FEASIBILITY STUDY FOR CENTRALISED ANAEROBIC DIGESTION FOR TREATMENT OF VARIOUS WASTES AND WASTEWATERS IN SENSITIVE CATCHMENT AREAS

Final Project Report

Project Co-ordinator:
Professor Emer Colleran

Authors:
Dr. Therese Mahony[1], Dr. Vincent O'Flaherty[1], Professor Emer Colleran[1], Dr. Eamonn Killilea[2]; Ms Sue Scott[3] and Dr. John Curtis[3]

Project Participants
[1]Environmental Research Unit, Microbiology Department, NUI, Galway
[2]Department of Civil Engineering, Institute of Technology, Sligo
[3]Economic and Social Research Institute, 4 Burlington Road, Dublin 4

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ENVIRONMENTAL PROTECTION AGENCY
An Ghníomhaireacht um Chaomhú Comhshaoil
PO Box 3000, Johnstown Castle Estate, County Wexford, Ireland
Telephone: +353-53-60600 Fax: +353-53-60699
Email: info@epa.ie Website: http//www.epa.ie/

Feasibility Study for Centralised Anaerobic Digestion for Treatment of Various Wastes and Wastewaters in Sensitive Catchment Areas
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PROJECT PARTICIPANTS

Environmental Research Unit, Microbiology Department, NUI, Galway

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EXECUTIVE SUMMARY

This study was commissioned by the EPA in the context of (i) the current need to control and reduce greenhouse gas emissions in Ireland; (ii) the requirement to develop renewable energy sources in order to replace traditional fossil fuel use; (iii) the need to appropriately manage and recycle animal manure and slurry arisings from intensive livestock production units, sewage sludge and food industry organic wastes in such a way as to prevent surface or groundwater contamination and reduce soil phosphate build-up, and (iv) the requirement to implement the recent EU Landfill Directive (99/31/EC) which sets targets for the phased reduction of biodegradable organic waste to landfill and requires development of appropriate alternative technologies for its recycle and re-use by composting, anaerobic digestion or materials/energy recovery.

Centralised Anaerobic Digestion (CAD) technology was developed in Denmark in the late 1980s and has, more recently, been applied in Sweden, Italy, Germany and the UK. The objectives of application of CAD technology are to achieve efficient management, recycle and re-use of, and renewable energy generation from, animal manures and other biodegradable wastes in defined geographical areas. The primary objective of this study was to evaluate the feasibility of applying CAD for treatment of organic wastes and wastewaters in sensitive catchment areas in Ireland.

In the absence of oxygen in natural environments, organic matter decomposition is mediated by the co-ordinated and sequential activity of a consortium of anaerobic bacteria, resulting in its conversion to methane (CH_4) and CO_2. Approximately 70-80% of the energy content of the initial organic compounds is conserved in the methane product and resultant bacterial growth and biomass production is, consequently, much lower than during aerobic decomposition. This natural process has been harnessed (anaerobic digestion) since the late 1890s for the treatment of, and renewable energy generation from, sewage sludge, animal manures and, more recently, industrial wastes and wastewaters and the biodegradable fraction of municipal solid waste (MSW).

In Centralised Anaerobic Digestion (CAD) plants, the animal manure/slurry arisings from intensive livestock production units in a defined and limited catchment area are transported to a central treatment facility and co-digested with other organic wastes originating within the area (industrial wastes/wastewaters, sewage sludge, the organic fraction of MSW etc.). The biogas produced (typically 60-80% methane) is utilised for electricity generation, district heating, steam generation in local industries, or as a vehicle fuel. Anaerobic digestion does not reduce the nitrogen, phosphorus and potassium (NPK) content of manure feedstocks to any significant extent. Consequently, the treated CAD digestate retains its fertiliser value and must be either landspread on pasture or tillage lands within the catchment area or further processed (composting of the fibrous fraction; production of a liquid fertiliser) in a manner which maximises re-use of its fertiliser and soil-conditioning value, while ensuring that nitrate contamination of groundwater, excessive accumulation of soil phosphorus, and eutrophication of surface waters does not occur.

A State of Technology review was initially carried out on a national and international basis, with particular reference to the application of AD technology in other EU Member States. Although the review documented the current application of AD for sewage sludge, industrial waste/wastewater and MSW treatment in non-centralised

plants, its primary focus was to analyse the application of CAD technology for co-digestion, using animal manures/slurries as the primary feedstock. The review was based on publications in the international scientific literature, on previous site-visits to CAD plants in Denmark and Italy and to commercial on-farm AD plants in Germany, and on the involvement of one of the project participants (NUI, Galway) in an EU-funded programme, AD-Nett. The AD-Nett project included participants from all EU Member States and its primary objective was to promote application of biogas technology by shared experience of existing CAD and commercial on-farm AD plant design, operation and financial viability. The State of Technology review included evaluation and analysis of CAD plant design and operation; feedstock sourcing and management, including transport, storage and hygienisation; biogas productivity, purification and use; odour control; potential options for nutrient (N/P) removal from the digestate, and initial financing and ongoing viability of existing Danish plants.

A review of the EU and national legislation that could potentially impact on the licensing and planning permission conditions for CAD plants in Ireland was also carried out. Although the siting of CAD plants in sensitive catchment areas is likely to require conformity with a variety of EU directives and national legislation, the standards required for CAD plant operation should not be so stringent as to cause excessive cost or to act as a disincentive for the application, in Ireland, of centralised biogas technology. In particular, national codes of practice must be developed for the hygienisation of CAD feedstocks and/or digestates, in line with those developed in Denmark, Germany, Austria and Sweden.

A survey was carried out of the national waste organic arisings that could potentially be used as feedstocks for CAD plants. This was carried out on a county by county basis, relying on previously published statistics and on responses received from Local Authorities, the EPA, Teagasc etc. In addition, information was collated, on a county by county basis, on the sensitivity of individual catchments with respect to soil type and digestate spreading opportunities; potential contamination of ground and surface waters; restriction on digestate spreading due to nature conservation designations (NHAs, SACs, SPAs), and spreading limitations associated with farmer uptake of the Rural Environmental Protection Scheme (REPS). The level of interest in AD and the feedback obtained from individual local authorities was also an important criterion in the subsequent selection of appropriate regions for installation of a CAD plant. A weighting system was devised which resulted in the selection of Co. Monaghan as the most appropriate county for the initial installation of a demonstration CAD plant. A detailed study was subsequently carried out in Co. Monaghan in order to identify areas where organic waste arisings, potential users of the produced biogas, availability of land for digestate spreading, and farmer and industry interest would support the installation of a demonstration CAD plant. A catchment area with Lough Egish at its centre was chosen as the most suitable site, based on the above criteria, and this area was subsequently subjected to more detailed evaluation, including meetings with waste producers and potential end-users of the biogas. It should be pointed out, however, that many other potentially suitable sites for CAD plant installation were identified throughout the country and that the Lough Egish catchment area was chosen out of many possible sites on the basis of best-fit to the criteria and weighting scheme used in this survey.

Based on the available waste arisings in the Lough Egish catchment area (dairy cattle manure, pig slurry, poultry litter and industrial wastes and wastewaters from dairies, milk powder production and meat processing plants, abbatoirs, etc.), a detailed design

for a full-scale CAD plant processing 150 tonnes of organic waste per day was prepared. The design provided specifications for waste offloading and reception; influent storage and blending tanks; pasteurisation (hygienisation) facilities; two anaerobic digesters (each 2,000 m^3, mesophilic); a biogas storage tank; on-site digestate storage; sludge dewatering facilities; a CHP unit for electricity and heat recovery from the produced biogas, and 23 decentralised digestate storage tanks (each of 1,500 m^3 capacity) for optimal access of farmers to the digestate for landspreading. Detailed operating conditions were specified for each stage of the proposed CAD plant and costings were provided for each unit of the overall plant. In addition, health and safety considerations were taken into account and recommendations for minimisation of potential environmental impacts (i.e. odour control) were included.

A more detailed cost/benefit analysis of the proposed Lough Egish CAD plant was carried out by the ESRI. In addition to evaluating the actual transport and CAD plant operational costs, together with the benefits of biogas use, income from gate charges, etc., the ESRI attempted to quantify the benefits of CAD with respect to reduction of greenhouse gas emissions; improvement in water quality; public health benefits; odour reduction and recreational amenity benefits.

Animal manures and slurries are a major contributor to organic waste arisings in Ireland. CAD technology offers a management system whereby animal wastes can be utilised for renewable energy generation on a centralised basis, with consequent reduction in greenhouse gas emissions. The co-digestion of industrial and municipal wastes in CAD plants provides a procedure for integrated organic waste management, recycle, re-use and energy recovery on an individual catchment basis. In addition, centralisation of AD treatment provides an opportunity to maximise the return of manure nutrients to pasture and tillage lands and to minimise run-off or leaching of nutrients to surface and ground waters. The coordinated management of CAD plant digestate reduces the requirement for synthetic fertiliser application and also diminishes the risk of disease transfer and odour generation associated with the landspreading of untreated animal wastes.

CONCLUSIONS AND RECOMMENDATIONS

1. Centralised anaerobic digestion of animal manures and other organic wastes is an established, mature technology with full-scale experience in Denmark, Sweden, Italy and other EU countries. Although technical and operational parameters have been largely established for CAD plants, economic considerations, subsidies and incentives and management regimes vary from country to country.

   Recommendation: **It is recommended that one medium-scale CAD plant should be constructed in Ireland in order to demonstrate the technical, economic and environmental sustainability of this technology.**

2. The availability of appropriate feedstocks for CAD and their proximity of origin was evaluated on a county-by-county basis, bearing in mind the sensitivity of spreadlands for treated waste return. It is clear from the data obtained and analysed that there are many areas/catchments throughout the country where appropriate quantities of waste arisings exist and where CAD technology could be applied with benefit.

   Recommendation: **It is recommended to site, in the first instance, a demonstration CAD plant in the Lough Egish catchment area of Co. Monaghan for the following reasons:- (i) availability of an appropriate mix of feedstocks, (ii) acceptable waste and digestate transport distances, (iii) presence of end-users (industry) for the biogas produced or for the electricity and heat generated from burning the gas in a CHP plant, (iv) appropriate catchment area with no EU Environmental Designations, and (v) interest and enthusiasm at Local Authority, farmer and industry level.**

   Consideration should also be given to establishing a CAD plant at a location where sources of other wastes (e.g. sewage, animal manures, organic wastes etc) are readily available.

3. A system design together with a detailed description of plant and instrumentation for a 150t/d CAD plant is described in this report. The design includes reception and storage areas, sanitation tanks, as well as on-site and off-site digestate storage tanks. Information is provided on equipment types and sources and on overall operation and maintenance of the proposed plant.

   Recommendation: **It is recommended to use the system design and plant and instrumentation information provided as the blue-print for the demonstration plant proposed for the Lough Egish area.**

4. The installation of a medium-size CAD plant on a demonstration basis in the Lough Egish catchment area would allow detailed cost-benefit evaluation of this technology in an Irish context and in a real situation.

   Recommendation: **It is recommended that, together with a thorough financial (cost/benefit) appraisal of the proposed demonstration CAD plant, a detailed environmental cost/benefit evaluation should be carried out (odour reduction; pathogen removal; renewable energy use; reduction of greenhouse emissions; improved nutrient recycle etc.).**

5. Since CAD plants treat mixtures of animal manures/slurries from different animal production facilities, together with food-processing wastes, sewage sludges and/or the organic fraction of MSW, the risk to human and animal health via dissemination of pathogens must be minimised. The transport of raw wastes and the landspreading of digestate (with or without solids separation) creates new pathways for pathogen dissemination and has led to new legislation and/or codes of practice for waste sanitation in other EU countries.

   Recommendation: **In the context of impending EU legislation on sanitation requirements for anaerobic digestion and composting plants, it is recommended that the Departments of the Environment and Agriculture liaise with the EPA in setting codes of practice and legislative requirements for the operation of CAD plants in Ireland.**

6. The return of the digestate for landspreading on grass or tillage lands represents the most environmentally sustainable means of recycling the nutrients present in the digestate. In addition to reducing reliance on synthetic fertilisers, return of the digestate is beneficial with respect to soil conditioning.

   Recommendation: **It is recommended that an enforceable code of practice for landspreading of CAD digestate (specifying time and method of spreading, application rates etc.) be developed by the appropriate authorities (Dept. of the Environment, EPA, Teagasc, Geological Survey of Ireland).**

7. Since soils in certain regions of Ireland already contain excessive phosphorus levels, landspreading of CAD digestate in these areas would further contribute to a deterioration of water quality. Given the requirements under Statutory Instrument No. 259 of 1998 (Water Quality Standards for Phosphorus Regulations) to maintain or improve the quality rating and trophic status of rivers and lakes, it is likely that landspreading of digestate would be prohibited in these areas. Current technologies for nitrogen and phosphorus removal from sewage and industrial wastewaters are not suitable for animal wastes or the digestate from CAD plants and would, in any case, be prohibitively expensive to operate. However, new technologies are currently being developed for phosphate removal from wastewaters in a form that can be recycled by the phosphate industry, the fertiliser industry or other industries utilising phosphorus products.

   Recommendation: **It is recommended that a detailed review be commissioned of new and emerging technologies that may be applicable to phosphorus removal and recovery from CAD digestates. A detailed cost/benefit appraisal (in financial and environmental terms) should also be carried out.**

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