UK Biomass Strategy 2007

Working paper 3 – Anaerobic Digestion

Agriculture and Environment Team Defra

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Anaerobic Digestion

1. Anaerobic digestion has significant potential to contribute to our climate change and wider environmental objectives. It can help us to meet three of the UK's needs at the same time by:

- producing more renewable energy in the form of biogas for biomass heat and/or power or for transport fuel;
- helping to mitigate methane emissions from agriculture; and
- helping to divert other kinds of organic waste, especially food waste, from landfill or incineration.

Annex 1provides a brief introduction to anaerobic digestion.

2. The Government will work with stakeholders to drive a faster growth in the use of this technology by local authorities, businesses and farmers. Our objective is to stimulate and develop the markets for anaerobic digestion and its products, and to address the administrative and technical challenges which may hamper its development. This Working Paper outlines the key actions the Government will take to achieve this. These are summarised in the box below.

Action to promote anaerobic digestion

Stimulating and Developing Markets for Anaerobic Digestion and Its Products

- Anaerobic Digestion is eligible for Renewable Obligation Certificates (ROCs). Government proposals to band the Renewables Obligation, providing different levels of support to different technologies, presents the opportunity to provide higher levels of support to anaerobic digestion.
- We will consider the case and prospective mechanisms for long term support for the renewable heat sector.
- We will explore possible means to support the development of local infrastructure and supply chains for anaerobic digestion.
- The Waste and Resources Action Programme (WRAP) will continue to support the uptake of this technology for treating commercial and municipal food waste through its capital support programme and its work with the Carbon Trust and the food industry.
- Defra will work to establish the full potential of the market for digestate, drawing on the ALOWANCE project to identify the location and capacity of land suitable for the use of digestate.

- WRAP will support the development of the market for digestate alongside its work to establish markets for waste-derived compost.
- the Environment Agency and WRAP will develop a standard and protocol for digestate by Spring 2008. The objective is to help build the market for digestate as a fertiliser and soil conditioner.

Addressing Administrative and Technical Challenges

- Defra will encourage and facilitate communication between interested parties in industry, regulators, government delivery bodies and non-governmental bodies about addressing administrative and technical challenges to the uptake of anaerobic digestion.
- Defra will work with stakeholders to develop and disseminate guidelines on best practice and technology for the use of anaerobic digestion in a way that is both cost effective and beneficial to the environment.
- Defra will build on its existing research to improve the contribution of anaerobic digestion to reducing greenhouse gas emissions and delivering other environmental benefits.
- Defra will continue to develop its New Technologies Demonstrator Programme to include, for example, guidance to potential operators on application of anaerobic digestion to biodegradable municipal waste.

International Dimension

- The UK will continue its work with the international Methane to Markets Partnership to drive forward thinking about the role of anaerobic digestion internationally and to learn from the experience of other countries to inform the development of effective policies in the UK. Key actions that we are taking forward with the Partnership include:
    - holding a workshop in Argentina in May 2007 to showcase anaerobic digestion technology used successfully in cold climates;
    - organising a high profile Partnership Expo in Beijing, China in October 2007 to highlight the work of the Partnership, showcase projects and so enhance funding opportunities;
    - designing a common accounting framework for the benefits of anaerobic digestion based on the best elements of methodologies in each country; and sharing information about the status or standards for digestate in each country.

Coordinating Delivery

- A cross-cutting project team will coordinate delivery of the above actions within Defra. It will also work with other key Government Departments and stakeholders to identify and further address barriers and maximise the synergies between the different markets in which anaerobic digestion has a contribution to make.

Stimulating and Developing Markets for Anaerobic Digestion and Its Products

Market Support for Anaerobic Digestion

3. The Government recognises that there is currently a market failure which is inhibiting the optimal investment in the anaerobic digestion sector. We are therefore examining whether there is a role for Government intervention to help overcome this, and whether economic instruments might have a role to play.

4. The electricity derived from the energy recovered in anaerobic digestion is eligible for Renewable Obligation Certificates (ROCs) [1]. ROCs are currently worth £44/MWh and as such can encourage greater use of anaerobic digestion. Following the 2006 Energy Review the Government announced a number of proposals for changes to the Renewables Obligation (RO). These changes would provide differentiated support levels to different renewables technologies (banding) and give additional certainty on long-term Renewable Obligation Certificate prices by increasing the Obligation up to 20% on a guaranteed headroom basis. The Government published a consultation document on these proposals on 9 October 2006 and launched a further consultation alongside the Energy White Paper. This consultation sets out the level of support each technology would receive under a banded RO. Alongside other more emerging technologies, anaerobic digestion is among the technologies that will receive additional support in the form of multiple ROCs. This should provide an additional incentive to deploy these technologies.

5. Anaerobic digestion is also a potential source of renewable heat. The Government is committed, through the Climate Change and Sustainable Energy

[1] The Renewables Obligation (RO) requires electricity suppliers to deliver a stated proportion of their electricity from eligible renewable energy sources. Companies can meet their obligation by presenting Renewable Obligation Certificates (ROCs). ROCs are currently issued to renewable generators for each 1MWh of electricity generated, these are then bought by supply companies. Suppliers can also meet their obligation by paying a buy-out fund contribution per MWh or a combination of the two. Money from the buy-out fund is recycled pro-rata to companies presenting ROCs, hence the value of a ROC = buy-out price + money recycled from buy-out fund. The recycling mechanism gives suppliers an additional incentive to invest in renewables and acquire ROCs.

Act[2], to promote the use of renewable heat. We have commissioned Ernst & Young to analyse the case for long term support for the renewable heat sector. We will work with the Office of Climate Change to consider if there are appropriate measures to reward the carbon savings of renewable heat sources, securing sustainable investment in this developing sector.

6. Complementary to potential measures on the demand side to encourage the greater use of anaerobic digestion, we will explore possible means to support the development of local infrastructure and supply chains for anaerobic digestion.

7. Defra's New Technologies Programme is already supporting the development of an anaerobic digestion plant to demonstrate application of the technology to biodegradable municipal waste. The Waste and Resources Action Programme (WRAP) has also invited bids for capital support for additional plant as part of its organics programme, and is working with the Carbon Trust and the food industry to encourage greater take up of this technology for treating commercial and municipal waste.

Market for Digestate

8. The digestate (treated liquid) from anaerobic digestion contains useful nutrients and can be used as a fertiliser and soil conditioner. The sale of digestate is a potential additional source of revenue for the operators of anaerobic digestion plants. It has the potential advantage over undigested manures and slurries that it is consistent in nutrient content and availability. This makes it easier for farmers to calculate the correct fertiliser applications to crop requirements compared with using manures and slurries. This reduces the risk of leaching and run off and so can prevent diffuse water pollution. It can replace mineral fertiliser, the production of which requires significant energy input. In this way it can provide additional benefits in terms of reducing greenhouse gas emissions.

9. Defra is working to establish the full potential of the market for digestate. WRAP is charged with developing this market along with its work to establish markets for waste-derived compost.

10. Crucial steps in facilitating the growth of the market for digestate are the development of a standard and protocol. These would provide regulatory clarity and

[2] http://www.opsi.gov.uk/ACTS/acts2006/20060019.htm

confidence in its recovery on land. Defra has therefore asked the Environment Agency and WRAP to develop a standard and protocol for anaerobic digestate. Once developed, protocols provide guidance to business on the process for waste recovery for various waste streams which will result in defining the point of full recovery from a waste back into a product (i.e. the point at which the regulations cease to apply). We aim to have an operational protocol by Spring 2008.

11. Anaerobic digestion does not change the nutrient content (nitrogen, phosphate) of material put through it. Plants that co-digest other waste streams with livestock slurries in order to improve the economics will in fact lead to an increase in the nutrient concentration of the digestate produced compared with livestock manure alone. Unless suitable outlets or markets for the resulting digestate are found, the net result could be to add an additional nutrient management burden, in areas where insufficient land may be available locally to accommodate the nutrient loading. Careful management is therefore needed to reap the full benefits of anaerobic digestion in these circumstances. A Defra funded research project, known as ALOWANCE[3], is underway to develop a strategic management tool to assist in planning for the recycling of organic materials. It is due to be completed by December 2007. ALOWANCE will quantify and locate, temporally and spatially, the national capacity of agricultural land to beneficially use organic materials such as anaerobic digestate, untreated manures and slurries, biosolids and compost. This will enable the identification of the location and capacity of land suitable for the use of digestate. The findings from ALOWANCE will feed into Defra's work to establish the full potential of the market for digestate, referred to above.

Addressing Administrative and Technical Challenges

Regulatory Challenges

12. As with any industrial facility, anaerobic digestion plants are subject to a number of regulations and administrative procedures designed to protect the environment and human health. Depending on the circumstances of the individual plant, these might include:

- Planning Permission,
- Waste Regulations,
- Animal By-Products Regulations (ABP) Regulations,

[3] Agricultural Land and Organic Waste - A National Capacity Estimator: ALOWANCE (ES0128)

- Integrated Pollution Prevention and Control (IPPC) and
- OFGEM accreditation.

Environmental Opportunities and Challenges

13. Anaerobic digestion presents both opportunities and challenges for the environment. The odour from treated animal slurries is significantly lower than that of raw slurry applications. By destroying pathogens, anaerobic digestion reduces the risks of pollution of water from faecal indicator organisms (FIOs). It has the potential to reduce uncontrolled methane, ammonia and nitrous oxide emissions. However in order to fully realise these benefits, it is important that the system is operated well and that the digestate is correctly applied to land so that the nutrients can be used effectively. Inefficient or poorly operated systems could fail to realise the potential benefits or even increase emissions of these gases. For instance, poor management, uncontrolled venting of the digester or inadequate biogas storage facilities can lead to potentially higher methane emissions than without anaerobic digestion.

14. Anaerobic digestion reduces the dry matter content of the digestate. The digestate can therefore better infiltrate the soil. This can lead to lower ammonia emissions on land spreading. The lower carbon content present to fuel nitrous oxide formation can also reduce nitrous oxide emissions on application to land. However it is important that appropriate application methods, timing and rates are used when applying digestate. These must be matched to the needs of the crop. Otherwise, there is a potential for ammonia and nitrous oxide emissions to increase, both during the storage of the digestate (which should therefore ideally be covered) and following application to land. This is because anaerobic digestion increases the available nitrogen content of digested livestock manures and slurries by breaking down the more complex organic compounds.

Addressing Challenges

15. The Government recognises the potential scale of the challenges that these administrative and environmental issues pose to those interested in taking advantage of the benefits of anaerobic digestion. We will therefore encourage and facilitate communication between interested parties in industry, regulators, government delivery bodies and non-governmental bodies about meeting these challenges. This will include working with stakeholders to develop and disseminate

guidelines on best practice and technology for the use of anaerobic digestion in a way that is both cost effective and beneficial to the environment.

16. We will build on our existing research programme to improve the contribution of anaerobic digestion to reducing greenhouse gas emissions and delivering other environmental benefits. We will also continue to develop the New Technologies Demonstrator Programme to include, for example, guidance to potential operators on application of anaerobic digestion to biodegradable municipal waste.

International Dimension

Methane to Markets Partnership

17. The report, *Livestock's Long Shadow*, published by the United Nations' Food and Agriculture Organization on 29 November 2006, highlighted the large proportion of global greenhouse gas emissions generated by the livestock sector. It identified anaerobic digestion as an important means of addressing this problem.

18. As well as our work to support anaerobic digestion domestically, the UK is taking the leading role in driving forward thinking about the role of anaerobic digestion internationally. In particular the Government is committed to identifying solutions as part of the G8 inspired international Methane to Markets Partnership and co-chairs a new Agriculture Subcommittee of the Partnership. Under the auspices of the Partnership, the UK hosted a high level workshop of international experts on 29-30 November 2006. The objective was to "identify the policies needed to grow markets for anaerobic digestion in order to reduce global levels of agricultural methane emissions". The workshop was attended by 63 delegates from 12 countries, including Argentina, Canada, China, Germany, India and USA. These included leading policy, technical and finance experts and business partners. The workshop featured presentations and discussions on the experiences from various developing and developed nations, which explored the benefits, opportunities and challenges for the further development of the sector.

19. Anaerobic digestion is currently underutilised in the UK. However a number of our European partners have been more successful in utilising the technology. For example, the table below is quoted from the Defra-commissioned study, conducted in 2005 by AEA Technology (AEAT) and Future Energy Solutions, *Assessment of Methane Management and Recovery Options for Livestock Manures and Slurries*.

This shows the number of agricultural anaerobic digestion plants in several EU countries and their electricity generation capacities. We are looking to learn from the experience of other countries. The Agriculture Sub-Committee of Methane to Markets Partnership is an important mechanism for this. The UK will continue its work with the Partnership to drive forward thinking about the role of anaerobic digestion internationally and to learn from experience elsewhere to inform the development of effective policies in the UK.

20. Key actions that we are taking forward with the Partnership include:

- holding a workshop in Argentina in May 2007 to showcase anaerobic digestion technology used successfully in cold climates;
- organising a high profile Partnership Expo in Beijing, China in October 2007 to highlight the work of the Partnership, showcase projects and so enhance funding opportunities;
- designing a common accounting framework for the benefits of anaerobic digestion based on the best elements of methodologies in each country; and
- sharing information about the status or standards for digestate in each country.

21. The following table shows the number of biogas plants in EU Countries producing electricity.

Numbers of biogas plants in EU-countries producing electricity (Source: Michael Kőttner, November 2005)

Country	Agricultural AD plants	Installed capacity MWe
Austria	159 +150 to end 2007	29 + 40 to end 2007
Belgium	6	12.3
Denmark	58 on-farm 20 CAD	40
France	3	n/a
Germany	> 3000	550
Great Britain	<20	<2
Ireland	5	0.2
Italy	80	62
Netherlands	12	3.8
Switzerland	71	n/a

Key

CAD: Centralised anaerobic digestion

Coordinating Delivery

21. A cross-cutting project team will coordinate delivery of the above actions within Defra. It will also work with other key Government Departments and stakeholders to identify and further address barriers and maximise the synergies between the different markets in which anaerobic digestion has a contribution to make.

Annex 1

What is Anaerobic Digestion?

Anaerobic digestion is a well-proven renewable energy technology. At the same time, it can reduce greenhouse gas emissions by capturing methane from the decomposition of organic materials, such as livestock manures and slurries, sewage sludge and food wastes. Anaerobic digestion involves harnessing the natural process whereby organic matter is broken down by bacteria in the absence of oxygen. The materials ferment in a closed vessel and produce a biogas which is a mixture of about 60% methane and 40% carbon dioxide, with other trace gases, such as hydrogen sulphide. This can be used as a renewable energy source, both for heat and power, and as a transport fuel.

The treated liquid (or digestate) can be used as a fertiliser. In certain circumstances, it may prove attractive to separate fibre from the digestate and sell this as a soil conditioner and low grade fertiliser. Anaerobic digestion can be carried out in small scale systems, for example located on the farm and operated by farmers, or to serve businesses (or clusters of businesses) with large food waste arisings. Alternatively it can be carried out in large centralised systems, for example to treat municipal food waste being diverted from landfill by local authorities or manures and slurries from several farms.

Anaerobic digestion can lead to significant reductions in methane emissions from manures and slurries. Agriculture accounts for 7% of all UK greenhouse gas emissions of which about a third is due to methane emissions (a greenhouse gas with a global warming potential 21 times that of carbon dioxide over a 100-year time horizon[4]). About 86% of this methane comes from enteric fermentation in the digestive system of animals, and 14% from manures and slurries. Anaerobic digestion offers the opportunity to capture methane from manures and slurries and so can lead to reductions in emissions to the atmosphere.

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[4] This figure is the 1995 Global Warming Potential (GWP) value. Whilst the GWP values have since been updated, the Kyoto Protocol states that "global warming potentials used by Parties [to the Protocol] should be those provided by the Intergovernmental Panel on Climate Change in its Second Assessment Report ("1995 IPCC GWP values").".

All biodegradable wastes have a significant potential to produce greenhouse gases when they decompose in landfills, which account for 3% of UK greenhouse gas emissions[5]. For rapidly degrading wastes, such as food or kitchen wastes, anaerobic digestion offers climate change and energy benefits over some alternative food waste treatment methods, such as IVC (In Vessel Composting). Other environmental benefits, when anaerobic digestion is operated well and the digestate applied correctly to land, include improved air and water quality. The odour from treated animal slurry is significantly lower and less offensive than that of raw slurry applications to land. By destroying pathogens, anaerobic digestion reduces the risk of pollution of water from faecal indicator organisms (FIOs).

[5] For example, work undertaken for WRAP - add footnote - suggests that treating the 5.5 million tonnes of food waste in the municipal waste stream by AD could generate 477-761 GWh electricity per annum, saving around 0.22 – 0.35 million tonnes CO2 equivalent/year (or 1.6 - 3.6 million tonnes CO2 equivalent/year if the same amount of material had been landfilled).