Anaerobic Digestion (AD)

Briefing for Waste Campaigners

Version 2

UK wIn
UK Without Incineration

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Contents

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Briefing Objectives

This briefing is intended to assist waste campaigners in mounting confident, robust, professional and effective campaigns that persuade Local Authorities (LAs) to adopt forward looking, sustainable, waste management strategies, in line with the Waste Hierarchy, that:

- Reduce consumption, maximising reuse, and then recycling.
- Change patterns of consumption and reduction so as to minimise residual waste through high recycling and the gradual withdrawal of materials that cannot be reused, recycled or composted.

and

- Pass biowaste that cannot be reused or recycled, through recovery processes that are sustainable in the carbon balance (climate change) context, and are otherwise non-polluting.

For food waste, this means AD!

This briefing should be read in conjunction with Friends of the Earth's (FoE's) September 2007 briefing, entitled 'Anaerobic Digestion'

http://www.foe.co.uk/resource/briefings/anaerobic_digestion.pdf

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Links to Appendices to this briefing and to Associated Briefings are listed in section 7 at the end of this briefing, and are available at

http://ukwin.org.uk/knowledge-bank/ad-briefing/

Endnotes appear in section 8.

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1. AD, Biowaste and Biogas

AD is a biological process that occurs naturally when bacteria break down biowaste in environments with little or no oxygen and create biogas and a stabilised[1] digestate (a fertiliser). Biogas is a mixture of methane (60%) and carbon dioxide (40%). AD is effectively a controlled and enclosed version of the process taking place in landfill but the methane and CO_2 emissions are captured, not vented into the atmosphere.

Biogas (with or without removal of the CO2) is a valuable source of heat energy.

Biogas can be

- Converted to meet the specifications of mains gas.
- Converted into liquid fuel. The technology for direct conversion to electricity exists although is not yet at a production stage.
- Converted to hydrogen or other hydrocarbon gas.
- Cleaned and then used to meet local energy needs by, for example, using spark ignition gas engines to power electricity generators.
- Cleaned and used to power road vehicles – this may soon attract Government funding along the lines of the ROC system. For details of biogas as a substitute for diesel, see **Appendix D.**
- Cleaned and used to heat the biowaste in the AD plant that produced the gas.

Biowaste is a term used to describe organic waste that is putrescible (liable to decay) and which forms a substantial proportion of MSW in the UK. Biowaste can include food waste, horticultural and most agricultural wastes, sewage sludge and timber.

The garden and food waste element in biowaste forms an important part of domestic waste as a whole – at least 30% of it, or according to the Open University Household Waste Study carried out on behalf of DEFRA, 41.5%. See:

http://www.defra.gov.uk/environment/statistics/waste/research/download/ou-rpt-20081008.pdf

Almost any organic material, except for timber and 'woody' materials, can be processed with AD including waste paper and cardboard that is of too low a grade to recycle (e.g. because of food contamination), garden waste, food wastes, industrial effluents, sewage and animal waste. However, within the municipal solid waste (MSW) scenario, AD performs best with food waste.

For further details, see **Appendix A.**

2. Anaerobic Digestion – its advantages

AD is the only available technology for recovering the full potential from food waste and diverting it from landfill, and AD is a sustainable technology.

Combustion[2] processes are unsustainable approaches to domestic biowaste treatment because

- of its high water content, because
- incinerators are inefficient (they waste most of the energy that they accept) and rely on a proportion of dry materials, usually plastics, of high calorific value (CV) and
- because of the GHG and toxic emissions,

Whilst AD works well with green (leafy) garden waste, source segregated, it cannot break down the lignin content in the woody materials that are difficult to segregate from garden waste. The most effective solution for garden waste is aerobic[3] composting. Whilst no biogas is produced, aerobic processing is cheaper to operate than AD.

For domestic waste, effective kerbside segregation is and will remain the best basis for AD / aerobic treatments and is essential if the requirements of PAS 110 are to be met. PAS 110 is a Quality Protocol and a link is available in **section 7**.

Purpose grown energy crops may be used on their own in AD plants or in combination with biowaste

For further details on the AD process see Appendix A.

3. Progress with AD adoption and why

Waste management companies and AD plant suppliers are, normally in partnership with local government, progressively installing AD plants across the UK and much of Europe for energy recovery / recycling purposes. Some plants take energy crops as their feedstock and are primarily for the purpose of biogas generation. **See Appendix B.**

Elsewhere in the world, in India and China in particular, AD is delivering an important means of capturing the potential in biowaste, and, at the same time, improving health and reducing forest clearance

The UK government is encouraging the use of AD, and further development and is supporting the Anaerobic Digestion Task Group in developing a wide ranging Anaerobic Digestion Implementation Plan.

In line with continental Europe (eg Germany), The National Grid has begun to develop biogas recovery so as to replace North Sea gas supplies to domestic consumers over the next decade.

For links to more details see Section 7 (Appendix D and under UK Government and National Grid).

(section 3 continued)

AD not only recovers much useful energy from waste but, unlike thermal technologies,

- recovers it in a form that can readily be stored and / or utilised efficiently and flexibly
- recovers it in a form that is compatible with conversion to meet natural gas specification thereby reducing dependency on a fossil fuel from neighbouring countries and thereby offering an element of security of supply.
- produces it at plants that are environmentally friendly

Sewage has for many years been anaerobically treated and water authorities (e.g. Northumbrian Water) are now installing Advanced AD plants that, using the latest technology, can output greatly increased volumes of useful gas.

4. Local Authorities within the UK

Within the UK, AD may still viewed with some suspicion by some waste disposal authorities, who are vulnerable to being persuaded to see incineration as a tried and tested, simple, solution, particularly if they are reluctant to maximise kerbside segregation such as to ensure that residual waste is free of biodegradable material and can thus safely be put to landfill.

In these circumstances, AD may, as part of a Mechanical Biological Treatment (MBT) plant, be used, in conjunction with aerobic composting facilities, to treat residual[4] waste. Once stabilised, this waste can be put to landfill, or subject to its fitness for purpose, be used for land remediation or afforestation. It will provide benefits in abating methane emissions and sequestering carbon.

However, MBT should not be seen as a stepping-stone within a true ‘zero waste’ strategy as, once installed, it will become a reason for not maximising segregation. The output from MBT should not be used as Refuse Derived Fuel (RDF).

5. Environmental and Greenhouse Gas Implications

The proximity Principle is best met by ‘community’ AD plants (these can be part of distributed energy schemes) in each locality processing separately collected food waste and, in rural areas, animal wastes. AD plants can be supplied with capacities of less than 5000 tonnes per annum implying serving 5000 households or a combination of farms, households, food processors and retailers.

An AD plant at Selby will process 165 000 tonnes annually.

AD plants are normally designed to blend into the background, rural or industrial, and many operate now on relatively remote agricultural sites. The process is a quiet one.

(section 5 continued)

The desirability of utilising biogas for heating rather than power generation is illustrated by the fact that, for the same level of CO2 emission, utilising biogas for heating implies some three times the usable energy compared to utilising it for electricity generation. In addition, the GHG offset that results from the fertiliser output from AD replacing chemical fertiliser can be of the similar order as that achieved by using the biogas output for heating.

For more details see appendix E at:

For links to more details of how, in environmental terms, AD compares with thermal and other waste disposal processes see section 7

6. The AD plant

AD plants are complex and there are numerous configuration variations dependent on feedstocks and suppliers, but there are some standard requirements. Moreover, the technology is continually advancing, particularly with the aim of increasing biogas recovery.

There must be provision for the receipt of waste such that odours cannot escape. An enclosed area, maintained below ambient pressure and with 'airlock' entrances is essential.

The feedstock must be suitably shredded, turned into a sludge and then pumped into the digestion vessel and if the entire digestion process is to be completed in one vessel, each stage must take place at a different level within the digester vessel and the contents must be agitated. Two or more vessels may be operated 'in parallel', or different vessels, 'in series', may house different digestion stages.

Biogas is collected during the digestion process and piped away for storage and 'scrubbing' to remove any impurities. Fully processed digestate must be extracted from the vessel(s).

To optimize the digestion process, the biodigester must be kept within defined temperature limits and rapid changes will upset bacterial activity. In most cases digestion vessels require some level of insulation and/or heating. Some installations circulate the coolant from their biogas-powered engines in or around the digester to keep it warm, while others burn part of the biogas to heat the digester. Heating can be expected to result in an increase in biogas production during colder periods.

For details of AD plants, flow charts and a schematic layout see Appendix C.

7. Information

Appendices

Appendix A: AD and Biogas – the biochemical process
http://www.ukwin.org.uk/files/pdf/Appendix_A_UKWIN_AD_Briefing_December_2009.pdf

Appendix B: AD Plants in the UK
http://www.ukwin.org.uk/files/pdf/Appendix_B_UKWIN_AD_Briefing_December_2009.pdf

Appendix C: The AD Plant
http://www.ukwin.org.uk/files/pdf/Appendix_C_UKWIN_AD_Briefing_December_2009.pdf

Appendix D: Gas from AD, Strategic and Energy Efficiency considerations
http://www.ukwin.org.uk/files/pdf/Appendix_D_UKWIN_AD_Briefing_December_2009.pdf

Appendix E: Safety and Monitoring
http://www.ukwin.org.uk/files/pdf/Appendix_E_UKWIN_AD_Briefing_December_2009.pdf

UK Government and National Grid

The recent (March 2010) DEFRA report, based on input from the AD task group, is available on:
http:// http://www.defra.gov.uk/environment/waste/ad/documents/implementation-plan2010.pdf

More details of government strategy, and those of supporting stakeholders, can be found via: http://www.defra.gov.uk/environment/waste/ad/government.htm

Defra's Information Portal on Anaerobic Digestion – http://www.biogas-info.co.uk/

Environment Agency and PAS 110

http://www.environment-agency.gov.uk/static/documents/Business/MWRP_RPS_045_AD_QP_V8_09-10-09_rev2.pdf

National Grid

http://www.nationalgrid.com/NR/rdonlyres/9122AEBA-5E50-43CA-81E5-8FD98C2CA4EC/32182/renewablegasWPfinal1.pdf

Friends of the Earth (FoE)

FoE briefings can be found at
http://www.foe.co.uk/community/campaigns/healthy_planet/incineration_index.html

- Dirty Truths – the climate impacts of energy from waste and residual waste treatment: http://www.foe.co.uk/resource/briefings/dirty_truths.pdf
- Up in Smoke- why Friends of the Earth opposes incineration http://www.foe.co.uk/resource/media_briefing/up_in_smoke.pdf
- Mechanical Biological Treatment www.foe.co.uk/resource/briefings/mchnical_biolo_treatmnt.pdf

- Pyrolysis, gasification and plasma
  http://www.foe.co.uk/resource/briefings/gasification_pyrolysis.pdf

- Food waste collections
  http://www.foe.co.uk/resource/briefings/food_waste

- 'Landfill Allowance Trading Scheme' briefing:
  http://www.foe.co.uk/resource/briefings/lats.pdf

Associated Briefings

These are expected to include:

- MSW preferred recycling methods and disposal processes
- Pyrolysis and Gasification
  http://ukwin.org.uk/knowledge-bank/other-thermal-treatments/pyrolysis-and-gasification/
- Thermal Processes: Incineration, Pyrolysis, Gasification and Autoclaving
- MBT and aerobic processes
- Waste Treatment Technologies compared.
- Carbon Sequestration
- Health and Safety (emissions related)

These will be available at

http://ukwin.org.uk/knowledge-bank/ad-briefing/

8. Endnotes

[1] Stabilisation refers to the reduction of bio volatility or biodegradability such that the production of Greenhouse Gas (GHG) is reduced by up to 90%.

[2] Combustion processes include conventional incineration, gasification and pyrolysis

[3] Aerobic digestion, often called composting, is a bacterial process occurring in the presence of oxygen. When biowaste is treated under aerobic conditions, bacteria gradually consume the biological element and convert it into carbon dioxide whilst leaving a slowly biodegradable element as compost.

[4] residual waste is waste remaining after recyclables have been recovered. Residual waste in an MBT plant will be the waste remaining after mechanical and other mechanised sorting processes have captured these recyclables. This could be as little as 7% of MSW.
See http://wales.gov.uk/docs/dsjlg/meetings/090106pc304annex2e.doc