A Food Waste Recycling Action Plan for England
Theme 4 Ensuring quality as well as quantity

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CASE STUDY FROM DENMARK

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Developing technologies to meet Denmark's changing food waste management environment.

Recent changes in waste management policy and practice in Denmark have had a positive impact upon the AD feedstock supply chain and process efficiencies.

Denmark – National policy and practice:

For many years Denmark relied on thermal 'Energy from Waste' technologies for the disposal of 80% of the country's household waste. In an effort to promote a circular economy, by making more sustainable use of the resources found in household waste, the Danish Government have now set a recycling target of achieving a 50% recycling rate by 2022.

In addition, as part of a new Resources Strategy "Denmark without waste" launched in October 2013, a dedicated target was set specifically for food waste. By 2018, at least 50% of food waste from households, commercial kitchens, shops and restaurants will be separated and treated biologically for energy recovery.

Around this time the challenge of food waste reduction was also taken up by a pressure group led by waste activist Selina Juul. The group's goal was to reduce the amount of avoidable food waste generated in Denmark. Selina started promoting the redistribution of edible food through a campaign called 'Spild Af Mad'- Stop Wasting Food. Over a period of just 5 years, Selina Juul and her supporters have been credited by the Danish Government for reducing Denmark's avoidable food waste by 25%.

Selina Juul – Food waste activist

The above factors have increased the awareness of communities and corporations across Denmark to recycle more, take positive action not to waste food that can be eaten and to ensure energy is recovered from food that is no longer fit for consumption.

Meeting the demand for increasing the diversion of food waste for energy recovery:

Domestic and commercial food waste

Drivers were now in place based on both public demand and national policies. The aims being to reduce overall food waste and to ensure unavoidable food waste was used for energy recovery. The AD industry became concerned that as avoidable food waste was reduced at source this would adversely affect quality of feedstock needed for conversion to biogas. The performance of food waste pre-treatment technologies and AD processes would need to improve to become more efficient and effective in dealing with more contaminated feedstock.

These demands on technology included -

- Capability to process food waste feedstocks with greater levels of physical contamination
- Processing more problematic feedstocks, for example materials that include glass and metal packaging
- Maximising the capture of bio-degradable materials from feedstocks
- Producing substrate that is virtually free from physical contamination to enhance the efficiency of AD operation and purity of digestate for use as a fertiliser on farm land.

Food waste in glass packaging

Development of a high-performance pre-treatment technology by Gemidan Ecogi A/S:

Gemidan Ecogi A/S were quick to realise that a high-performance food waste pre-treatment technology would be needed to meet the future demands for treating food waste for energy recovery. In 2011 a dedicated food waste treatment facility was set up in Holsted, Denmark to develop a new water-based pre-treatment technology for source separated food waste. The objective being to supply a high-quality substrate for energy recovery by local AD operators.

ECOGI pre-treatment technology

Pulp based substrate

Over the last 6 years the development facility has been operated at commercial scale as a standalone food waste pre-treatment facility.

Energy recovery would need to be maximised requiring the pre-treatment process to be designed to capture 95% of the organic material present in feedstock. The pulp-based substrate produced also needed to have a very high level of purity i.e. virtually free from residual non-organic contamination.

The future effectiveness of the pre-treatment technology was dependent on being sufficiently flexible and robust and have the capability of processing domestic, commercial and industrial feedstocks. These materials would be likely to contain high levels of physical contamination, perhaps as high as 20%. This contamination should not be allowed to compromise the effectiveness of the process, even when the contamination included problematic materials like glass and metals.

Developing Linkogas's AD operations to take advantage of increased supplies of food waste feedstocks:

Linkogas was formed in 1990 as part of a co-operative initiative by a group of farmers in the Vejen municipality in Jutland, Denmark. Vejen is very rural in nature and has an agricultural economy largely based on livestock (mostly pigs and dairy herds).

The objective was to construct and operate a biogas plant to convert manures and cattle slurries to renewable energy in the form of biogas. The facility also sought to address the growing agricultural and environmental issues associated with managing the end use of livestock manures.

Linko Gas AD faclility, Lintrup Denmark

The Linkogas AD plant provided cooperative members an economically favourable and environmentally sustainable solution for the storage, handling and end use of manure from their livestock. Linkogas collect manures direct from member farms and in return, as part of a service agreement, farmers are required to accept equal quantities of digestate for use as an organic fertiliser. Collections of manure and deliveries of digestate are made using specially designed tankers.

Linko Gas Tanker

Since day one the facility has an on-going commitment to improving process efficiency. In 1999 the digestion process was converted from mesophilic to thermophilic operation which significantly reduced digester retention time. Seeking to increase biogas production further the facility expanded its range of feedstocks to include food waste, initially sourced from local slaughterhouses and the fishing industry. This expansion in the sources of feedstock was also influenced by the National campaign to increase the diversion in food waste for energy recovery. Processing food waste required heat-based sanitation equipment to be installed at the facility as part of the food waste treatment operation.

The co-digestion of farm-based materials with food waste was successful in boosting the amount of biogas produced at the facility. Another benefit was in the additional nutrient content of the digestate which is used as an agricultural organic fertiliser.

Nutrient values (Kg per Tonne)	Typical digestate from manures and cattle slurry	Typical digestate from food waste
Nitrogen (N)	3.7	4.8
Phosphorus (P)	0.6	1.1
Potash (K)	2.3	2.4

The source and range of food waste feedstocks for processing were expanded to further exploit the above benefits. However, problems started to be experienced caused by physical contamination within the feedstock. Residual fragments of packaging and other non-biodegradable materials caused issues with the pumps used as part of the AD operation. In addition, this physical contamination also carried through into the digestate causing soil pollution on the farms spreading the digestate as a fertiliser. Member farmers started to become reluctant to receive their quota of digestate.

Securing a high-quality substrate, free from contamination from non-biodegradable materials, became a priority.

By this time the technology, under development by Gemidan Ecogi A/S, had reached the stage of testing at commercial scale. This enabled Linkogas to take deliveries of a high-quality pulp-based substrate that met their needs in terms of purity.

Today Linkogas continue to receive pulp-based substrate from Gemidan Ecogi, in 2017 30,000 tonnes of pulp were received and processed by Linkogas. Substrate quality is closely monitored at the pre-treatment facility and prior to digestion by Linkogas. The pulp is tested for purity and dry matter content to safeguard processing equipment, ensure biogas generation and digestate quality.

As part of the energy recovery operation, Linkogas generate electricity onsite using 2 CAT gas engines and biomethane injection into the Danish gas transportation grid. The residual heat generated during the generation of electricity is used to raise the temperature of substrate prior to thermophilic digestion, sanitise digestate and as part of a local district heating network.

Gas engine used for power generation

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