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Rural Economy and Land Use Programme

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Farm diversification into energy production by anaerobic digestion

A Rural Economy and Land Use project investigating the potential for the development of anaerobic digestion on farms, and the implications for rural development and the environment.

Kalmari Farm in Central Finland – a working example of anaerobic digestion integrated into a farming system

Policy and Practice Notes

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The Rural Economy and Land Use Programme is a UK-wide research programme carrying out interdisciplinary research on the multiple challenges facing rural areas. It is funded by the Economic and Social Research Council, the Biotechnology and Biological Sciences Research Council and the Natural Environment Research Council, with additional funding from the Scottish Government and the Department for Environment, Food and Rural Affairs.

Anaerobic digestion on farms can provide additional income through using the biogas to generate electricity and heat, or upgrading it to a transport fuel. This contributes towards renewable energy targets, with the option of using the energy to supply the local community. It also offers environmental benefits by reducing greenhouse gas emissions associated with farming, and promotes the recycling of nutrients which can be used in place of artificial fertilisers. The process can use waste biomass, manures, slurry and energy crops and, by careful planning and adaptive land use, can maximise the use of the whole crop for food and energy.

What are current European and UK policies on anaerobic digestion?

The EU requires that, by 2020, 15% of the UK's energy consumption should come from renewable sources.

The UK Government is currently promoting anaerobic digestion as a key technology for biodegradable waste treatment and energy production.

- The Government encourages the generation of renewable electricity from anaerobic digestion in two ways:
  - By offering a higher price for renewable energy through its Renewable Obligation Certificates – this means suppliers have an obligation to supply a minimum amount of energy from renewable sources, verified by the Certificate, or pay a penalty.
  - By the introduction of special feed-in tariffs for renewable electricity supplied to the grid, and a separate feed-in tariff for heat planned for 2011.
- Anaerobic digestion can be used to produce agricultural fertiliser which has quality assurance.
- The Government has declared that it will implement measures to promote a 'huge increase in energy from waste through anaerobic digestion'.

However:

- Regulation on some details of planning, taxation and use of the digestate (the material residue) from anaerobic digestion is still unclear.
- At present the Government is not supporting or promoting the environmental benefits of anaerobic digestion via regulation or taxation. Most of the regulation arises from European Union incentives for energy production and minimising urban waste going into landfill.

What do farmers and consumers think of anaerobic digestion?

A survey of 2000 farmers in England found that:

- Around 40% described themselves as 'possible adopters' of anaerobic digestion. Such farmers tended to have larger farms, were more likely to be owner-occupiers and were younger and better educated than average.
- Adoption of on-farm anaerobic digestion was seen as a strategy both to improve farm profit and to reduce pollution and contamination of land and water.
- As well as using slurry from their beef and dairy cattle and pigs, the 'possible adopters' said they would grow feedstocks for the digesters on land currently used for growing food or animal feed.
- Potential barriers to adoption were seen as the high establishment costs and the perceived difficulty of obtaining planning permission.

When consumers were asked about these points in surveys and focus groups:

- They thought the most acceptable form of feedstock for anaerobic digestion was cattle and pig manure.
- Most were happy for food crops to be used for anaerobic digestion, and said that its most important benefit was that it provided an alternative to landfill for organic wastes.
- They were concerned that anaerobic digestion uptake might increase traffic on rural roads and this would be a planning issue.
- 70% would be happy to pay higher taxes to provide grants to encourage uptake of anaerobic digestion.

Would anaerobic digestion be profitable for farmers?

The economics of anaerobic digestion on farms in England were modelled for arable farms, where energy crops can be produced, and for dairy farms, where large volumes of animal slurries are captured.

Two alternative models of farm-level anaerobic digestion were considered. In the first, anaerobic digestion competes with existing farm enterprises to secure crops for feedstock. In the second, it co-exists with existing enterprises and uses their waste products.

The modelling showed that:

— Under 2009 prices and policies, anaerobic digestion is economically viable. A 500kW anaerobic digestion unit would double the net margin of a 300ha arable farm, and a 200kW unit would add 6% to the net margin of a large dairy farm. A significant part of the improvement comes from savings on fertiliser purchases.

— While many potential feedstocks are available, not all can be used profitably. On dairy farms, slurry is the feedstock of choice, while on arable farms a small number of crops can be used profitably.

— Forage maize is not the most profitable crop to use in digesters – better returns are available for whole-crop wheat and beet crops, though rotations will have to be based on a broader set of crops.

— Anaerobic digestion would remain profitable even if commodity prices rose by 50% and more; but a 50% cut in feed-in tariff would make most units uneconomic. Anaerobic digestion units based on use of waste products are far more resilient in the face of commodity price rises than units based on energy crops.

— Cropping patterns and livestock numbers would not change much on farms adopting anaerobic digestion, but there might be some simplification of rotations, as farms would focus on crops that can profitably be used in the digester.

— Use of waste material, pre-processed before arrival on farms, would reduce the farm based capital investment and improve the economics of the enterprise by enhancing biogas yields and reducing artificial fertiliser requirements.

What would be the environmental impacts of increasing anaerobic digestion on farms?

Unlike other bio-fuel systems, anaerobic digesters can process a wide range of agricultural crops and materials. In order to assess the impact of any changes in the crops grown on the farm to provide feedstock materials for anaerobic digestion, the project developed an environmental risk assessment framework which showed that:

— Crops can be selected to minimise environmental impacts: for example legumes to reduce nitrogen requirements and flowering crops to attract insects and bird populations.

— Crops grown as feedstocks do not need to be 'weed free' so reducing herbicide and pesticide requirements. Thus they can include crops from headlands and marginal areas.

— Although there is some possibility of weed spread from the application of the digestate, digestion of slurries and other feedstock materials has been shown to reduce pathogens and weed seed viability.

— Digestion of slurries and manures reduces uncontrolled emissions that would occur if waste and animal slurry are left untreated.

— The anaerobic digestion plant itself has a physical appearance similar to other farm buildings and structures and with careful attention to siting the impact on the landscape should be negligible in most cases.

What are the implications for Government targets on energy production and emissions?

Anaerobic digestion provides both energy and bio-fertiliser, while processing of animal slurries and food wastes, achieves reductions in greenhouse gas emissions.

The use of crops, manures and wastes provides a renewable energy source and reduces the requirement for fossil fuels:

— Digesting the slurry produced by one dairy cow has the potential to reduce methane emissions by 25kg and generate 1000kWh of electricity per year (equivalent to three months' electricity consumption for an average household).
— Each tonne of food waste digested on farms could replace 9.5kg of mineral nitrogen fertiliser, saving 105kWh of energy and 77kg of CO_2 equivalent emissions (equivalent to the CO_2 produced from the use of 29 litres of road diesel).
— A typical dairy farm could supply most of the electricity required for its dairy by digesting the slurry from the dairy cows.

The Government could support the development of more anaerobic digestion on farms by:

— Promoting anaerobic digestion as a "green technology" that makes use of farm and urban wastes.
— Providing local planning authorities with better guidance and information to help in making planning decisions.
— Committing themselves in the longer term to providing subsidy for capital investment in farm based digestion.
— Encouraging the import of high energy value waste substrates, such as food waste, onto farms to reduce artificial fertiliser use. A simplified system for managing this is required and could be achieved through centralised pre-processing of wastes to ensure biosecurity and reducing the complexity of farm based digesters.
— Introducing incentives to specifically promote on-farm co-digestion of agricultural and urban wastes and reduce dependence, for economic viability, on the use of energy crops.
— Designing systems and procedures to promote anaerobic digestion at a farm scale. Thus far the Government has shown support for anaerobic digestion but the technology needs to be integrated into the larger framework of waste management, and promoted with the Environment Agency and local government waste disposal authorities.

Further information

The research has been carried out at the universities of Southampton and Reading.
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Useful resources:

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EU requirements: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:en:PDF
Tariffs for energy generated through AD:
http://www.srminfo.co.uk/uploads/downloads/factsheets/ROCs.pdf
Digestate protocol and PAS110:
http://www.environment-agency.gov.uk/static/documents/Business/AD_Quality_Protocol_GEHO0610BSVD-E-E.pdf
http://www.organics-recycling.org.uk/index.php?option=com_docman&task=cat_view&gid=64&Itemid=86
Government vision and implementation plan:
http://www.defra.gov.uk/environment/waste/ad/documents/implementation-plan2010.pdf
http://trevorcarbin.org.uk/news/000130/the_coalition_manifesto.html (see section 11.3)

Useful websites:

www.iea-biogas.net
http://www.biogas-info.co.uk/

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