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Assessing the potential for the uptake of on-farm anaerobic digestion for energy production in England

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ABSTRACT

We report on an assessment of the potential for energy production from on-farm anaerobic digestion (AD) in England based on findings from a survey of farmers where it was found that around 40% of 381 respondents might install AD on their farms. These 'possible adopters' tended to have large farms and might together utilise some 6560 ha of land for feedstock production along with the wastes from some 12,000 beef and dairy cattle and 9000 pigs. When raised to the national level, such a level of AD activity would produce around 3.5 GWh of electricity. This approximates to just 0.001% of national electricity generation. Further, there are considerable perceived barriers to the widespread adoption of AD on farms in England; these include the high capital costs of installing AD and doubts about the economic returns being high enough.

1. Introduction

The European Union (EU) has committed itself to a 20% reduction in greenhouse gas emissions[1] by 2020 compared to a 1990 base, and prior to the Copenhagen Conference on Climate Change it endorsed the 'objective of a 30% reduction … provided that other developed countries commit themselves to comparable emission reductions and economically more advanced developing countries commit themselves to contribute adequately according to their responsibilities and capabilities' (European Parliament and Council, 2009b: 136). Although the Copenhagen meeting failed to deliver this outcome (Anon, 2009), the EU's 30% target by 2020 could be well observed; in the United Kingdom (UK) for example the *Climate Change Act 2008* has set 'A legally binding target of at least an 80% cut in greenhouse gas emissions by 2050 … [*and*] a reduction in emissions of at least 34% by 2020 … against a 1990 baseline'.

In addition to its Emissions Trading System, covering power generation and heavy industries, part of the EU's strategy to reduce greenhouse gas emissions is embodied in its Renewable Energy Directive, which mandates that, by 2020, 'energy from renewable sources' should supply at least 20% of the EU's 'gross final consumption of energy', with specific targets for each member state (15% in the UK for example), and that in each member state by the same date 'the share of energy from renewable sources in all forms of transport … is at least 10% of the final consumption of energy in transport' (European Parliament and Council, 2009a: 28, 46; Swinbank, 2009). Energy from biomass is a form of renewable energy.

'Anaerobic digestion (AD) has long been recognised as a means of producing energy in the form of biogas while at the same time stabilizing waste organic matter' (Banks et al., 2009). On-farm AD of biomass has the potential to make a small contribution to the above targets by directly reducing greenhouse gas emissions and by the production of a renewable source of energy—biogas. Livestock manures and slurries, and crop residues, which might otherwise release methane into the atmosphere, can be converted into biogas, which can then be used for heat, to generate electricity, or to fuel vehicles. However, livestock manures have a relatively low energy content, and so a farmer might import onto the farm food wastes that would otherwise go for landfill or composting, or crops might be grown specifically for the AD unit. Crop residues such as sugar beet tops and other material unsuitable for export from the farm such as damaged potatoes and spoiled silage are also suitable feedstocks. Bringing food wastes onto the farm poses biosecurity risks; growing crops for AD raises the same sorts of questions about net savings in greenhouse gas emissions, and the impact on land use and food prices, which arise over the production of other bioenergy crops such as maize for ethanol (Howard et al., 2009; Sherrington et al., 2008).

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[1] Emissions of 'carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) … expressed in terms of tonnes of carbon dioxide equivalent' (European Parliament and Council, 2009b: 139).

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We do not address all these issues in this paper, but we do assess the likely uptake of on-farm AD and the contribution this could make to renewable electricity generation. The intentions survey of farmers towards AD adoption or otherwise on their farms reported here was an early element in a larger project on exploring opportunities for farm diversification into energy production through AD. Implications of such diversification for rural development, farm economies and the environment were also examined. Although there were a few enthusiasts at the time of survey, on-farm AD was not widely practiced in the UK (Banks et al., 2009), and an early objective in the project was to gauge how farmers *might* react to the suggestion they incorporate AD into their farm businesses in future. Accordingly, this article proceeds as follows. In the next section we set the scene, reporting in particular on the policy incentives and regulatory uncertainties that face AD adopters. Then we introduce our sample of farms and our survey methods, before moving to a section that presents our main findings. In a concluding section we draw some conclusions about the likely uptake of AD on farms in England and provide an illustration of the potential for such electricity generation under certain assumptions.

2. On-farm AD in the UK: policy incentives and regulatory concerns

In several parts of the developing world many households have small AD units to turn wastes into biogas for cooking. In some developed countries AD has also been taken up to a considerable extent: in Germany, 3000 farmers grow forage maize to feed their, or their neighbour's, AD unit; in Sweden, biogas is widely used as a fuel for public transport (Weiland, 2006; Lantz et al., 2007). In the UK, the few existing on-farm AD plants have been installed primarily for slurry management purposes, and some off-farm installations have attracted a lot of comment in the farming and renewable energy trade press (for example at Holsworthy in Devon), but very few on-farm installations are currently in place (Banks et al., 2009). In February 2009, the Department for Environment, Food and Rural Affairs set out 'the shared goals that businesses, regulators, Government and other stakeholders aim to achieve by the cost effective, innovative and beneficial use of anaerobic digestion in England'. It included the National Farmers' Union's aspiration 'of 1000 farm-based anaerobic digestion plants by 2020, alongside at least 100 larger waste-linked anaerobic digestion facilities in which farmers may also have an interest' (Defra, 2009: 2, 5). For comparison, there were some 208,000 farm holdings in England in 2009 (Defra, 2010c). But on-farm AD had become a more favoured Government option than it had been in the immediate past, and not just an element in its strategy to divert food wastes from landfill. In the spring of 2010, on-farm AD received positive mention in the Government's new food strategy *Food 2030* (Defra, 2010a).

As well as the possibility of improved revenues from energy generation, there are some potential agronomic and farm management advantages from AD. It can help in slurry management on intensive livestock farms, and help in combating plant pests and animal diseases (although a pasteurisation plant will then be required). There can be better nutrient management, especially when energy crops are used, with the digestate applied to the land, reducing fertilizer bills, although nitrate loadings can still be problematic in Nitrate Sensitive Zones. For the moment, a gate-fee can be charged for food wastes coming onto the farm, as food manufacturers and waste disposal firms try to minimise payments of the landfill tax, but these revenues could dry-up if there is heavy investment in off-farm AD units quickly absorbing the available supply of this feedstock. In addition, AD could be developed as an *alternative* farm enterprise; indeed an AD unit is often likened to a giant 'cow' turning grass and other green feedstock material into biogas, which can make money for the farmer and might increase rural employment.

In addition to investment grants (under the EU-mandated Rural Development programme for example) and other nationally-funded capital investment incentives, the production of bioenergy in the UK is also heavily supported. The two main schemes are the Renewables Obligation on designated electricity suppliers and a combination of road-fuel tax rebates and the Renewable Transport Fuel Obligation (RTFO) (Swinbank, 2009). Under the former, Renewable Obligation Certificates (ROCs) are issued when renewable electricity is generated, and these have a market value. From April 2009, under a new banding system, two ROCs have been issued when 1 MWh of renewable electricity is generated from gas of AD plants (previously one ROC per MWh had been issued). When sold, ROCs are an important source of revenue for renewable electricity generators, potentially trebling the value of the electricity generated (Jefferies, 2009). However, dealing in ROCs is a fairly sophisticated transaction, and to facilitate small-scale renewable energy generation, such as many AD units on farms, the government announced plans to introduce *feed-in tariffs* for electricity from renewable sources from April 2010. In its consultation paper of July 2009 the government indicated that for AD plants there might be a *generation tariff* of 9 pence/kWh for all renewable electricity generated, whether used on the farm or exported to the grid, and a guaranteed *export price* (referred to as an *export tariff*) of 5 pence/kWh for all electricity sold to the grid (DECC, 2009: 83–84). A *generation tariff* of 9 pence/kWh was subsequently determined for larger AD plants, but for smaller 'farm scale' schemes the rate will be 11.5 pence. However, across all technologies, the *export tariff* was fixed at 3 pence/kWh (DECC, 2010a, 24–27). As yet there is no incentive scheme for heat (although ROCs provide greater incentives for combined heat and electricity plants), but a new *Renewable Heat Incentive* is planned from April 2011, which would also apply to biogas injected into the national gas grid (DECC, 2009: 24–25).

Biogas has barely figured as a renewable transport fuel in the UK: in the first full year of implementation of the RTFO biogas accounted for 0.03%, by volume, of biofuels supplied (Renewable Fuels Agency, 2009: Table 2). As with connections to the electricity or gas grids, there are a number of legal and technical obstacles to overcome before biogas can be used as a vehicle fuel.

Furthermore, when we were undertaking our survey, there remained a number of other uncertainties relating to the regulatory structure. These included planning issues, taxation, and the treatment and use of digestate under the waste regulations; some of which are now being addressed (see Defra, 2010b).

3. Method

A four page A4-sized questionnaire,[2] which had been trialled with farmers in a pilot survey exercise, was mailed out to 2000 farmers in England who were randomly selected from the lists of Yell Data, the widely used telephone directory organisation. The questionnaire was in three parts: some contextual questions about the farm business and the farmer; some questions about the respondent's experiences with alternative enterprises; and some questions designed to ascertain their likelihood of adopting AD on their farms and, if so, the likely scale and nature of such activity.

[2] A copy of the questionnaire used is available from the corresponding author.