parameters for digested materials made from specific input materials that arise within the producer's premises or holding and that are used entirely within the producer's premises or holding, (see 11.2.5 and 12.2.4). Those producers are exempt from carrying out a pasteurization step during anaerobic digestion (see 7.2 and 3.58). Similar provisions are made for farming / horticultural / forestry co-operatives, but without exemption from a pasteurization step. (see 7.2.4).

55 PAS 110:2010 Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials. WRAP 2010.

Accreditation shows that digestate is of consistent quality and fit for purpose as a fertiliser with EoW status.

Many AD plants *want* to be regulated because EA permits have a less secure and profitable market than PAS110. Only five AD plants in the UK have PAS110 accreditation, although this does not necessarily signify a problem with the process which was only introduced in 2010 and so remains a relatively new standard. Having said this, it can be an arduous process; the requirement for three consecutive passes means that a plant with an 80 day rotation cycle would need at least eight months to receive accreditation. It is particularly hard for waste plants to pass three consecutive times because their feedstocks, and thus digestates, are less homogeneous.

Although a temptation exists to relax the accreditation process in light of the low pass rates, it is essential that confidence in accreditation is not eroded. Thus the pasteurisation requirement for animal and food waste is likely to remain. There is room to help farms spread digestate outside regulation. Currently individual farms are allowed to co-digest their own waste with off-farm waste that has been pasteurised as long as it is spread on their own farm.

The EA could consider amending regulations so that farms registered in co-operatives could also spread pasteurised off-farm waste that has been co-digested with pasteurised wastes from their farms without paying for a permit. This would expand their ability to spread digestate and allow more AD plants to accept waste. This would also make it consistent with the other exemption that co-operatives may spread farm waste from other members of co-operatives as long as it has been pasteurised.

Action 12: Amend regulations so that farm co-operatives can spread waste co-digested on-farm waste as long as both feedstocks are pasteurised (EA).

Desirable product

Although there is recognition that digestate has value as a fertiliser, doubts remain amongst farmers and supermarkets,

meaning that many AD operators currently have to sell their digestate at a significant discount to commercial fertilisers. Indeed, others give it away for free while a minority even see it limit their capacity.

PAS110 should give farmers confidence that digestate is a safe product, but AD operators must recognise that farmers need to know what nutrient proportions they are receiving. Yields define their livelihoods and the risk of buying a digestate with unknown nutrient values will deter them from using it.

Some water companies have taken a lead to address this by measuring the nutrient levels in their digestate so that they can specify exactly how much nitrogen they are selling. More AD plants should follow this example, and space certainly exists for companies offering a digestate nutrient testing service to assist AD operators. There have also been suggestions that companies which manage and spread compost could also deal with digestate, although it is unclear whether their involvement would be advantageous because of the localised nature of digestate markets given the adverse environmental impact of transporting digestate for long distances.

Moreover, although digestate may have a specific content of nitrogen, phosphorous and potassium, these nutrients may not be of equal value to farmers throughout the year.[56] Indeed, they may have to store digestate if Nitrogen Vulnerable Zone (NVZ) windows are closed. With a greater appreciation of how demands for different nutrients may fluctuate, operators can better tailor their digestate to farmers' needs.

Many farmers are dependent on contracts with the 'big four' supermarkets, which control more than three-quarters of food sales in the UK.[57] Supermarkets remain somewhat cautious about the use of digestate for their produce, particularly for vegetables. The same goes for food standard assurance boards such as Red Tractor and Quality Meat Scotland. It

56 Many AD plant operators come from either a waste management or a renewable energy background, and may not be familiar with the farming needs from fertiliser.
57 The big four are Asda, Morrisons, Sainsbury's and Tesco.

is important to step up the process of education between supermarkets, assurance boards and advocates of digestate, and that any remaining concerns are heard. Supermarket confidence in the use of digestate would enable more farmers to use it and stimulate growth in the market.

Where digestate is trusted and economically viable, producers will prefer to use a recycled product rather than non-renewable options. Greater dialogue between AD operators, farmers and supermarkets will help drive the development of an AD market.

Finally, WRAP is developing a biofertiliser matrix similar to the safe sludge matrix which would show where and when digestate should be used.

Action 13: Promote dialogue with the NFU, supermarkets and AD sector to educate about the safety of digestate and discuss how it can be provided by AD plants so that it is trusted and useful to farmers (EA and WRAP).

8 - Conclusion

AD is the best solution for a variety of organic wastes and has the potential to produce 11 TWh of energy by 2020, whereas currently it is producing 1.3TWh.

A significant capacity gap exists and the government must act to ensure that it delivers the "huge increase" it pledged in the Coalition Agreement.

Government's six priorities should be to:

- Phase out organic waste to landfill by 2020
- Promote source segregated collection of MSW and C&I Waste
- Introduce accreditation of AD schemes at financial close to fix all tariffs
- Encourage bio-methane injection to the grid because this is one of the most efficient uses
- Encourage use of bio-methane to fuel Heavy Goods Vehicles, another efficient use of AD derived energy
- Ensure that the WRAP loan fund and Green Investment Bank have sufficient funds to support AD development

The 13 specific actions we have recommended are set out in the table overleaf.

Summary of recommended actions

No.	Action	Organisation	By when
1	Build on the expertise and experience of the ADBA Finance Forum to produce a succinct guide for developers and potential funders about AD's key financial risks, and how they can be managed	ADBA	Oct 12
2	Government should ban all food waste to landfill in England by 2020	Defra	2020
3	DCLG should make provision for financial support to local authorities switching to split-body collections	DCLG	Dec 12
4	Introduce a system of pre-accrediting AD schemes to fix applicable tariffs at financial close	DECC	Dec 12
5	Introduce a step in the tariff pre-accreditation process for assessing the total environmental benefits of proposed schemes, taking account of feedstock/digestate miles in the light of other local options, compared on a like for like basis	DECC Defra	Dec 12
6	Expand the heat element of the RHI to 1 MW	DECC	Oct 12

7	Amend the RTFO scheme so that AD plants can claim certificates for bio-methane injection which can be used to claim RTFO at larger compression centres	DfT	Oct 12
8	Proceed with plans to develop a code of conduct for farmers growing energy crops, and incorporate an assessment of compliance with the code in the new pre-accreditation process for tariffs	DEC Defra	Dec 12
9	Government to review its policy on PGCs for AD and confirm that, with a code of conduct and sustainable land use criteria for all forms of bioenergy, it will continue to support PGCs for AD with tariff incentives	DECC Defra	Oct 12
10	Produce a standard exemption template of regulation specifically for bio-methane injection which raises the oxygen allowance to 1% as soon as possible	HSE	Oct 12
11	Introduce a functional specification for grid connections to standardise connection requirements and open them up to competition with other gas distribution networks	Ofgem	Dec 12
12	Amend regulations so that farm co-operatives can spread waste co-digested with on-farm waste as long as both feedstocks are pasteurised	EA	Dec 12
13	Promote a dialogue with the NFU, supermarkets and the AD sector to educate about the safety of digestate and discuss how it can be provided by AD plants so that is trusted and useful to farmers	EA WRAP	Oct 12