Potential and utilization of manure to generate biogas in seven countries

Summary Series

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Production of biogas from manure at a farm level is the very epitome of a sustainable bioenergy system. The system incorporates a circular economy decentralised production of organic biofertilizer and biogas for use in heat, power or transport fuel, whilst simultaneously reducing fugitive methane emissions from open slurry holding tanks, reducing smells and minimising pollution effects on rivers and wells. Why therefore is the practice of producing biogas from manure not more widespread?

The characteristics of manure depend on farm animal source and the method of husbandry, which in turn leads to a wide range of levels of technically available manure resource and costs of biogas produced from manure. IEA Bioenergy published a report "Potential and utilization of manure to generate biogas in seven countries" which examines the potential of manure for utilization in biogas facilities across seven countries: Germany; Australia; Austria; Norway; Canada, Ireland and the UK. These countries have differing levels of biogas industry, different farming practices and a range of climates. It is hoped that the country selection should allow the lessons learned from these seven countries to be applied to many countries across the planet.

The major factors which define the suitability of manure for an economic anaerobic digestion process include: the biogas potential of the manure; the water content of the manure; unwanted and inhibitory materials in manure; the herd size where the manure is processed; and the resulting amount of manure available to the biogas facility. These variables are interdependent as exemplified here. If the manure has a very high-water content (such as from pigs) this impacts greatly on the heat demand for processing and cost sustainability if transportation is necessary. Chicken manure on the other hand has a high solids content and is already transported in Europe for disposal over large distances. Both pig and poultry tend to be associated with more intensive farming, but the manures produced are not as amenable to digestion as cattle manure; chicken manure is nitrogenous and requires innovation in biological digestion or co-digestion with other substrates. Pig manure is dilute, with a low specific methane yield and as such is not ideal for long distance transport or mono-digestion.

Cattle manure is very amenable to digestion, with potentially the lowest cost of abatement; open storage of cattle slurry leads to significant levels of fugitive methane emission, which can be abated by biogas facilities. However, a very significant barrier to collection of cattle manure is an animal husbandry system whereby cattle are pasture grazed for the majority of the year. This form of husbandry may generate collectable manure only in the winter months when cattle are housed but leads to complexity in a biogas system that includes for cattle manure. This would necessitate a centralised anaerobic digestion model whereby cattle manure is a winter feedstock, and the model depends on other feedstocks for the majority of the year.

Viability of manure-based biogas facilities depend on economies of scale. A herd of 50 dairy cows (close to average in many countries) housed in barns does not produce enough manure for an economic biogas operation. Current trends in agriculture see pressure on small family farms, which is leading to an ongoing consolidation resulting in a smaller number of larger farms. While this may not promote a vibrant rural society, it does increase the potential for an anaerobic digestion industry based on manure. The seven countries described in this report each have specific regions, where the farming of specific animals is concentrated and the potential for a viable biogas industry is high.

Manure might require co-substrates for a successful biological digestion process. Energy rich co-substrates can also improve profitability. Waste materials (such as from food) are a sustainable addition but might come with different regulations for their treatment and subsequent land application. The use of energy crops can have a negative impact in the case of regions with an already high animal density as they add to the quantity of digestate and nutrient load requiring application to, and assimilation in, agricultural land and as such increase the potential for eutrophication.

Anaerobic digestion of manure requires incentives to be financially viable. Any measure or strategy for incentivisation of manure digestion needs to consider the structures of existing farms and characteristics of the produced manures to achieve a significant impact efficiently. Anaerobic digestion facilities using manure as the main substrate typically have a small capacity and consequently high specific costs. Species of animals and type of husbandry have a significant impact on the costs of digestion and biogas yield. Support schemes need to reflect these factors to be effective.

To optimise the benefits of subsidies applied to biogas it is essential to maximise the potential impact on emission reductions and minimise the cost of abatement. This would suggest that incentives should focus on the manure types with high emission reduction potential and the lowest cost to treat; an example of this is liquid cattle manure (or slurry). The biogas system should be designed to ensure the digester has sufficient retention time to optimise the potential for collectable biogas production and minimise the biogas potential in the digestate; the digester needs to be gastight to ensure minimisation of fugitive methane emissions through leakage. Future support or state aid for animal husbandry should facilitate optimization and integration of anaerobic digestion into existing farming practices. The biogas facility should ensure easy collection of manure with minimal storage prior to the anaerobic digestion process to minimise fugitive emissions and to utilise as much of the biomethane potential in renewable energy provision as possible. To synthesise, the strategies for manure utilization need to reflect:

- Farming structure, in particular herd size and characteristics of animal husbandry to be targeted (say intensive dairy farms);
- Long term perspective for animal husbandry in the region;
- The particular target sector for biogas utilization (electricity, green gas, transport biofuel, district heating);
- Cost structure for utilization of specific manure type with particular end use of biogas;
- Potential co-substrates and the regional impact on the utilization of these co-substrates in AD facilities;
- Support mechanisms which reflect long term operation of agricultural facilities which will have a lasting positive impact;
- Development of animal husbandry (renovated or newly constructed dairy farms) which optimizes manure handling for usage in AD facilities;
- Impact of the measures on greenhouse gas reduction.