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# Anaerobic Digestion across the UK and Europe

The following paper considers the use of anaerobic digestion in the UK and Europe. It explores the legislative framework in Europe and NI, and the current situation in the UK and NI in terms of AD plant development. While considering case studies from across the UK it looks to Europe to appreciate how the biogas industry and anaerobic digestion is facilitated. It concludes by discussing a number of considerations for NI.

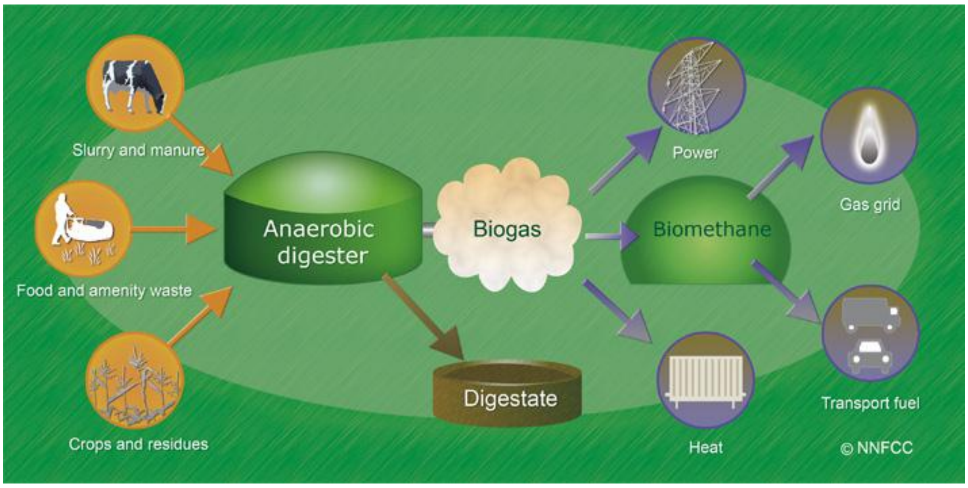
# Contents

# Introduction

Anaerobic digestion (AD) is a naturally occurring process where biodegradable material such as plant and animal material (biomass) is converted into biogas (a combination of methane and carbon dioxide) and a semi-solid material known as digestate, by micro-organisms in the absence of oxygen. Naturally, anaerobic digestion occurs at landfill sites and in slurry tanks, however, organic material or biomass can be put inside sealed tanks allowing naturally occurring micro-organisms to digest it, releasing biogas in the form of methane that can be used to provide renewable energy.

This process can be engineered and optimised in dedicated digestion plants to maximise the biogas yield. Biogas is normally burnt directly in a gas boiler to produce heat or burnt in a combined (CHP) unit to produce heat and electricity. Alternatively, the biogas can be cleaned of carbon dioxide and upgraded to 98% methane to produce biomethane. This can be injected into the national gas grid in the same way as natural gas to be used for widespread consumption and vehicle fuel. Almost any biomass can be processed in AD including food waste, energy crops, crop residues, slurry and manure, and it can therefore accept waste from homes, supermarkets/restaurants etc., industry and farms, helping to reduce waste to landfill. Leftover material from the process is rich in nutrients and can be used as a fertiliser.

The following diagram shows the AD process using all types of biomass:




Source: The Official Information Portal on Anaerobic Digestion[1]

Anaerobic digestion of dairy manure is a widely used practice in Europe because of stricter environmental regulations, lack of available farmland for disposal of manure, high energy costs, and proximity of urban populations to livestock and dairy operations (and therefore greater odour and fly control concerns). According to RW Beck (2003) anaerobic digestion produces very small amounts of energy compared with other opportunities such as the

[1] This portal is sponsored by DECC and DEFRA, with content managed by NNFCC http://www.biogas-info.co.uk/ and http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/waste/waste.aspx

combustion of woody fuels. As previously mentioned, the real benefit and motivation of digestion is the mitigation of a waste problem, not production of energy. Even at the large scale of 550,000 gallons per day, the anaerobic digester would only produce about 3 to 4 MW of electricity.[2]

### Centralised anaerobic digestion

Agriculturally based centralised AD (CAD) plants typically use farm products (livestock manures and crops) as the main feedstocks, as well as other organic material from food processing for example. According to a guidance document from the NIEA (2012), co-digestion can provide an additional source of income through gate fees and can improve the yield of biogas per unit of feedstock input. CAD plants can be thermophilic (approx 55-60 degrees Celsius) or mesophilic (approx 35-37 degrees Celsius). In comparison to on-farm plants, CAD plants are larger, give greater economies of scale (RW Beck, 2003[3]), and offer better market opportunities for heat (for local industry and/or district heating) and fibre production.

CAD facilities can involve a number of farms roughly within a 10km radius. Normally digestate is distributed back to the supplying farms for fertiliser rich in plant nutrients (nitrogen, phosphorus and potassium).[4] CADs operate by transporting the slurry or manure from the farms to the digester by lorries, which can have significant transport costs, especially if the farms transport the processed effluent from the digester back to offset the amount of fresh water required for the flush systems. Another option is by piping the material to the digester from the surrounding farms. However, this method would depend on the suitability of the location of the digester. The throughput rates and production of biogas from centralised digesters would need to be high to be cost effective; therefore the size of the facility would need to be large to accommodate the amount of manure/slurry needed for this.[5]

### On-farm anaerobic digestion

Across Europe there are a large number of on-farm digesters in operation, and according to NIEA, there are roughly 30 on farm plants in operation in the UK. In Germany, for example, over 2,500 on-farm digesters are currently in operation. Frost and Beck (1991) in a report for the Department of Agriculture, Northern Ireland (DANI) concluded that, at 1991 due to oil prices and capital costs for digesters, on-farm AD in Northern Ireland was not a viable economic proposition. However, NIEA explains that current oil prices are considerably greater than those in 1991 and as a result on-farm AD may be financially viable. Within Germany, for example, the current economics of on-farm AD are favourable. This is as a result of the Renewable Energy Sources Act (EEG) 2000 and 2004 that guarantees (for 20

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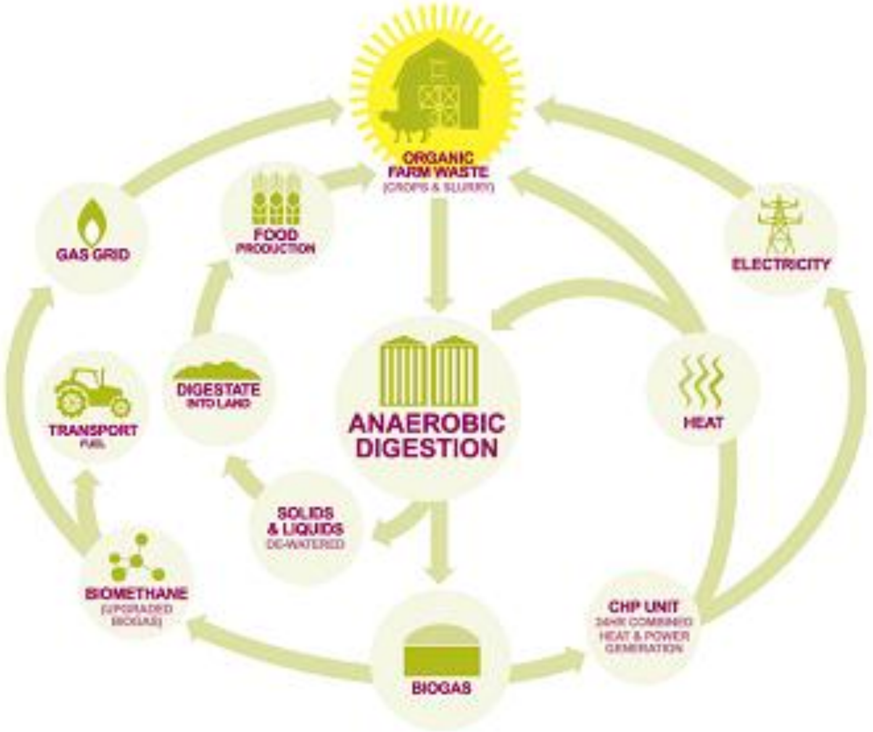
[2] RW Beck,2003, *Review of Biomass Fuels and Technologies,* Yakima County Public Works Solid Waste Division.
[3] Ibid p.24
[4] NIEA, Natural Heritage Development Management Team Guidance for Anaerobic Digestion Facilities August 2012. http://www.doeni.gov.uk/index/information/foi/recent-releases/publications-details.htm?docid=8955
[5] RW Beck, 2003, *Review of Biomass Fuels and Technologies,* Yakima County Public Works Solid Waste Division. p.23/34

years) a premium price for electricity generated from solar energy, hydropower, wind power, geothermal power and biomass. [6]

Originally most plants were built to accommodate slurry only, however it was discovered that digesters running on animal slurry alone did not produce enough biogas to be economical and when mixed with green crop silages, the biogas yield was greatly enhanced. European biogas plants are commonly fed a 'diet' of 70 percent green crop silage and 30 percent slurry




Source: Anaerobic Digestion and Biogas Association[7]

The following table gives an indication of the reported relative gas yields of different feedstuffs in Europe, showing the potential benefits of mixing animal waste with green crop silage:

| Feedstock | Dry Matter% | Biogas Yield $m^3$/tonne |
|---|---|---|
| Cattle Slurry | 10 | 15-25 |
| Maize Silage | 33 | 200-220 |
| Grass Silage | 28 | 160-200 |

Source: DARD: Anaerobic Digestion – Production of Biogas[8]

[6] NIEA, Natural Heritage Development Management Team Guidance for Anaerobic Digestion Facilities August 2012. http://www.doeni.gov.uk/index/information/foi/recent-releases/publications-details.htm?docid=8955
[7] http://www.adbiogas.co.uk/about-ad/how-ad-benefits-everyone/the-public/
[8] http://www.dardni.gov.uk/ruralni/index/environment/renewables/anaerobicdigestion.htm

According to DARD, research is on-going at AFBI Hillsborough to examine the potential biogas yields from co- digestion under conditions in Northern Ireland[9].

## The Legislative Framework

The EU's 1999 Landfill Directive obliges member states to reduce the amount of biodegradable waste in landfill by 65% by 2016 compared to 1995 levels. The diversion route includes composting and anaerobic digestion.

In 2005, the European Commission adopted a Biomass Action Plan[10], which sought to promote the use of biomass in heating, electricity, and transport. It focused predominantly on bio ethanol and biodiesel, but mentioned the possibility of recovering biogas from animal bi-products. To complement this, the Commission published a strategy for biofuels in 2006[11].

The EU's Waste Framework Directive (WFD), revamped in 2008[12], encourages member states to organise separate collection of bio-waste, which indirectly supports the anaerobic digestion of municipal waste. A Green paper on the management of bio-waste in the EU, published by the Commission in 2008[13], emphasised the benefits of separate collection that would facilitate biogas production.

Biofuels are most heavily promoted in 2009's Renewables Directive[14], which put into law the EU's objective of producing 20% of its energy from renewable sources by 2020:

> *The use of agricultural material such as manure, slurry and other animal and organic waste for biogas productions has, in view of the high greenhouse gas emission savings potential, significant environmental advantages in terms of heat and power production and its use as biofuel. Biogas installations can, as a result of their decentralised nature and the regional investment structure, contribute significantly to sustainable development in rural areas and offer farmers new income opportunities.* [15]

The net result of many of these initiatives has been that by June 2010 all member states of the European Union have to develop their national renewable energy action plans (NREAP), which should accurately detail the development of and reliance upon renewable energy sources, including biogas, within each member state and the EU as a whole.

[9] ibid
[10] EU Biomass Action Plan,2005
[11] EU Strategy for Biofuels, 2006
[12] EU Waste Framework Directive, 2008
[13] EU Green Paper - On the management of bio waste in the European Union, 2008

[14] EU Renewables Directive 2009
[15] ibid

## At the Northern Ireland level

### NI Waste Management Strategy

In response to the WFD, the Department has recently undertaken a process of revising the Waste Management Strategy and is consulting on the draft revised Strategy which has been prepared. The draft revised Strategy changes the focus of waste management in Northern Ireland from *resource management* to *resource efficiency*. This is reflected in the new title 'Delivering Resource Efficiency'. The structure reflects the primacy of the waste hierarchy and contains separate sections on:

1. Waste Prevention;
2. Preparing for re-use;
3. Recycling;
4. Other Recovery, and;
5. Disposal.

As in the WFD, the revised NI Waste Management Strategy has greater emphasis on the use of anaerobic Digestion and in-vessel composting. Focus in the revised strategy on the separate collection of bio-waste would be appropriate for the production of biogas by anaerobic digestion:

> *"The development of policy on separate collections of recyclables and plans to restrict separately collected food waste going to landfill which will support the recycling and composting industries and emerging technologies such as anaerobic digestion and in-vessel composting"*[16]

It is envisaged with the revised strategy that anaerobic digestion facilities along with thermal treatment plants provide energy from waste that can contribute to meeting NI's non-fossil fuel obligations, Government's policies on renewable energy, and NI's targets on landfill diversion.[17]

### Planning

Planning permission is essential for all anaerobic digestion installations in Northern Ireland and falls under Northern Ireland planning policy, PPS 18: Renewable Energy. Planning applications are dealt with centrally by the Renewable Energy Team who, according to PPS18, will take the following factors into consideration:[18]

- Site selection, Transport and Traffic
- Feedstocks and Product Storage

[16] Revised Waste Strategy NI http://www.doeni.gov.uk/waste_strategy_review.pdf (P.6)
[17] Ibid (p.37)
[18] PPS 18 http://www.planningni.gov.uk/index/policy/policy_publications/planning_statements/planning_policy_statement_18__renewable_energy__best_practice_guidance.pdf (p.54/55)

- Odour
- Emissions to Ground and Watercourses
- Emissions to Air

As such, PPS 18 suggests that the following information should accompany an application for anaerobic digestion:

- site plan and elevation drawings to help determine visual impact;
- photomontage of digester, plant building(s) and chimney stack with
- clear indication of building material;
- information on grid connection works, including transformer and
- transmission lines;
- details of potential noise or emissions to air and an assessment of
- their impact;
- details of vehicular access and vehicular movement;
- landscaping provisions;
- site management measures during the construction phase;
- model of emissions dispersion; and
- community consultation plans.

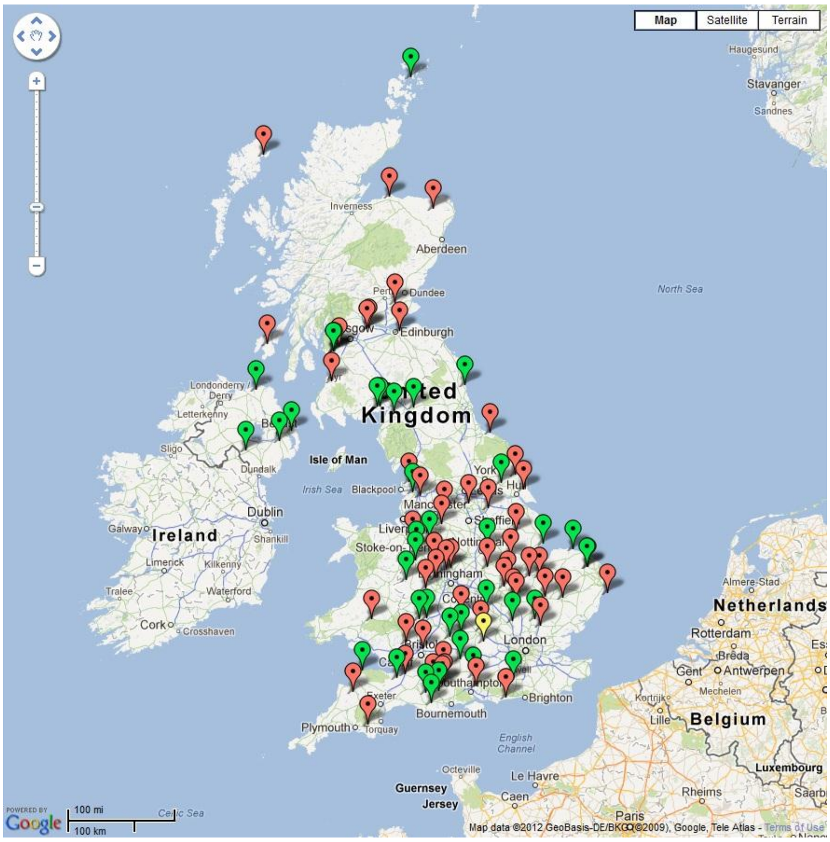
**Grid Connection**

All electricity generators connecting to the Grid must meet certain standards and there are costs associated with Grid connection. In Northern Ireland, the Northern Ireland Electricity (NIE) Transport and Distribution Group are responsible for assessing the feasibility of connecting an AD plant to the grid and the associated costs. An initial feasibility study can be carried out, and then following a successful planning application, a grid study will assess the appropriate connection requirements and the fee involved. If upgrades to the local network are involved, this may require NIE to obtain planning permission which may add a time delay to the process.[19]

[19] NIE (2011) Northern Ireland Electricity Grid Connection Information Pack May 2011 http://www.nie.co.uk/documents/Connections/Generation-Connections-Application-pack.aspx

# Current Situation in UK and NI

The map shows the operational anaerobic digestion plants in the UK (excluding those in the water industry) captures at the end of September 2011. Green flags mark "'Farm Feedstock Only", red "Waste Feedstock" and yellow "Biomenthane Injection". Up to September 2011, the only plants operating in NI were farm based only. It is apparent that NI is very much under represented compared to the rest of the UK.




Source : Official Information Portal on Anaerobic Digestion[20]

**Dungannon:**

However, developments are underway for a large commercial and industrial AD facility in Dungannon, bringing the first of its kind to NI. B9 Energy Group[21] is to open the 50,000 (per annum of commercial and industrial food waste) anaerobic digestion facility which received £3.75m of a grant from the UK government. According to B9 Organics, the project has received unofficial backing from NI ministers and received planning permission in February 2010, development is currently underway.

[20] http://www.biogas-info.co.uk/index.php/ad-map.html

[21] B9 Energy Group http://www.b9energy.com/B9EnergyHomepage/tabid/4021/language/en-US/Default.aspx


*Granville Eco-Parks Limited – Source: B9 Energy Group*[22]

**Lisburn Plans**

Plans have recently been revealed for a 500 Kilowatt AD plant in Blaris Industrial Estate, Lisburn. A local transport firm, McCulla Transport hope to secure planning permission by April 2013 and invest over £3m into the plant that will draw feedstock from the agricultural sector in the wider Lisburn area.

The anaerobic process will be powered by a combined heat and power plant that will produce renewable energy from an organic mix of agricultural feedstocks. Surplus energy will be sold back into the grid, with the by-product of organic digestate proposed to be used as a bio-fertiliser.[23]

# UK

In the UK the number of anaerobic digesters rose in 2011 by about a third (excluding the waste treatment industry) and represented 75 MW of electricity generating capacity. According to the Biogas Barometer the reason for this surge is the introduction of new Renewable Heat Incentives (RHI) promoting renewable heat. This means that renewable heat producers and biomethane producers with <200 Kw installations constructed since 15

[22] B9 Energy Group Organics Project http://www.b9energy.com/B9OrganicEnergy/Projects/tabid/4169/language/en-US/Default.aspx

[23] Newsletter (17/01/2013) *Plans for 'anaerobic digestion' plant unveiled* http://www.newsletter.co.uk/news/around-the-province/plans-for-anaerobic-digestion-plant-unveiled-1-4695056 [accessed 4/02/2013)

July 2009 are to be paid. Biogas is paid at the rate of 7.1p/kWh of heat, with the same for biomethane into the grid. However, a new RHI option is being prepared for anaerobic digestion plants in excess of 200kW, and will be combined with renewable electricity incentives.[24]

## Farm-scale case studies

The following section considers a number of case studies throughout the UK. These are classed by WRAP as excellent case studies showcasing a range of types and scales of plant:

### Staples Vegetables

Staples Vegetables built an anaerobic digester to process out of specification and by-passed vegetables created by the existing on farm vegetable harvesting and packaging process. Maize is also being grown on the farm to supplement the vegetable feedstock. Energy generated powers the entire plant with 80% of the excess heat used for a cooling system for stores crops and packing areas. On the continent heat is mostly sent for district heating of housing, but the UK currently does not have the necessary infrastructure available for such systems. The resulting digestate can be used to fertilise the crops grown to feed the plant.

The plant received £2 million funding from WRAP through the Environmental Transformation Fund (ETF), towards a total capital expenditure of £6.5 million. Up to 70 per cent of the power generated is already being used on site, with more expected as the plant continues to develop. According to the project consultants,

> *"the site typically drew in up to 6,000MW of electricity per year from the grid at a cost of around £480,000, so replacing those requirements with a renewable solution that also solves a waste problem, cools produce and makes a valuable contribution to the nutritional value of the land, is an appealing prospect."*[25]

### Langage Farm

Langage Farm is a family run farm situated in Smithaleigh near Plymouth in Devon. It has been a working farm for over 900 years, and has a herd of over 250 head of Jersey and Guernsey cows producing milk used to manufacture a large range of products such as clotted cream, yoghurt and ice-cream which is sold to both local customers and nationally.

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[24] EurObserv'ER Biogas Barometer (2012) (go to http://www.eurobserv-er.org/ and for more information see http://www.biogas-info.co.uk/index.php/incentives-qa.html

[25] WRAP, *Anaerobic Digestion closes the loop for Staples Vegetables* http://www.wrap.org.uk/sites/files/wrap/Staples%20Case%20study.pdf

By introducing AD, it was able to generate its own power, feeding any excess back into the National Grid, employing the waste heat on site, and spreading the resulting digestate back on the land where it would improve grazing quality in its pastures, and therefore help to feed its herd of 250 cows.

From a total capital expenditure of £3.6 million, the Langage facility received £1.2 million in funding from the ETF, delivered by WRAP through the Anaerobic Digestion Demonstration Programme. The permitting capacity of the plant is 20,000 tonnes but expects to operate at 16,000 tonnes; of which 3,000 tonnes will be farm slurry, 1,000 tonnes factory waste, and 12,000 tonnes external feedstock made up typically of food waste.

The owners have stated that,

> *"the benefits to the farm are already clear – financial stability for the factory brought about by reduced power costs and improved soil conditions, but in the future it aims to set its sights further afield and expand its customer base."*[26]

**Kemble Farm**

Kemble farm is located in Gloucestershire and encompasses 2000 acres of arable land and 750 dairy cows. In 2008 a 300Kw anaerobic digester was installed. The whole system cost approximately £1million which included all the anaerobic digestion equipment, additional storage and silage clamp. While the majority of this cost was financed by the farm, it received a 32% grant from the Department for Energy and Climate Change.

All the electricity produced is exported to the national grid which the farm also receives double ROCs due to the production of electricity by anaerobic digestion. For the plants first year it received £42/MW AD production and a drop to £35/MW in 2010 due to fluctuation of the market. The farm benefits from increased fertiliser efficiency and income from electricity and heat production, and has an expected pay-back period of 5-7 years.[27]

[26] WRAP, Grass is greener with AD http://www.wrap.org.uk/sites/files/wrap/Langage%20Farm%20Case%20study.pdf

[27] Farming Futures, Kemble Farm Ltd http://www.farmingfutures.org.uk/sites/default/files/casestudy/pdf/Case%20Study%2031%20-%20Kemble%20Farms.pdf

## Ryes Farm Scotland[28]

| | |
|---|---|
| **Digester Size:** | 250m$^3$ |
| **Digester Type:** | Mesophilic, gas mixed, round insulated steel glass coated tank, fixed glass coated steel insulated roof, covered in fibreglass, external heat exchanger. |
| **Gas Use:** | Small Rayburn cooker, digester heating |
| **Commissioned:** | 2004 |
| **Feedstock (T/yr):** | Slurry from 100 head dairy cows plus 250 young stock. |
| **Farm Size:** | 110 ha, 5-10 ha planted with spring barley; the rest split equally between grass silage and grazing. |
| **Capital Cost:** | N/A, estimated by farmer to be between £200K & £250K |
| **Issues:** | No significant operational issues, other than reception tank gritting up, however, insufficient gas was available to heat the house as hoped. |
| **Barriers to AD:** | Capital cost of the unit. |
| **Advantages:** | Digestate much better product than raw slurry |

[28] Royal Agricultural Society of England, *Review of Anaerobic Digestion Plants on UK Farms* http://www.rase.org.uk/what-we-do/core-purpose-agricultural-work/AD-Full-Report.pdf

### Corsock Farm Scotland[29]


*Installation showing input mixing tank on left, control kiosk, digester tank and post store*

| | |
|---|---|
| **Digester Size:** | 80m$^3$ |
| **Digester Type:** | As above |
| **Gas Use:** | Digester heating. |
| **Commissioned:** | 2004 |
| **Feedstock (T/yr):** | Slurry from 260 overwintered cows on slats; 100 cattle in summer |
| **Farm Size:** | 55 ha, including 29 from remote site |
| **Capital Cost:** | £160,000 (estimated by farmer) |
| **Issues:** | Some problems with pumps |
| **Barriers to AD:** | Cost of plant |
| **Advantages:** | Ease of slurry handling, odour reduction, less taint and how well digestate works on the crops. |

For more case studies see the full report: Review of Anaerobic Digestion Plants on UK Farms[30]

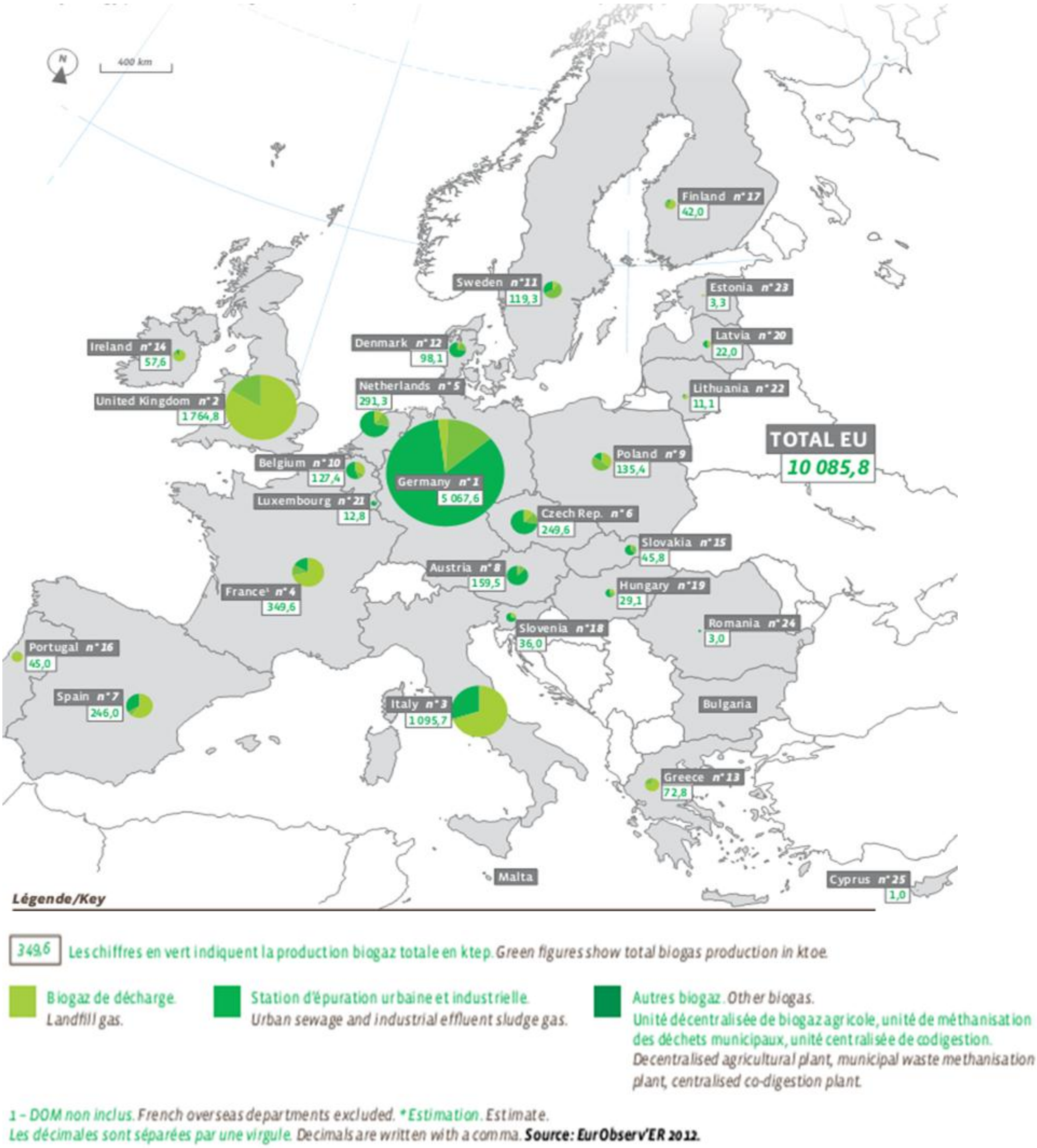
# Europe

The following diagram is taken from the EurObserv'ER Biogas Barometer which assists policy makers to measure the progress made by renewable energies in each Member State of the European Union.[31] It shows that Germany produced the most amount of biogas in 2011, with the United Kingdom in second place.

29 ibid

31 EurObserv'ER Biogas Barometer (2012) (go to http://www.eurobserv-er.org/ )

## Primary Energy Production of Biogas in the EU in 2011 (ktoe) with respective shares of each sector



## Germany

Germany commissioned a record 1310 new biogas plants (anaerobic digesters) in 2011, increasing the total to 7215 with a total capacity of 2904 MW. The decrease in feed-in tariffs since January 2012 has been suggested by the Biogas Barometer as being the reason for the increase in installations. In relation to Germany's electricity production mix, the 19.4 THW generated in 2011 from biogas covered 3% of the country's power production.[32]

### Incentives

Biogas electricity feed-in tariffs have been brought down by 1 to 2 euro cents per kWh due to amendments to the renewable electricity law. From the 1st January 2012, new biomass plants are paid on the basis of their allocated plant capacity:

- € 0.143/kWh for -<150 kW
- €0.123/kWh for <500 Kw
- € 0.11/kWh for <5 MW
- € 0.06/kWh for <20 MW plants

A potential bonus of up to € 0.08/kWh may be added depending on the types of input used. Plants that use at least 80% of their input from slurry and that recover at least 60% of the heat will be eligible for a flat rate tariff of € 0.25/kWh. Anaerobic digestion plants that use selectively- collected organic waste will be paid € 0.16/kWh for <500 kW plants or €0.14/kWh for <20 MW plants.

Under the renewable energies law a new option ratified was the development of direct sales of biogas electricity. This means electricity is negotiated directly on the electricity market between the producer and the purchaser. However, the producer receives a market premium redefined every month as a measure to reduce the price differential between the market selling price and the FiT tariff. This is expected to reduce the installation pace where it was forecasted in 2011 that an additional 300 plants amounting to 105 MW of generating capacity would only be installed in 2012.[33]

The economics of AD remain finely balanced and it is vital to get the feedstock and size of the plant right. A report by the National Non Food Crops Centre (NNFCC) revealed that feedstock composition is crucial in determining the most appropriate digester size for maximising yield and income. Supplementing manure and slurry with crops can make all the difference to the profitability of some digesters.[34]

Germany uses a system where digesters often use purposely grown crops instead of manure and slurry. However, the NNFCC has stated that digesters using high proportions of crops typically require specialist modifications and higher initial investment. The NNFCC inform that due to the lack of large amounts of available land in the UK the German model would not

[32] ibid
[33] ibid
[34] NNFCC Renewable Fuels and Energy Factsheet: Anaerobic Digestion (PDF, 1.5 MB)

be suitable. Also, the purpose of the German model is to maximise biogas output, whereas the UK focuses on waste throughput and using crops to supplement rather than replace manure and slurry.[35]

## Austria- Güssing

### Background

EU member states' progress towards meeting renewables targets through biofuels is, in general, not great. Austria is ahead of the EU's targets, but others, notably Finland and the UK, are well behind.[36] Under EU law, 34%, or 388 petajoules (PJ), of Austria's final energy consumption must come from renewable sources by the end of this decade. The renewables share in 2008 was 29%, which means only a small effort will be needed in order to achieve its 2020 target.

Over the years Austria has developed agri-cultural codigestion installations (350 units in 2007) and household waste methanisation units (15 units). Austria also has 62 landfill sites equipped with methanisers, 134 household waste treatment plant digesters and 25 industrial waste treatment plant digesters. The buying price of energy produced works out at €c17/Wh, which, according to the Biogas Barometer, suits smaller scale installations with power outputs less than 100kWe. However the increase in price of raw materials obtained from energy crops caused a slowing down in the rate of installation of small agricultural units in 2007. This said, Austria is in 5th place in Europe in relation to the ratio of "production of primary energy for every 1,000 people"[37]

Güssing is the capital of an Austrian district with approximately 27,000 inhabitants. This region was one of the poorest in Austria. It had little in the way of industry, poor infrastructure, a high rate of unemployment and migration. The annual bill to external providers of energy represented a significant loss of money to the region (6.1 million euros spent on oil, fuel and electricity in 1991). However, around this time local experts developed a model for the region which aimed for complete abandonment of fossil fuels in favour of renewable energy from local resources. Güssing currently produces more energy (heat, fuels, and electric power) from renewable resources than it consumes on an annual basis. The degree of self-sufficiency in private homes and public buildings is now 100% and when industry is added it is 56%.[38] The aim is ultimately to create a closed loop, whereby the money for energy circulates within the region and jobs are created locally in the biomass industry.

A scheme promoting the establishment of enterprises in the area brought 50 new enterprises with approx. 1,000 direct and indirect jobs in the renewable energy sector for the region.

[35] http://www.nnfcc.co.uk/news/biogas-in-germany-a-model-to-follow-or-avoid
[36] Biofuels: a bright future or a blind alley? ENDS Europe 30/03/2009
[37] EU Observers 2008 Biogas Barometer
[38] http://www.smallestnpp.eu/CaseStudies.htm#Gussing

Güssing has since developed into an important location in the fields of woodwork production, hardwood drying, and other environmental technologies.[39]

### Green Energy Tourism

Approximately 15,000 people from a wide range of countries come to Güssing each year to visit the numerous demonstration plants (biomass, biogas, solar and photovoltaic installations). Green energy tourism has become an additional economic sector of significant importance for the region.

### Anaerobic Digestion

Güssing has recently become home to a demonstration anaerobic digestion plant 'GRE'(Gussing Renewable Energy[40]) that aims to capture the non-food residual organic biomass gas 'biomethane' and convert it into energy. The plant claims to do so cleanly and cost effectively. Energy in the form of electricity is generated for use within the Güssing region. The plant has been operating at a 5 kilowatts (kw) capacity since 20th August 2012 with an aim to increase capacity to 20 megawatts (mw) by 2020.

In biological gas generation, the AD plant at Gussing makes use of anaerobic technology. Organic mass such as green waste, micro algae, urban liquid wastes, and food processing waste streams is fermented with the assistance of various groups of bacteria. The bulk of the energy contained in the organic mass is turned into high-purity biogas. The biogas can be used to generate electric power and heat either through an engine optimized for gas operation[41]. The biogas may also be upgraded to BioSNG (Synthetic Natural Gas) which can be converted into transportation fuels.[42]

## Denmark

Most of Denmark's biogas is produced by collective co-digestion units. These units mainly process agricultural effluents (liquid manure) mixed with waste from food and food processing industries and municipal authorities. In 2007 Denmark had:

- 160 methanisation units;
- 10 waste storage centres;
- 64 household waste treatment plants;
- 5 food and food processing industries waste treatment plants,
- 21 condigestion units; and
- 60 small farm biogas production units. [43]

[39] http://www.eee-info.net/cms/EN/
[40] http://www.gussingrenewable.com
[41] http://www.gussingrenewable.com/index.php5?lang=en&show_nav=biologische-vergasungfermentation
[42] http://www.biofuelstp.eu/bio-sng.html
[43] EU Observers 2008 Biogas Barometer

According to the EurObserv'ER Biogas Barometer from 2008[44], 6.5% of Denmark's liquid manure is currently treated by methanisation. Heat recovery from cogeneration is used extensively due to the large amount of small district heating networks which supply 60% of Denmark's households.

Denmark has introduced new legislation to simulate biogas production where the buying price has been increased to DKK 0.745/kWh (€c10/kWh) for electricity produced from biogas. Purified biogas (natural gas quality), that is injected into the natural gas network also benefits from an obligation to buy of DKK 0.405 per kWh (€c5.4/kWh). The buying price is adjusted every year and according to the Biogas Barometer, the government aims to increase current production from 97.9ktoe to 239ktoe by 2020. [45]

## Sweden

In 2007 Sweden had 233 biogas units:

139 waste treatment plants,

70 waste storage centres,

13 codigestion units,

4 food and food processing industry effluent treatment units, and

7 agricultural biogas units.

While it gave priority to heat production for district heating systems (1/3 of energy produced), it also uses biogas for fuel production, electricity, and injection into the natural gas network (this replaces almost 2 million cubic metres of natural gas). At the end of 2007 Sweden had 14,400 gas-fuelled vehicles, and 86 service stations distributing the fuel.

Biogas use is promoted by:

- excluding it from a tax on CO2 emissions;
- a government granted subsidy of 30% of the investment for construction of biogas units;
- giving subsidies to local government and companies that invest in solutions for reducing greenhouse gas emissions; and
- giving a subsidy of 1100 euros for buying cars that use biofules.

Electricity production is supported by a 'green certificate system.[46]

[44] In the field of renewable energy in Europe, the EurObserv'ER (www.eurobserv-er.org)'Barometer' assists policy makers to measure the progress made by renewable energies in each Member State of the European Union

[45] EurOBserv'ER, 2008, Biogas Barometer

[46] EU Observers 2008 Biogas Barometer

# Considerations for NI

### Challenges

According to DETI, some stakeholder in NI indicated the following challenges faced by the AD industry:

- High upfront capital costs associated with AD;
- Reluctance by banks to finance renewable energy projects in NI;
- High grid connection costs; and
- Lack of grant support.

In terms of technology, communication with B9 Organics stressed the point that there is no need for importing material as NI has the resources and expertise to produce the technology locally.

Responses to DETIs draft Bioenergy Action plan 2010-2015 highlighted a number of points, these included:

- Considerable obstacles to AD in last four years – DARD & NI Environment Agency need to develop a cohesive response to issues.
- Huge AD potential in District Heating Systems; also provides huge benefits in nutrient management.
- WRAP currently delivering AD Demonstration Programme with support from Carbon Trust, designed to help UK deliver increase in generation on renewable energy; reduction in waste to landfill and GHGs.
- AD is not a known technology in NI and with current financial climate, funding of such projects is even more difficult. Need a Challenge Fund to ensure development of bioenergy demonstration projects to provide investor confidence with local market, whether farmers or financiers.

In relation to the issue of funding, DETI responded that DARD has introduced the Biomass Processing Challenge Fund ( part financed by the European Regional Development Fund) to support the purchase of a range of biomass fuelled renewable energy technologies that improve business efficiency and sustainability at farm level, which would include AD technologies.[47] Outlining her support for renewable energy technologies Minister O'Neill stated:

> *The production of food will always remain the primary focus of the agricultural sector, however the diversified income streams and avoided energy costs associated with renewable energy projects can only be of benefit. I want to see sustainable farm-based AD projects proposed. These should utilise the available resources of the farm efficiently and can*

[47] DARD, Biomass Processing Challenge Fund http://www.dardni.gov.uk/index/grants-and-funding/biomass-processing-challenge-fund.htm

> *produce energy for farm use. I want to see a focus on supporting existing farming activities."*[48]

However, the scheme which ran for 12 weeks from 10 September 2012 to 30 November 2012 is now closed.

**Promoting a sense of community ownership**

An APSRG (Associate Parliamentary Sustainable Resource Group) research report produced in 2010 highlighted the need for community buy-in to waste facilities through the sense of promoting community ownership. The report highlights that many small scale renewable energy projects in the UK also utilise community ownership structures as a successful way of providing a community benefit that is closely tied to the performance of a production unit. The report turns to the case of community owned wind farms where shareholders enjoy a stake in profits derived from electricity generated and sold back to the national grid, with other benefits such as local employment, training and regeneration. The report suggests that community ownership structures should therefore be explored as a means to foster a sense of involvement in waste management facilities.[49]

**Shifting Direction in Biogas Growth**

A report published by Rabobank 31 January 2013 suggests that future growth in the biogas sector is likely to be seen in food waste plants, rather than those using manure and energy crops. According to the report, long term drivers for the sector suggest that the technology is less of a renewable energy and more of a waste management solution for organic residues. The report explains that some of the reasons for this are due to:

- the decreasing costs of alternative technologies such as solar and onshore wind;
- rising commodity and feedstock costs;
- increasing sustainability demands; and
- lagging efficiency improvements in biogas generation.[50]

[48] Farming Life, 7 October 2012, *Benefits of on-farm renewable energy highlighted* http://www.farminglife.com/news/benefits-of-on-farm-renewable-energy-highlighted-1-4340242

[49] APSRG, 2010, *Waste Management Infrastructure: A sense of community ownership* http://www.policyconnect.org.uk/apsrg/resources

[50] Rbobank, 2013, *Shifting direction in biogas growth* http://rabobank-food-agribusiness-research.pressdoc.com/37816-rabobank-report-shifting-direction-in-biogas-growth