NFU Briefing

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Anaerobic Digestion: progress towards NFU's aspiration of 1000 on-farm plants

WHY IS THIS OF INTEREST TO NFU MEMBERS?

Anaerobic digestion (AD), the production of biogas from organic materials, is a key renewable energy technology with the potential to deliver multiple environmental benefits to farmers and growers, at the same time as providing an on-farm source of low-carbon energy. AD is one of a variety of renewable energy technologies that have become commercially available to agriculture in the 21st century. In principle, it is well-suited to application on UK dairy and livestock farms, where it is one of the most promising mitigation measures for reducing greenhouse gas emissions from manure and slurry management.

WHAT THE NFU IS DOING

The NFU continues to lobby the Government to incentivise the deployment of AD in the agricultural sector, as well as for the management of food waste and recycling of nutrients to land, and has strongly championed the cause of small and medium-sized on-farm AD plants for processing of agricultural manures and residues together with crop feedstocks.

BACKGROUND

Climate change is driving policy and regulations on reducing greenhouse gas (GHG) emissions at international, national and regional level. The 2015 Paris Agreement, which entered into force in 2016, commits over 190 countries to regulate GHG emissions to keep the global temperature increase below 2 degrees Celsius. Binding EU-wide targets were set for the contribution of renewable energy in 2020, and a range of policy measures implemented in Britain to support renewable electricity, heat and transport fuels. But whereas the 2010 Coalition Government promised to be the "greenest ever" and committed to a "huge increase" in energy from waste resources through anaerobic digestion, the 2015 majority Conservative administration has been less enthusiastic in its support for renewables.

The development of AD in Britain has been relatively slow compared with other renewable energy technologies, there being about 350 plants operational by mid-2016 and a pipeline of up to 800 by 2019 – so is this consistent with the historic and widely-shared NFU goal of 1000 AD plants on farms by 2020?

WHAT IS ANAEROBIC DIGESTION?

AD is the controlled breakdown of organic matter in a closed 'digester' vessel. The air supply is restricted to stimulate 'anaerobic' decomposition (as opposed to composting, which takes place in the presence of air). After 20 to 60 days, depending on the configuration and internal temperature of the digester, a methane-rich 'biogas' is produced. This gas is commonly used for electricity and heat generation, and may also be upgraded for other applications.

The residual co-product is an odour-free 'digestate', which is rich in plant-available N, P and K and may

be directly spread on the land as a fertiliser. Alternatively, digestate can be further separated or "dewatered" into a solid fraction (typically 25-35% dry matter, enriched in P) suitable for use as a soil amendment, and a liquid biofertiliser containing much of the ammonium and potassium that can be pumped or transported for landspreading.

Feedstocks suitable for use in the AD process include:

- animal manures and slurries
- energy crops such as maize or hybrid rye silage and fodder beet
- food processing by-products and pack-house residues
- food waste from retailers
- biodegradable household waste

AD AND THE ENVIRONMENT

Apart from its potential contribution towards managing business energy costs, on-farm AD offers multiple environmental benefits, including:

- reduced emissions of methane from manures and agricultural residues, helping farmers and growers to achieve climate change mitigation commitments
- air quality benefits through the control and reduction of odours such as ammonia
- more efficient management of nitrogen and other nutrients present in manures and slurries
- full or partial replacement of manufactured fertilizers with digestate containing known amounts of N, P and K

Last updated in 2013, areas designated as Nitrate Vulnerable Zone (NVZs) are being revised for 2017. Consultation on a new NVZ Action Programme (which defines the rules in NVZs) is also expected. The changes will be implemented during early 2017. NVZs presently cover around 58% of England and the regulations require farmers to have sufficient storage for 6 months in the case of pig slurry and poultry manure, and 5 months storage for other livestock slurries. The requirement for individual farms to increase slurry storage capacity could mean that farmers look to AD as an alternative option for manure management. Rather than each investing up to £50,000 in upgraded slurry tanks, a group of farmers might choose to collaborate and invest/borrow a total of around £1 million for an income-generating AD project.

POLICY ISSUES RELATED TO AD PLANT SIZE

From 2008 onwards, a key priority for the NFU was to ensure that smaller, farm-based AD plants were encouraged, and not mistakenly labelled and shunned as "waste management". Many agricultural digesters use inputs from the farm or its near neighbours only, and under these circumstances the NFU has lobbied for on-farm AD plants to be exempted from Environmental Permitting, or subject only to simple low-cost Standard Permits. Together with other industry stakeholders, we have worked with Defra, the Environment Agency and the Waste and Resources Action Programme (WRAP) on making a clear distinction between low-risk on-farm digesters and larger centralised waste-licensed 'merchant' plants, and on encouraging government support to reward the beneficial environmental outcomes from smaller-scale on-farm deployment of the technology.

With income only from the sale of energy (plus some additional financial benefits from the replacement of manufactured fertilisers), on-farm AD plants ought to be subject to 'light touch' regulation and should be considered favourably by local planners (subject to the usual planning process and conditions). Many such plants are medium-sized, between 250 and 1000 kilowatts (kW) electrical generating capacity, producing the electricity needs of several hundred homes or a village. In addition, over 100 small-scale AD plants (between 25 and 250 kW capacity) have been deployed over the past 4-5 years,

particularly well-suited to medium-sized dairy and livestock enterprises, meeting predominantly the energy needs of the farm itself. However the economic return on investment for smaller plants has diminished markedly with the tapering-off of government incentive payments such as the Feed-In Tariffs and Renewable Heat Incentive.

Larger so-called 'merchant' AD plants accept multiple biodegradeable wastes, and receive income from both energy sales and gate fees. Such centralised AD plants may be located on a farm, on a rural industrial estate or close to food processing facilities. These are relatively large facilities, with biosecure reception areas and electrical capacity (or equivalent biomethane output) from about 500 kW to 5 MW. Mixed-feedstock plants require higher-risk or bespoke environmental permitting, and may be expected to progress more slowly through the planning and project development process. However, the economies of scale enjoyed by large crop-fed or waste-fed AD plants mean that they are continuing to attract investment, unlike smaller plants.

PRODUCTION OF BIOMETHANE

Although the majority of AD plants burn the biogas from the digester on site in a combined heat and power unit, many larger plants upgrade most of their biogas production to 'biomethane', for direct injection into the natural gas distribution network, and (less commonly) for motor vehicle use, as a tradeable low-carbon fuel. From around 2012-13, equipment for biogas upgrading and pressurisation became available, notably from Germany, where around 200 biomethane projects have been implemented. As of mid-2016, the UK has over 60 gas-to-grid installations, responsible for annual biomethane production of about 3 TWh. About another 25 plants are in development, and the AD industry ambition is for as many as 150 projects by 2020, equivalent to 3% of domestic natural gas demand. Installations may also be linked to filling stations for dedicated or dual-fuel vehicles (agricultural or road vehicles) adapted for compressed biogas (CBM) or cryogenic liquefied biogas (LBM). The capacity of gas-to-grid plants is commonly expressed as m^3/hour of raw biogas or biomethane, whereby a typical large AD plant might be rated at 500 m^3/hour biomethane = 833 m^3/h biogas, equivalent to 5 $MW_{thermal}$ or 2 MW_e for a conventional CHP plant.

OUR VISION – 1000 BIOGAS PLANTS ON FARMS

AD is used widely across Europe – notably in Germany, Italy and France as well as Austria, Denmark and Sweden, in addition to the UK – and the technology is proven and well-established. Growth of AD in Britain was modest until around 2011-12, when a favourable policy environment enabled the number of plants to increase by about 40% per year until 2015 – as documented by the official AD Portal web site. By mid-2016, there were nearly 350 recently-constructed plants operating outside the wastewater treatment sector. About two-thirds of these are on-farm systems using mostly feedstock of farm origin (crops, discards and manures), although presently only around 1.5% of UK livestock manures are treated by AD. The AD Portal team estimates there is a substantial 'pipeline' of nearly 500 more AD projects under development in agriculture, industry and the waste management sectors, a potential for over 800 plants in operation by 2019.

Previous government analysis of the energy supply potential of AD (Renewable Energy Strategy, 2009) was 10-20 terawatt-hours (TWh) - equivalent to the output of about 1250 to 2500 megawatts (MW) of installed capacity. At that time, the NFU called for at least one-third of these to be located on farms, and recommended that the government set a national aspiration of 1000 farm-based AD plants (typically 500 kW), and around 200 larger waste-linked AD facilities (typically 1.5 MW) by 2020. Between them, these could account for around 800 MW of electrical generating capacity, contributing about 6 terawatt-hours (TWh) of electricity and potentially another 6 TWh of heat – together, the equivalent of roughly one million tonnes of oil per year, or 4.5% of the UK's renewable energy target. In 2011, the Coalition Government's AD Strategy set a more modest ambition of 3-5 TWh of electricity by 2020.

AD industry experience is that the entire feedstock needs of a 1 MWe plant can be met from about 1000 acres (400 ha) of maize silage. However, co-digestion of slurry and manures, etc. together with silage may bring down the extra land requirement for a medium-sized 500 kWe plant to around 100-125 ha (4-5000 tonnes, based on silage yield of 35-40 t/ha). The land area theoretically required to fuel 1000 such medium-sized AD plants is therefore about 100-125,000 ha – quite moderate compared with the 300-700,000 ha of set-aside land area around the year 2000, or the potential land requirement for other forms of bioenergy. Existing pasture and grassland may also be managed for silage, although the yields will be generally lower than for maize. The direction of Government policy favours the use of crop feedstocks only to supplement manures, discards, outgrades and residues, rather than as the principal input to AD plants. However, banks and investors often require an initially assured supply of 'starter' crop feedstocks, which may be progressively displaced by cheaper discards and residues later in the project lifetime.

The capacity for throughput of manures and slurry (co-digested with silage) may be estimated similarly at about 36-45,000 tonnes or cubic metres per year per megawatt (MW) of digester generating capacity. The amount of manures and slurry processed by 1000 x 500 kWe AD plants could therefore be as much as 18-22.5 million tonnes. This theoretical goal represents 20-25% of total UK arisings of 90 million tonnes – but current utilisation (pro-rata) is only about one-third of this level.

Compared with agricultural feedstocks, the food waste resource for AD is more limited and ultimately finite. Based upon a typical 'model' rated at 1.5 MWe utilising 50,000 tonnes/year of waste, 200 such merchant AD plants could account for 10 million tonnes of organic feedstocks by 2020, equivalent to 50% or more of total UK food waste arisings. Significant progress has been made towards this goal.

According to the October 2016 deployment update report from NNFCC, who maintain the official AD Portal web site, there are 342 operational AD plants in the United Kingdom, 225 of which are predominantly fed with farm-based feedstocks, and 117 of which are mostly waste-fed. Operating AD plants in the UK require annually 1.24 Mt of manures and slurries, 2.54 Mt crops, 2.90 Mt food waste, 0.375 Mt of crop waste and 1.81 Mt of other wastes. The area of crop feedstocks required by AD plants in 2016 is estimated at 56,000 hectares.

OUTLOOK – A RANGE OF OPTIONS

The NFU's vision for 1000 on-farm AD plants by 2020 remains modest compared with the achievements of farmers in Germany, where nearly 9000 AD plants have been installed over the past 15-20 years. Through consultation with the AD industry and our members already active in this area, the NFU can foresee four broad models for further biogas deployment, varying in both size and complexity.

(a). Large single farm

In this simple model, a single substantial farm enterprise would supply its own farm-based inputs to the digester (manures, slurries, silage crops) and the resulting digestate would be spread only on the farm's own land.

(b). Multi-farm cooperative or subcontracted operation

Essentially similar in principle to Model (a), but with typically three or four farms within a locality supplying farm-based inputs to a digester optimally sited on one of the farms. The resulting digestate may be shared and spread among these farms, but only moved a few miles at most.

(c). Centralised or merchant AD facility

Likely to be larger than Models (a) or (b), a facility utilising some agricultural inputs but also receiving gate fees for processing organic wastes diverted from landfill, including food processing wastes and local authority wastes. In some cases this might be based on a farm, but utilisation of the digestate will be subject to stricter regulation than for Models (a) or (b).

(d). Large materials reclamation facility

Probably operated by a conventional waste processing company, a large-scale facility accepting a wide variety of organic wastes. Here, the AD process would be integrated into an overall waste management system, and subject to stringent environmental regulations.

The NFU has been lobbying for Models (a) and (b) to be subject to the minimum regulatory burden. Model (b), which may enable smaller livestock farms to consolidate resources and operating a single digester collaboratively, still requires regulatory reform to allow easier movement of feedstocks and transfer of digestate between nearby farms.

HISTORY OF GOVERNMENT POLICY AND RECENT DEVELOPMENTS

In February 2009, Defra launched its own Vision Statement "Anaerobic Digestion – Shared Goals" and an AD Task Group, on which the agricultural industry was represented together with the food chain, water and waste management industries and the energy sector. This group reported back in July 2009 with some headline priorities among a list of 46 recommendations – released as an AD Implementation Plan in March 2010.

Following the previous Coalition Government commitment to a "huge increase" in energy from waste resources through anaerobic digestion, the NFU and other stakeholders worked closely with Defra officials on the development of a new joint industry/government AD Strategy and Action Plan published in June 2011. The NFU sat on a Steering Group which oversaw the implementation of the 56 actions identified in the plan.

Two kinds of Standard Permits for environmental permitting of AD plants were introduced in April 2010; one for farm-based feedstocks, and one for AD using a wider range of waste inputs. Small-scale on-farm AD plants (maximum capacity of 1,250 cubic metres of manures and crop feedstock) are exempt from environmental permitting altogether. The Environment Agency continues to regulate ensiling of AD crop feedstocks in the same way as other agricultural activities, in order to reduce the risk of causing water pollution: amendments made to the SSAFO Regulations in 2013 require prior notification of construction work on any new or improved store, whether inside or outside an NVZ.

Revision of the Renewables Obligation in April 2009 introduced an enhanced rate of payment for electricity production from AD (2 ROCs per MWh), and Feed-in Tariffs commenced in April 2010 for renewable electricity projects including AD up to 5 MW capacity. Since 2011, the Renewable Heat Incentive scheme has offered support for biomethane upgrading and biogas heat up to 200kW, and heat tariffs for medium and large scale biogas heating were introduced in 2014. Through Defra and WRAP, business plan development grants of up to £10,000 were available from 2013 until 2016 for small-scale on-farm AD.

Together, this range of incentives have enhanced the economic viability of farm-based AD and enabled the development of a UK industry supply chain. However, there are now serious concerns that 'degression' (progressive reduction) of the Feed-In Tariffs has decreased to the point where the smallest scale of AD plants are no longer financeable, and the 'deployment cap' introduced in early 2016 as a cost control measure (a mere 20 MW of new plants per year) is restricting growth and stifling investor confidence.

At the time of writing, the AD sector is still awaiting the delayed outcome of two government consultations from the Department of Business, Energy and Industrial Strategy (BEIS) – on wider reform of the RHI, and a further review of FITs for AD from April 2017, including new rules expected to restrict the use of crop feedstocks with burdensome quarterly reporting. The NFU is very disappointed at government proposals to further restrict support for AD in 2017, cutting FITs for electricity from small-scale biogas plants (under 500 kilowatts) by a further 27%, and abolishing the tariff altogether for larger plants.

Recent technological developments in AD plant configurations include 2-stage digesters that can process up to 80% straw-based manure feedstock, as well as dual-purpose variable-volume digesters that also function as slurry stores.

Despite its 'rollercoaster ride' in Britain, the AD industry seems to remain fairly robust, innovative and ambitious about its prospects for further growth, as it comes within reach of the widely-shared ambition of 1000 plants by 2020. But the political landscape remains clouded, and NFU members should seek independent advice (e.g. from the NFU Farm Energy Service – see below) and consider instructing professional advisers to assist them with any negotiations, written documents and agreements, before committing to this potentially very useful form of on-farm diversification.

FURTHER INFORMATION

Government Information Portal on AD: http://www.biogas-info.co.uk

NFU pages on renewable energy:

http://www.nfuonline.com/cross-sector/farm-business/energy-and-renewables/

NFU Farm Energy Service – members should call 0370 844 5700 and consult Business Guide No. 842:

http://www.nfuonline.com/membership/your-nfu-services/nfu-farm-energy-service/

Through a reciprocal exchange of membership with the Renewable Energy Association (REA), which has a specialist biogas sector group, the NFU participates in joint communications, lobbying and publicity activities. We also work closely with the Anaerobic Digestion and Bioresources Association (ADBA), which publishes an annual AD market report.

REA biogas sector group: http://www.biogas.org.uk/

ADBA: http://adbioresources.org/