

CASE
Centre For Advanced Sustainable Energy

In collaboration with:

AgriAD · Bryson Recycling Limited · PHOENIX NATURAL GAS · QUEEN'S UNIVERSITY BELFAST

THE CASE FOR RENEWABLE ENERGY FROM AGRICULTURAL WASTE

THE WASTE OPPORTUNITY

In some locations across Northern Ireland (NI) there is too much manure material and associated nutrients produced by livestock operations to be sustainably applied to farmland.

In addition to this, nutrient measurements from soil and river systems across NI indicate characteristics of surplus manure nutrient application, as the pollution of aquatic and terrestrial ecosystems has been linked to the overloading of nitrogen and phosphorus on agricultural land.

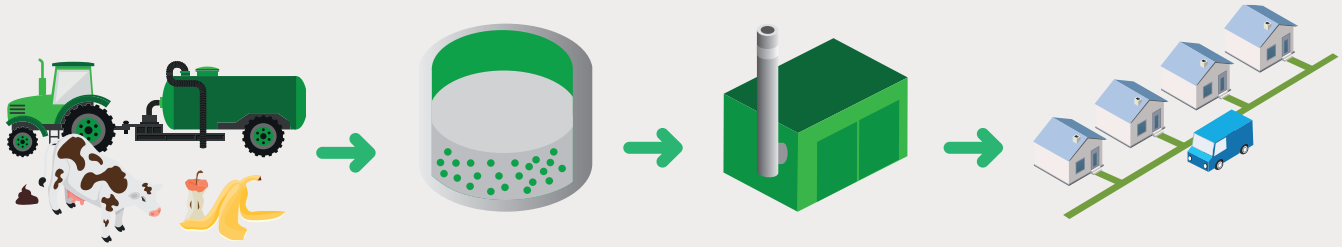
The existence of surplus manure material, opens up an opportunity locally, as excess organic material can be re-routed to facilities of anaerobic digestion (AD) to increase the production of biomethane for renewable energy. When manure material is redirected to AD facilities for the production of biogas, this also offers increased control over nutrient and carbon management.

This collaborative research project aims to support the increased use of manure as an agricultural feedstock for AD, to produce renewable energy, improve nutrient management and decarbonize heat and agriculture in NI.

HELPING FUEL THE FUTURE

Since its introduction locally in 1996, natural gas has been warmly welcomed in homes right across Northern Ireland, with the natural gas now available to almost 70% of properties. Although natural gas is the least polluting fossil fuel and currently supports carbon reductions in NI by moving energy users from oil systems, it is still a non-

The Biomethane Process



Raw Materials · Anaerobic Digestor · Clean-up Plant · Gas Network

renewable source of energy, and there is an ambition to replace these fuels with renewable energy sources.

The UK government has set a target to achieve net zero carbon emissions by 2050, and the switch from fossil fuels to renewables will be a key component in achieving this. Locally there is a significant opportunity for the development of the AD industry to help deliver carbon reductions by using organic material to produce biogas for energy production which can be used to lower the dependence on fossil fuels.

Using biomass as the feedstock for the AD process can also present an opportunity for waste recycling. The AD process directly produces biomethane, but in addition to this, the digestate produced from the process, can be treated thermo-chemically to produce additional synthetic methane and biochar.

Working with the Utility Regulator for NI, gas network operators are developing relevant frameworks to facilitate both biomethane and synthetic methane injection into the existing gas grid to be used by consumers without any change to their appliances or energy behaviours, making a significant contribution to the decarbonisation of heat in NI.

To increase the use of AD for the production of renewable energy and to develop the industry as a whole, the sustained provision of an organic feedstock is vital. NI offers a unique solution to this, through the existence of a manure nutrient surplus, which has been recently captured in nutrient balance modelling and identified by the Department of Agriculture, Environment and Rural Affairs (DAERA) as a problem that needs solved. A surplus volume of manure material and associated nutrients is an environmental issue as it can lead to aquatic and terrestrial pollution, which has been observed in river and soil chemistry measurements over the past 10 years.

This is a growing issue in NI, magnified by both anthropogenic and environmental factors. The former is leaving farmers with a lack of slurry disposal options, and high numbers of expansion application rejections has also led to a lack of outlet options for slurry.

Grasslands are also becoming smaller and smaller due to changing climate patterns and biophysical restrictions, meaning farms in NI are producing the same amount of manure but have less area to spread it on, resulting in some cases in the existence of an excess volume of biomass.

Farmers are left with limited options around manure management, and DAERA are looking for a solution to this. The increased use of excess manure as an agricultural feedstock for AD offers the agricultural sector a solution to the surplus, as the material could not only be rerouted to AD facilities, but could receive further processing to recover and redistribute the nutrients in a more efficient way.

A developed AD industry in NI would be supported by feedstock from agriculture, as well as offering a solution to lower the volume of excess agricultural biomass.

MAKING THE CASE FOR AD DEVELOPMENT

This collaborative research project has been designed:

- To support the development of the AD industry. This in turn will work to increase the production of biomethane, contributing to the decarbonisation of heat across the region
- To evaluate the feasibility of the thermo-chemical treatment of digestate and the injection of biomethane into the NI gas grid
- To estimate the quantity of biochar that can be produced through the thermo-chemical treatment of digestate
- To help reduce the manure nutrient surplus by evaluating the feasibility of rerouting the material to AD and then introducing addition digestate processing steps of nutrient recovery
- To demonstrate that agricultural outputs do not need to be compromised in order to achieve net-zero emission targets but rather status quo can be maintained and this can be more sustainable

A PARTNERSHIP APPROACH

This project is made up of both agricultural and energy sector stakeholders. All project contributors support a needed change in the energy and agricultural sectors, to produce more renewable energy and provide additional routes of sustainable manure nutrient and carbon management.

From the point of view of the energy sector, the main interest is centred around the increased production of biomethane from AD and synthetic methane from thermo-chemical treatment, contributing to the decarbonisation of heat in NI.

The interest and input of agricultural stakeholders is due to value of livestock manure as an organic feedstock for AD, as well as a need to find solutions to the manure nutrient surplus that exists in NI.

Agri-tech businesses, such as EnerChem Solutions Ltd and Agri-AD, are project stakeholders as the re-routing of manure material to AD offers an opportunity for secondary processing of digestate

material to produce synthetic methane and to aid nutrient and carbon management at a NI scale.

Contributors are also interested in the decarbonisation of agriculture, which can be supported through the creation of an export market for nutrients and biochar, an increased use of biochar on NI farmland and a reduced reliance on imported fossil fuel derived fertilizers.

All project contributors value the importance of both decarbonizing heat and agriculture in NI, and the following section highlights in more detail why each has taken an interest in the work.

PROJECT CONTRIBUTORS:

Agri-AD

Agri-AD is involved in the operation of several AD sites across NI using grass silage, cattle slurry and poultry litter as feedstock, to produce biogas to fuel CHP's for the generation of electricity which is distributed across the electrical grid. The valorization of digestate has been extensively researched over several years by Agri-AD and suitable technology providers have been identified and partnered with to recover nutrients and to thermo-chemically treat digestate to produce synthetic methane and biochar (BECCUS). These technologies will be deployed at the operational AD sites and contribute to the feasibility studies within this project.

CASE (Funding Body)

Injection of biomethane into the gas grid allows maximization of both energy and financial return. To this end, the main aim of this research would be to explore feasibility of biomethane for decarbonisation of heat. The necessary first step towards creation of such a bioenergy system would be identification, quantification and geographical distribution of biomass, waste residues and the AD-CHP plants. The second stage would be to identify and collocate gas grids across the region. This is because the practicalities of injecting biomethane into gas grid are affected by the access to gas grid. Software based tools such as multi-criteria decision making and life cycle assessment (LCA) would be further applied to identify suitable areas (i.e. those with the highest potential) within NI.

Concurrently, this research would also apply LCA to the production chain consisting of transportation of digestate, processing of digestate using thermo-chemical treatment by EnerChem Solutions Ltd and injection of the produced biomethane to the gas grid to understand the environmental feasibility of thermo-chemical treatment of digestate at the demonstrator site.

EnerChem Solutions Ltd

EnerChem Solutions Ltd will be trialing the secondary (thermo-chemical) processing of AD digestate and other excess agricultural biomass streams for further synthetic methane production and nutrient recovery. The site is located outside Ballymena, next to the gas grid hence its ideal location for gas grid injection and locality to other industry such as agri-food, construction and manufacturing within the area. It is anticipated that this site will be the demonstrator site with other site locations also being identified in due course across NI.

Phoenix Natural Gas

The introduction of natural gas to NI in 1996 has supported lower carbon energy solutions for domestic and business properties, with over 1 million tonnes of carbon being avoided each year as a result of c. 300,000 properties who have made the switch to natural gas. In 2022, there will be over 550,000 properties in NI with access to a modern natural gas network that is well placed to embrace renewable gas solutions and support further decarbonization targets for these energy users. The conversion of existing organic waste streams to biogas for biomethane injection into the existing natural gas infrastructure has considerable potential in NI due to the rich levels of waste produced by a strong performing agricultural sector. This evidence-based project will provide further insight into the volume and location of organic waste stocks, and in turn inform gas network operator's strategy in developing industry frameworks to support biomethane injection points.

Queen's University

Using livestock numbers recorded in the agricultural census and biophysical spatial data, the volume of nitrogen (N) and phosphorus (P) that is applied to farmland via slurry collection and spreading will be calculated across NI. At a townland scale, the annual input of nutrients will be simulated and evaluated in relation to thresholds of surplus N and P, using the guidance set forward in the NAP regulations (2019), such as application rate limits and plant requirement estimates. This will provide an overall nutrient balance calculation, and a tool to identify townlands that exhibit characteristics of surplus nutrient production. In addition to N and P balances, parts of the carbon cycle will also be quantified, specifically carbon sequestration rates from grassland/crops and carbon dioxide equivalent (C02e) emissions from livestock. In summary, the results will show C, N and P balances across NI, to locate townlands with a surplus balance for the introduction of AD and nutrient recovery.