BBSRC NIBB AD Network
All Business Interaction Vouchers: Titles and Summaries

2014 BIV Titles and Summaries

BIV2014001

Permastore / Dr Sonia Heaven
Testing of anaerobic digester components found in thermophilic digestion of food wastes

Permastore is the world leading manufacturer of Glass-Fused-to-Steel tanks and silos, with more than 300,000 structures installed worldwide in over 110 countries. The wide range of applications already includes anaerobic digestion and biogas and biofuels production. The company's aim is to remain at the forefront of development in this field, and to ensure its continuing ability to provide customers with optimum solutions for their containment requirements, and with secure, long-life systems for an expanding range of applications in both anaerobic digestion and novel anaerobic biotechnologies. The company therefore wishes, in association with the academic group at Southampton, to develop a testing protocol that will allow materials destined for potential use in advanced applications to be validated. This includes operation at thermophilic temperatures and where harsh conditions are likely to arise in digesters, both in normal operation and where the process becomes unstable or fails. The testing will be based on small-scale continuous simulation of the digestion process and will provide comprehensive data that would not be available from simple batch tests. Trials will be carried out using source separated domestic food waste, which is itself an interesting and challenging feedstock under thermophilic conditions. The project will thus allow the partners to draw on their extensive combined expertise to develop and use an appropriate in-vivo testing regime, and to work together on evaluating the results from trials carried out over a period of several months.

BIV2014002

IEA Task 37 / Dr Sonia Heaven
A modelling tool for the UK AD industry

Rapid expansion in the UK AD sector is creating a need for a powerful, flexible and readily-accessible tool for assessment of anaerobic digestion (AD) facilities. To achieve this it is proposed to take an existing model on which extensive development work has already been carried out by the academic partners, and to re-configure it into a user-friendly software package suited to the needs of a wide range of end-users. The task of transferring the model into a high-level programming language was begun in the FP7 VALORGAS programme. The proposed work will extend this to include other parameters, and will tailor inputs and outputs to meet the needs of industry and agriculture in the UK. The model itself allows prediction of detailed energy and nutrient balances for AD plants, which can be further translated in terms of their respective greenhouse gas emissions associated with the process. The combined expertise of IEA Task 37 (UK) and the academic partners will allow the development and testing of a new user interface suitable for industrial and farm-based applications at a range of scales. This will be achieved through close collaboration with industry members of Task 37 offering time and expertise as in-kind contributions to achieve the desired goal. The software will be freely available for download and will be promoted through Task 37. The resulting tool will be widely used by industry and researchers, promoting a common framework for evaluation of new and existing AD plants, and increased collaboration across the UK AD community.

2015 BIV Titles and Summaries

BIV2015002
Lutra Ltd / Dr David Styles **Providing a scientific evidence base for public subsidy support of biomethane for transport from waste**
Life cycle assessment (LCA) shows that food waste digestion achieves large environmental credits (e.g. greenhouse gas emission reductions) through replacement of mineral fertilizers and avoidance of composting or landfilling counterfactuals, in addition to fossil fuel replacement with biogas. Evergreen Gas have developed a cost-effective AD system for food waste linked with biogas upgrade that could improve the energetic and environmental balance of food waste AD by avoiding energy inefficiencies associated with combined heat and power plants typically linked to centralized food waste AD plants, and that could reduce harmful emissions from diesel-powered transport. The proposed two-month project will undertake a detailed LCA of this novel pilot system, called Barrett's Mill Anaerobic Digester (BMAD) to: (i) quantify the environmental balance of the AD system compared with alternative food waste management options; (ii) compare the use of biomethane as a transport fuel with diesel and biodiesel; (iii) evaluate the avoided external costs from the proposed system; (iv) compare the public cost-benefit ratio of BMAD with biofuels; (v) identify areas for further R&D. A research assistant will spend six weeks working closely with Evergreen Gas, mining literature data and adapting the "LCAD Eco Screen" tool to evaluate the BMAD system against alternative waste management and biofuel options. Results are anticipated to demonstrate a more positive energy and greenhouse gas balance for the BMAD system compared with alternative waste management options, and a significant human health credit associated with transport diesel substitution. A case will be made for public support of the BMAD concept.

BIV2015003
Renewable Energy Association / Dr David Styles **Evaluating cost-effective greenhouse gas abatement by small-scale anaerobic digestion**
Rapid expansion in the UK AD sector is creating a need for a powerful, flexible and readily-accessible tool for assessment of anaerobic digestion (AD) facilities. To achieve this it is proposed to take an existing model on which extensive development work has already been carried out by the academic partners, and to re-configure it into a user-friendly software package suited to the needs of a wide range of end-users. The task of transferring the model into a high-level programming language was begun in the FP7 VALORGAS programme. The proposed work will extend this to include other parameters, and will tailor inputs and outputs to meet the needs of industry and agriculture in the UK. The model itself allows prediction of detailed energy and nutrient balances for AD plants, which can be further translated in terms of their respective greenhouse gas emissions associated with the process. The combined expertise of IEA Task 37 (UK) and the academic partners will allow the development and testing of a new user interface suitable for industrial and farm-based applications at a range of scales. This will be achieved through close collaboration with industry members of Task 37 offering time and expertise as in-kind contributions to achieve the desired goal. The software will be freely available for download and will be promoted through Task 37. The resulting tool will be widely used by industry and researchers, promoting a common framework for evaluation of new and existing AD plants, and increased collaboration across the UK AD community

BIV2015007

William Jackson Food Group / Dr Davide Dionisi

Anaerobic digestion of vegetable waste from the food industry

The industrial partner of this project generates thousands of tonnes per year of vegetable wastes from which very little value is currently recovered. This project is aimed at investigating the feasibility of anaerobic digestion of vegetable waste from the industrial partner, in order to convert the waste to biogas, which can be then used for electricity generation at the partner's manufaccturing sites or, after purification, injected to the National Grid. Anaerobic digestion is a relatively established process, however the use of vegetable waste as feedstock presents some issues which need to be investigated at lab scale before a full-scale process can be designed. The main potential issues in the anaerobic digestion of food waste are the following: rapid acidification, due to the generation of volatile fatty acids at a rate higher than the rate at which acetogenic or methanogenic microorganisms are able to convert them; relatively low C/N ratio, with potential high ammonia concentration which could inhibit methanogenesis; possible low concentration of trace elements. With the feedstock provided by the industrial partner, a lab-scale anaerobic digestion process will be run in a completely mixed reactor (CSTR). The reactor will be run under mesophilic conditions (35oC) in a range of hydraulic residence times (HRT), and the volume and composition of the produced gas will be measured. The aim is to determine the minimum value of the HRT which ensures high biogas yield while minimising the possible inhibiting effects due to acidification and ammonia and the possible trace elements limitation.

2016 BIV Titles and Summaries

BIV2016001
Roam Agency/Dr James Lawrence **Comparison of Biological and Mechanical Processes to Generate Value from Digestate**
The project will compare the performance of two low cost systems involving different processes for the remediation of digestate from small-scale AD plants – a biological cascade and a mechanical separation. The aim of the project is to develop recommendations for the design of cost-effective remediation systems for small AD plants, focused on generating value from digestate, in order to support the viability of decentralized organic waste management.

BIV2016003
Tropical Power/Prof. Charles Banks **Process optimisation of Africa's first commercial grid connected AD plant**
Tropical Power is an Engineering Procurement and Construction company building renewable energy solutions for Africa: its focus is on developing utility-scale sustainable energy technologies including anaerobic digestion (AD) and photovoltaics. The Company plans to build renewable power assets producing over 130 MW of clean, distributed power. The first of these was recently commissioned as Africa's first commercial grid-connected AD plant. It is situated at Gorge Farm Energy Park in Nakuru County, Kenya and is currently fed on corn stover and trimmings from vegetables grown for export, mainly to the UK; future feedstocks will include drought-tolerant coppice plants from non-irrigated areas. Because this type of mixed feedstock has not previously been used elsewhere, there is believed to be scope for optimising the plant's performance in terms of its energy use and overall efficiency in relation to feedstock types. To achieve this, the Company needs a testing and monitoring laboratory and is seeking the University of Southampton's advice to establish this, and to work with Tropical Power on analysis and interpretation of data. The work will involve on-site evaluation of facilities, and discussions with the plant operational and management staff to assess which aspects of the monitoring can be carried out in Kenya, and which analyses require sample shipment to external laboratories. As part of the BIV project an initial range of samples and data will be analysed by the University partner to establish baseline values for benchmarking performance. The Company will assist by setting up site meetings and briefing sessions, provision of operational data and shipping of samples.

BIV2016006
LooWatt Ltd./Dr Tim Patterson **Evaluation of an integrated aerobic-anaerobic microbial system for enhanced degradation of biopolymers**
Loowatt Ltd. has developed a waterless toilet system which is clean and odourless and uses a patented sealing mechanism to wrap human waste in biodegradable polymer film. The mixture of the film and the waste collected aims to be treated by anaerobic digestion to recover energy and nutrients. The project aims to evaluate the benefit of aerobically pre-treating the biopolymer, in order to facilitate the subsequent anaerobic digestion of the material and its residual intermediates. The project will combine the toilet system and material expertise generated within Loowatt with the expertise in biological conversions and biopolymer

chemistry as well as state of the art reactors and analytical facilities available at the University of South Wales. Whilst chemical pretreatments have been successful in aiding polymer degradation, the sustainability of biological processes only would improve Loowatt's product credentials. Aerobic treatment methods have been used post anaerobic digestion for digestate maturation and organic polishing. Aerobic treatments upfront of anaerobic process are novel and more specifically in what relates to biopolymer degradation. The knowledge gained can be immediately utilized by Loowatt Ltd., but is also relevant to the wider AD community as the existing presence of biopolymer materials in feedstocks, including source segregated food waste, currently causes operational difficulties. In addition, as the use of biopolymers in applications such as food waste caddy liners is likely to increase, treating this material is likely to be a long term challenge of the waste management / AD community.

BIV2016007

G's Fresh/ Dr Ralph Noble

Optimising the use of separated anaerobic digestate fibre as a substrate for mushroom cultivation

G's Fresh is a major producer of fresh vegetables and mushrooms. It has a 3 MW, two-stage mesophilic AD plant at Littleport, Cambridgeshire which processes over 50,000 tonnes of maize and rye, 8,500 tonnes of vegetable wastes and 2,000 tonnes of chicken manure annually. This produces over 6,000 tonnes of mechanically separated digestate fibre, accredited to PAS 110, and currently disposed of to land. Adjacent, it has the UK's largest and most advanced mushroom farm, which utilizes 25,000 tonnes of imported substrate to produce 8,000 tonnes of button mushrooms annually. G's wish to collaborate with NIAB EMR to investigate the potential for utilising separated digestate fibre as a component in mushroom substrate. The fibre is pasteurised at >70C during AD, avoiding the need for subsequent pasteurization, a usual step in mushroom substrate production. However, further processing (controlled temperature 'conditioning' at 45-50C and/or addition of gypsum) is probably needed to stabilize the ammonium-N content of the fibre before it is suitable for mushroom cultivation. This project will determine the influence of AD feedstocks on the analysis and suitability of the separated fibre, and the subsequent processing needed for producing a mushroom substrate component. The UK mushroom industry currently uses around 300,000 tonnes of mushroom substrate annually. In Europe, more than 4M tonnes of substrate are produced annually. There are also large markets in North America, Australasia and China. This project has the potential to develop a new, high value market for separated digestate fibre, thus improving the economic viability of AD.

BIV2016009

Beeswax Farming (Rainbow) Ltd/ David Stainton - University of Lincoln

Improving the sustainability of Anaerobic Digestion by demonstrating the potential of digestate fibre to reduce peat usage in horticultural growing media.

A consortium of farm AD businesses will work with the University of Lincoln to evaluate the potential for combining their digestate fibre outputs to develop a peat reduction product for use within horticultural growing media. The aim is to convert AD fibre (ADF) disposal from a cost to a profitable element of AD plant operation.
The project will:

1. Analyse the fibre outputs from the individual AD plants to assess the degree of variation in output characteristics and provide the rationale for the fibre blend that will be used in the growth trial.
2. Mix a range of proportions of the blended ADF with commercial peat and compare the growth of selected horticultural plant species in these mixtures against a standard peat based formulation.
3. Analyse the nutritional performance of the growing media during the growth trial focussing on nitrogen and potassium mobility in relation to overhead, trickle and sandbed irrigation systems
4. Review with the commercial consortium the issues and opportunities to improve the sustainability of their AD operations through the forming of a cooperative venture to market ADF into the horticultural sector.
Over 1.3 million m3 of peat is consumed annually and contributes to a market for retail and wholesale horticultural growing media valued at over £400 million.
This proposal should enable AD plant operators to develop a route to that market for ADF that will improve the sustainability of their operations financially, whilst benefitting the environment though a decrease in peat usage by horticulture.

BIV2016011

Youlgrave Community Land Trust (YCLT) /Dr David Styles
Youlgrave Community Land Trust (YCLT) organic waste micro-AD feasibility study and case for support

Community-led projects are a promising way to extend AD, and associated GHG, energy and local economic benefits, to sparsely populated rural areas (supporting EU Horizon 2020, ISABEL project). Owing to unproven novelty & longer payback investors and local authority (LA) planners are presently unwilling to consider them for organic waste treatment. YCLT preliminary research suggests an environmental/economic case exists to replace current LA practice (composting/landfilling) of trade/domestic organic food-waste with community-based micro-AD approaches. Sufficient local trade food-waste appears available to support a micro-AD plant, which could significantly reduce transport (waste miles) whilst providing local energy, bio-fertiliser and reduced GHG emissions, & leading to incremental employment and social innovation. Independent evaluation is needed to validate/develop these findings to support the feasibility of a subsequent micro-AD demonstration project. The evaluation will involve data collection by YCLT from LAs, equipment suppliers etc.to develop realistic deployment scenarios. Bangor University (BU) will undertake expanded boundary life cycle assessment (LCA) of the net environmental consequences of shifting from composting/landfilling to AD treatment. BU will also undertake a basic cost-benefit appraisal of AD scenarios compared with existing waste management, applying sensitivity analyses to test the findings robustness to variation in e.g. rate of source-separation of organic waste, biogas yields, end-use of biogas/digestate. A rigorous evidence-base will be developed to support underpinning YCLT funding applications for a community-led micro-AD demonstration project, to validate recommendations to relevant LAs (and policy makers in general) regarding integration of AD into existing waste strategies.

BIV2016013
Western Isles IWM Facility/ Dr Sonia Heaven **Evaluating the feasibility of fish waste co-digestion with MSW in Stornoway**
The work will evaluate the potential for co-digestion of wastes from fish farming with municipal biowastes to maximise the energy output from the anaerobic digestion plant currently operating at Stornoway on the Isle of Lewis. The rate of growth in fish farming worldwide makes these wastes an important future resource, yet little is known about the impacts or benefits they may have in waste treatment systems and their potential for energy and resource recovery through nutrient recycling. The work will involve a six-month laboratory-scale simulation of the co-digestion process using a mixed municipal waste feedstock and fish wastes supplied from the Stornoway plant. The aim is to identify and where possible overcome process limitations, including those associated with the use of high protein feedstocks and ammonia toxicity. If successful the trial will establish suitable operating protocols for both mesophilic and thermophilic conditions: these will be of value to the anaerobic digestion (AD) and fish farming industries as a whole, while a decision to implement this at the plant will bring immediate economic and environmental benefit to the island community. The collaboration may lead to further opportunities for the partners to work together on sustainability and energy security issues for island sites, with links to further RCUK-funded work on renewable energy integration by coupling wind energy, electrolytic hydrogen production and biomethanisation of CO2.