EBNet
Environmental Biotechnology

Engineering and Physical Sciences Research Council

Biotechnology and Biological Sciences Research Council

ENVIRONMENTAL BIOTECHNOLOGY NETWORK

Anaerobic Digestion WG

Anaerobic Digestion (AD WG)

Led by Dr Mark Walker, University of Hull

Anaerobic digesters provide sustainable and low-carbon treatment of liquid and solid organic wastes using a mature technology, with growth in the sector predominantly determined by the increased capture of AD-appropriate waste materials. There remain exciting opportunities both in the improvement of existing AD technologies (e.g. emerging feedstocks, pre-treatment, process intensification), and in development of novel applications and new markets (e.g. biorefining/high value products, green hydrogen and CO_2 biomethanation).

The WG brings together interdisciplinary expertise to explore 'What's next for AD?' and how the wealth of historical and current research can contribute to the next generation of anaerobic biotechnologies across the energy, food, agriculture, water and biomanufacturing sectors. It aims to strengthen links between the AD research community, policy makers and industry to ensure activities support both near- and long-term industrial needs.

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This highly active WG benefited from the legacy of the previous BBSRC-funded Anaerobic Digestion Network (ADNet): many EBNet members work in and around AD.

Activity Synopsis

The AD WG hosted five webinars with leading international speakers, two of them jointly promoted by other NIBBS, one organised by the Water Biofilms WG and one in conjunction with IEA Bioenergy Task 37 and the UK's Anaerobic Digestion and Bioresources Association (ADBA).

ACTIVITY SYNOPSIS ctd

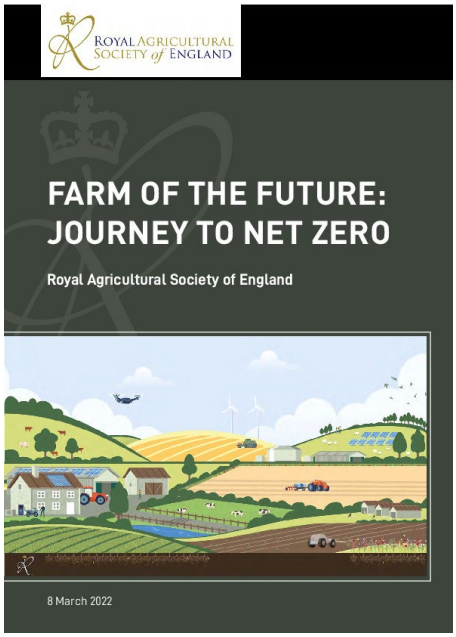
Webinar Advances in Anaerobic Membrane Bioreactors
Webinar Granular Activated Carbon Biofilms for Biomethanation from Wastewater *led by WB WG*
Webinar CO_2 Biomethanisation *co-promoted by Carbon Recycling Network NIBB*
Webinar Developments in Algal Gas Scrubbing *co-promoted by Algae-UK NIBB*
Webinar Opportunities in Biogas – an IEA Task 37 perspective *co-promoted by ADBA*

WG members carried out a very wide range of activities nationally and internationally, including presentations at a workshop in Alaska on Renewable energy from anaerobic digestion in remote and off-grid applications, organised by the US National Renewable Energy Laboratory (NREL).

Two Proof-of-concept (POC) projects and four Business Interaction Vouchers (BIV) were funded:
BIV202001 Determination of microbial communities of laboratory anaerobic digestion tanks and impact of the CreChar additive on the microbial community dynamics
BIV202002 Understanding anaerobic biodegradability of organic menstrual care products: technical feasibility and sector receptivity
BIV202102 Sludge dewaterability: improved tools for the emerging biotech industries
BIV202402 Improving the accuracy, reliability and user experience of low-flow gas meters for research and development in AD and biotechnological processes.

The WG carried out a study on CO_2 Biomethanation as an enabling process for carbon recycling, funded by Carbon Recycling Network with additional support from EBNet; and a small study on Food waste in conjunction with Royal Holloway College (see Resources). Other highlighted work with external organisations includes support and contributions to the RASE *Farm of the Future Report*, a DESNZ workshop on *Fugitive Emissions* and to IEA Task 37 reports and work plans. This WG also assisted in setting up the joint Gas Fermentation workshop and coordinated the *New Biomethane* workshop n collaboration with three other EBNet WGs.

AD was the most frequent topic at ECR events, and the Network funded four international Travel Bursaries for ECR from Leeds, Cranfield, Surrey and Newcastle, as well as UK conferences and a placement. Outreach activities included 10 articles in ADBA's twice-yearly magazine.



WG Journal papers:

Bywater, A. and Kusch-Brandt, S., 2022. Exploring farm anaerobic digester economic viability in a time of policy change in the UK. Processes, 10(2), p.212.
Bywater, A., Heaven, S., Zhang, Y. and Banks, C.J., 2022. Potential for biomethanisation of CO2 from anaerobic digestion of organic wastes in the United Kingdom. Processes, 10(6), p.1202.

Dr Dana Ofiteru
Newcastle University
POC202112

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Real-time monitoring of anaerobic digestion microbial communities as a foaming risk prediction method

"This EBNet PoC showed us the power of collaboration with the university and the potential of using multi-omics for understanding the pervasive foaming phenomena in the digester we are operating. While there is still a long way until the industry will be able to make routinely such analyses, we are proud to be one of the first AD companies in the UK who embarked on this path".
Stefan Weitz & Darren Smith, BioConstruct NewEnergy Ltd.

AIM

Decomposition of the organic wastes generated by humans (estimated to be 105 billion tonnes/year) releases methane and other harmful greenhouse gases (GHG) directly into the atmosphere. Methane is a much more potent GHG than CO_2, and simply by managing organic wastes more effectively we can cut global GHG emissions.

Anaerobic digestion (AD) is a 'ready-to-use' technology which can prevent methane emissions and generate biogas, bio-fertilisers and other valuable bio-products. One major concerns for AD companies is foaming, which has a significant impact on process efficiency and operational costs. Foaming is a manifestation of instability in the AD process, and microorganisms are the main functional body ensuring AD performance. Therefore, foaming mechanisms need to be explored at the microbial community level. Industry is keen to have a way to predict foaming as it affects productivity, can damage infrastructure and is dangerous for operators.

We propose to use microbial community fingerprinting through low-cost metagenomics (to answer, "who is there?") and metaproteomics (to answer, "what are they doing?") to provide data in real time for the risk prediction and control of foaming in AD. For the first time, we are going to apply this method for monitoring a full scale AD treating mixed waste.

RESULTS

Our samples were collected the end of October 2021, from two similar reactors which received the same type of feed: one going through a foaming event and one without foaming.

Due to the complexity of the samples, DNA extraction proved challenging. Firstly, we used the third-generation sequencing technology provided by MinION (Oxford Nanopore Technologies). This generates longer reads and should improve the metagenome assembly. Due to the challenging extraction, we also sequenced the samples through Illumina, a second-generation sequencing technology which generates shorter reads.

Metagenomic data analysis showed that the microbial communities in the two reactors differ significantly. Some common species between the two plants had significantly higher relative abundance in the foaming reactor. Metaproteomics also confirmed the presence of these putative foam-forming bacteria and identified numerous flagellin proteins that are markers for filamentous bacteria which are known to cause foam.

Our results are a first step towards using a combined 'omics approach in studying foaming in industrial reactors treating complex mixed waste.

FURTHER ACTIVITY:
Work is underway to analyse a second set of samples. The results have been shared with other researchers for application of more advanced bioinformatics tools. This work is ongoing and we will soon have a fuller picture of possible microbial markers for foaming in AD.

Dr Elizabeth Heidrich
Newcastle University

Dr Jan Dolfing
Northumbria University
JOINT POC 202207

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Pure biomethane - rather than biogas - from a single waste stream

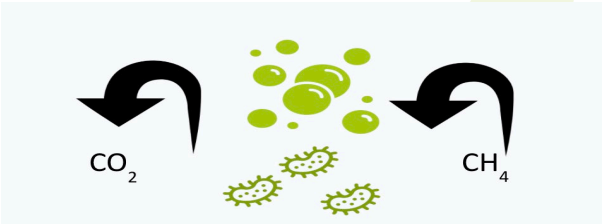
THE RESEARCH

Separation is one of the most challenging aspects of any recycling process, and anaerobic digestion (AD) of wastes is no exception. AD plants produce biogas, a mixture of methane and CO_2. The problem here is two-fold: firstly, biogas upgrading processes can consume 2-13% of the energy produced; secondly 1-4% of the methane can be lost in the off-gas, and it has 28-34 times the global warming potential of CO_2.

Through understanding the state of the art and building on thermodynamic insights, we developed a combined AD and bioelectrochemical reactor set-up which produced higher methane concentrations in the off-gas. The approach is deceptively simple: it allows the thermodynamically favourable biological reactions to proceed as normal; but separates the places in which the stages of this reaction occur, and thus the gaseous products, producing pure bio-CH_4 in one compartment and bio-CO_2 in another compartment of the same reactor.

By using bioelectrochemical membrane technology to manipulate the bioreactor space for a mixed microbial community, we can deliberately and intelligently separate the functionality and outputs of the microbes.

We would like to further develop the technology to work towards pure methane on one side, pure CO_2 on the other. This has the potential to be a simple retrofittable upgrade to all AD reactors which would then deliver improved environmental protection and enhanced resource recovery.



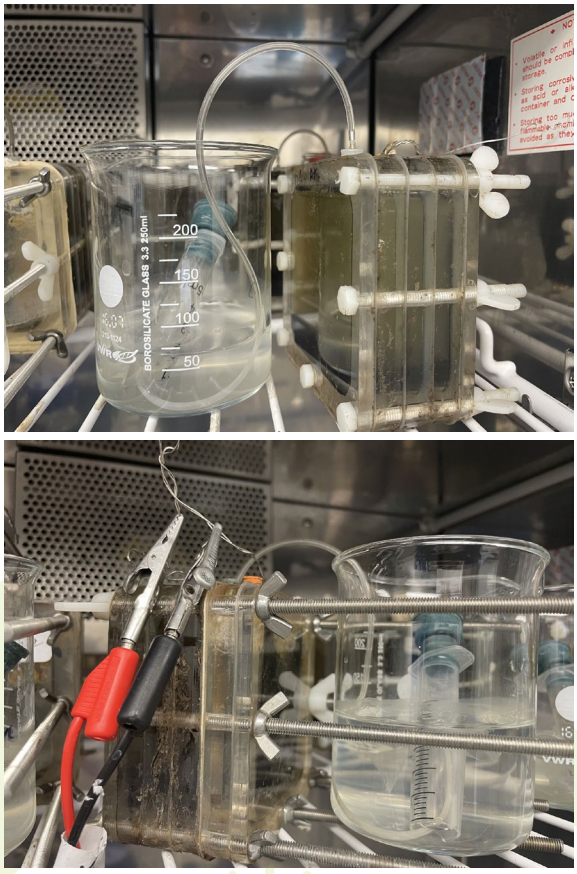


Fig.1. MEC-AD reactor set-up. Top: Stand-alone AD reactor with tubing to collect methane. Bottom: MEC-AD reactor separated by a CEM membrane with tubing to collect gas from the AD side and connected to a Pico logger for voltage measurement.

"These POC grants allow us to explore risky and interesting ideas with a view to taking the ideas further if they work. We gained valuable insights in this project which will help the development of bioelectrochemical menthane production technologies."
- Dr Elizabeth Heidrich, Newcastle University

EBNet Environmental Biotechnology

PROJECT PARTNERS:
***Prof James Chong**, University of York & **Dr Adam Ostrowski**, Carbogenics Ltd.*
BIV202001

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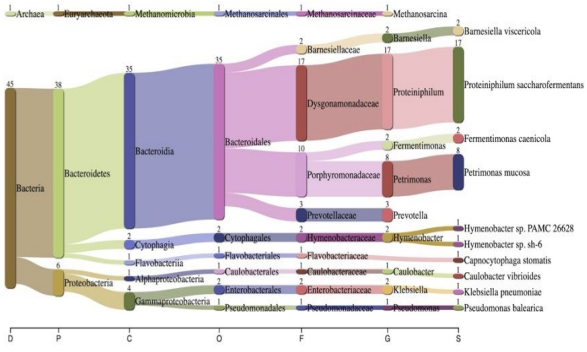
Determination of microbial communities of laboratory anaerobic digestion tanks and impact of Crechar® additive on community dynamics

"Our collaboration with Prof Chong and his group has been instrumental in making the first steps towards building a pipeline for analysis of microbial communities in anaerobic digestion. This will help us to further develop our expertise in this area, and ultimately will allow us to optimise our CreChar product. I am looking forward to continuing our collaboration with Prof. Chong, possibly within the remit of his new Cloud SPAN project". Dr Adam Ostrowski, Carbogenics Ltd.

AIM

Carbogenics Ltd has developed a novel carbon additive CreChar® intended to increase the stability and process efficiency of Anaerobic Digestion plants. CreChar® is expected to facilitate microbial interactions, biofilm development and increases in the abundance of essential microbial taxa. Carbogenics recently acquired a MinION sequencer from Oxford Nanopore Technologies and obtained a large quantity of genomics data from various experimental reactors. However, very little information is available on the microorganisms commonly found in AD, and the MinION technology is very young and currently not supported by user-friendly analysis software. Carbogenics managed to process approx 30% of the obtained data, but lacked the expertise required to unlock all the information in the datasets. The company wanted to partner with Prof James Chong's group at the University of York, who are leaders in development of the tools for AD metagenomics.

"I hope our analyses will provide useful insights that can be used by Carbogenics to further develop its products. Working together has demonstrated a clear need for more accessible training to boost microbial community analysis expertise in small companies who are developing exciting innovations on limited budgets and short time-scales. I hope our Cloud-SPAN project will help to address that need". Professor James Chong, University of York



RESULTS

Cutting-edge DNA sequencing technologies such as Oxford Nanopore Technologies' MinION sequencer are democratising science and making DNA sequencing routinely possible in nontraditional settings such as SMEs and micro-businesses. However, the expertise and computational hardware required to make full use of this data currently trails our ability to generate it.

Our collaboration supported the interpretation of Carbogenics' in-house generated data using University of York high performance computing (HPC) infrastructure and expertise. In addition to providing biological insights into how Carbogenics' CreChar® additive supports the productivity of anaerobic digestion, the data analysis carried out in this project will allow Carbogenics to further refine its products.

As well as directly supporting Carbogenics' investigations, our project has highlighted a skills (and infrastructure) gap that we think can be filled though on-line training and HPC resources.

https://cloud-span.york.ac.uk

PROJECT PARTNERS:
***Dr Yadira Bajón Fernández**, Cranfield University*
*& **Kimberley Dobney**, Turn and Flow*
BIV202002

Understanding anaerobic biodegradability of organic menstrual care products: technical feasibility and sector receptivity

"We are so grateful for this research. This is a great first step in working out better disposal systems for menstrual waste". Kimberley Dobney, Turn and Flow CIC

AIM

Turn is a product service system (PSS) to recycle organic menstrual care products and to stop them being sent to landfill, incinerated or flushed. This is a complex and stigmatised topic, hence Turn will also be raising public awareness on the impact of traditional menstrual management products (MMP) on the planet and the body, and encouraging the use of organic products as an alternative.

This proposal brings together engineers and social scientists to prove the feasibility of value recovery from organic menstrual care products. The focus is on elucidating technical viability by investigating product biodegradability and potential for biogas formation in anaerobic digesters (AD); as well as informing sector receptivity towards this new feedstock by conducting semi-structured interviews with key AD practitioners. The Environment Agency will be included in the interviews in order to gain a comprehensive understanding of the regulatory limitations for accepting used organic menstrual care products at existing AD sites. This proposal will start a collaboration between Turn and Cranfield University.

An exploratory study of the impact and potential of menstrual hygiene management waste in the UK Blair, L.A.G., Bajón-Fernández, Y. and Villa, R., 2022. Cleaner Eng and Technology, 7, p.100435.

RESULTS

Biodegradability of MMPs labelled as organic was found to be low compared with other organic feedstocks. Biogas potential was observed to be higher for wet AD than dry AD processes, although the difficulties of treating a solid waste with high water-absorbing capacity like MMP in wet ADs means that dry AD is comparatively more practical even if it results in more limited biogas yields.

59% of the survey participants stated they were aware of organic and biodegradable MMPs, although only 17% said they used them. The vast majority of respondents (82%) indicated they would be willing to try using organic and biodegradable period products at home.

Collection of soiled MMP with black bins at household level will classify them within the 'mixed municipal waste' category, diverting them to the treatment processes currently available, including AD for some UK areas. Separate collection of these products in commercial premises will result in a classification as 'offensive municipal waste' with their further acceptance in AD sites restricted by the operating permits of each facility.

"I am very happy to have delivered this project. Menstrual management is still a taboo in many scenarios and sustainable treatment of menstrual waste needs to gain much more attention. Current disposal routes are predominantly based on landfilling or incineration, with a significant amount of menstrual waste reaching the water bodies and polluting the environment. Turn's ambition to increase awareness about poor practices and identify opportunities to recover value from menstrual waste has potential to make a significant impact".
Dr Yadira Bajón Fernández, Cranfield University

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PROJECT PARTNERS:
***Dr Yue Zhang**, University of Southampton &*
Triton Electronics Ltd
BIV202102

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Sludge dewaterability:
Improved tools for the emerging biotech industries

"Very pleased to have gained some experience with our new CST device. Further, to have looked at dewaterability tests beyond the main market of sewage sludge dewatering. We are very keen to build on this project and have many ideas about how to exploit the excellent early results".
- Julian Tapp, Triton Electronics Ltd

THE PROJECT

Processing of wastewater biosolids is a major issue for the water industry, typically accounting for half the cost of wastewater treatment. This is due to both the volume and the nature of the material: sludges are complex biological substances capable of holding large amounts of water via different mechanisms.

The capillary suction time (CST) is one key parameter used to assess sludge dewaterability. Separation of liquids and concentration of the solid fraction can have very significant benefits both on transport costs and impacts, and on the organic loading rates that can be applied to digestion plant and infrastructure.

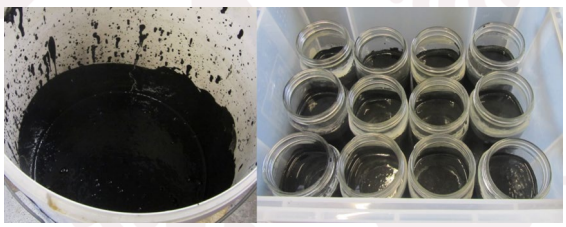
Other bioprocesses undergoing rapid development, such as anaerobic digestion for the circular bioeconomy, offer new opportunities and challenges for dewaterability analysis. This is due to the introduction of new feedstocks such as food and agro-wastes, and of new treatments including low-temperature anaerobic processes and biorefinery fermentations.

In collaboration with Triton Electronics, the international market leader on CST apparatus for decades, this project analysed a range of samples from wastewater treatment works, commercial anaerobic digestion plants and laboratory-based bioreactors. Factors affecting CST test repeatability included alternative test apparatus models and parts, test conditions and physicochemical and biological parameters of samples. Its comparability with other dewaterability test methods was also investigated (mainly with respect to frozen image centrifugation and specific resistance to dewatering).

Triton single-head CST apparatus

The results demonstrated that most commercial anaerobic digestate samples showed very different properties from the familiar waste activated sludge produced from biological treatment processes in wastewater treatment works, and different testing protocols need to be investigated for future real-world applications.

"It has been a great pleasure working with Triton on this project to explore the challenges and R&D needs for the dewaterability test methods on digestate and other emerging materials. The results obtained and the discussions carried out have formed a solid basis for future collaboration with Triton".



Digestate from wastewater biosolids (left) has a relatively low solids content. Other digestates from food and agro-wastes (right) have higher solids content and different rheological properties which make dewatering more challenging

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PROJECT PARTNERS:
***Dr Mark Walker**, University of Hull*
*& **CJC Labs Ltd***
BIV202402

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Low-flow gas measurement for R&D in AD and biotechnological processes: improving accuracy, reliability and user experience

AIM

CJC Labs Ltd has carried out extensive development on the design and low-cost manufacture of an effective, robust, user-friendly and reliable flowmeter for quantifying low gas flows. Its primary use is to measure biogas and methane production in laboratory studies and commercial testing of anaerobic digestion and other anaerobic biotechnology substrates and processes.

In this project, the company wished to develop a verifiable protocol to assess flowmeter accuracy and reliability. This was in response to requests from end-users indicating the need for a reliable calibration method which could be reported in the scientific literature and used by those working in this field. This protocol and method would also be relevant to users of similar equipment produced by others, or of self-fabricated in-house systems.

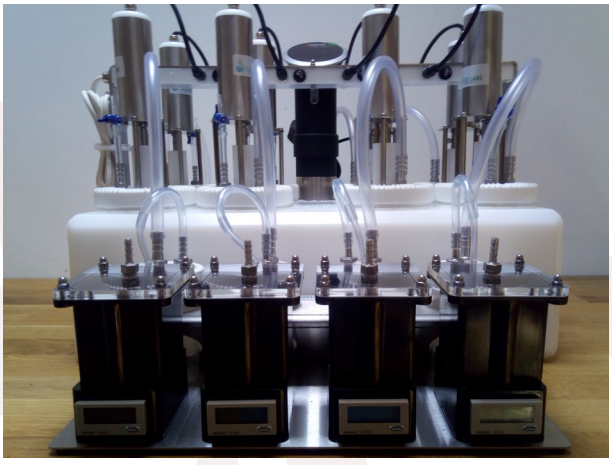
RESULTS

The results of the work are being incorporated into advice and support offered to CJC Labs' customers on use of the flowmeters. Useful insights include:

- The scale of potential errors introduced by use of a nominal calibration factor
- 'Count-to-count' repeatability of the flowmeters
- Flowrate dependence of the calibration factor

Use of a calibration rig developed at the University of Hull also allowed more detailed characterisation of flowmeter behaviour, including any 'non-symmetrical' performance and inter-flowmeter variability introduced by small manufacturing and assembly tolerances. This increased understanding is now being used to inform further product development at CJC Labs. Overall, the work has provided a better understanding of the in-service performance, especially in long-term usage and with live biological systems, that can be expected from this type of low-flow water-displacement meter. The results will allow CJC Labs to make recommendations on the frequency and duration of calibration runs and will also provide end-users with a referenceable calibration method backed up by substantial datasets subject to statistical analysis.

"The BIV project with CJC Labs has been interesting and practically valuable. It has provided us with an opportunity to apply scientific expertise to a real-world problem related to instrument accuracy and characterisation, which directly impact on our understanding of biological processes. The partnership has been a great example of how academic/industry collaboration can add value to a commercial offering".
Dr Mark Walker



Bioreactors with gas flow meters

"The BIV project has given CJC Labs the opportunity to make use of specialist knowledge and equipment that would otherwise be out of reach of a small company in a niche area. The planned research paper will allow public dissemination of knowledge essential to users of this type of flow meter and encourage its appropriate and accurate usage".
CJC Labs Ltd

PROJECT PARTNERS:
***Dr Mark Walker**, University of Hull*
***Dr Davide Poggio**, University of Sheffield*

CO_2 Biomethanation as an enabling process for carbon recycling and utilisation – critical review of gaps and opportunities for future scale-up in the UK

Biomethanation-CRU

INTRODUCTION

CO_2 Biomethanation is the biological conversion of carbon dioxide and hydrogen to biomethane via the action of hydrogenotrophic methanogens and can be used as part of a carbon capture and utilization scheme as shown in figure 1. In this work a biomethanation integration scenario was developed with four carbon intensive industries: cement, steel, distillery (for potable distilled spirits) and pulp and paper. For each, an exemplar **baseline** process was chosen, which was extended to produce a high-level design of the integration scenario. Relevant mass and energy flows were quantified based on reaction stoichiometry and literature data. Subsequently this data used to estimate the carbon footprint, using an approach summarized in figure 2, as well as additional costs, associated with the process integration only considering the differences between the **baseline** and **decarbonised** processes.

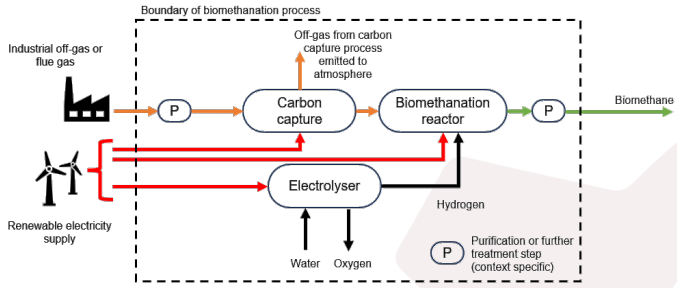


Figure 1. The biomethanation process.

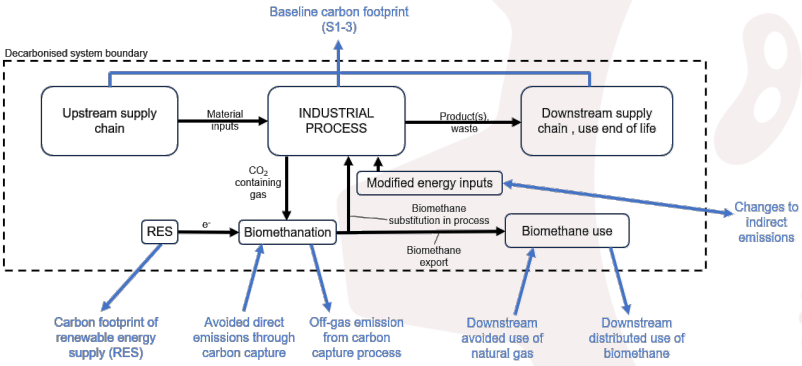


Figure 2. Generalised methodology for carbon footprint calculation.

RESULTS

For the other four industries considered, it was found that biomethanation can result in substantial decarbonisation, ranging from 0.70-2.87 tCO_{2e}/ $t_{product}$ as shown in figure 3. Where the carbon source was biogenic (pulp and paper, distillery) the decarbonisation replaced all direct fossil emissions with equivalent biogenic emissions. It was found to be critical to achieve decarbonisation that electricity be renewable and ideally to be from the lowest carbon options e.g. wind, solar.

The decarbonisation was mainly driven by the substitution of natural gas with biomethane, both in the industrial process and exported to downstream applications. For industries where the carbon source was biogenic (distillery, pulp and paper) this effect was more pronounced such that decarbonisation via biomethanation could be more effective than direct electrification (i.e. removal of direct fossil GHG emissions).

Economic assessment predicted significant increases in production cost for (+37-1070%) which , due to uncertainties involved, should be treated as indicative. Additional costs are dominated by hydrogen production which is predicted to remain high into the future even where curtailed electricity is targeted.

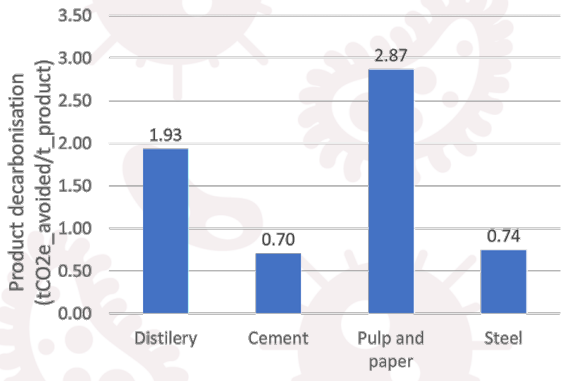


Figure 3. Product decarbonisation results for the four industries considered

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Ronak Shah, School of Business and Management (research assistant)
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Engineering and Physical Sciences Research Council
Biotechnology and Biological Sciences Research Council

Somebody's food: A social science approach to identify, discuss, and transform on-campus food waste behaviour.

INTRODUCTION

This project proposes a social science approach to create a generic process model designed for students residing in university campuses, accommodation managers, recycling companies, and other key stakeholders to identify, discuss, and transform on-campus food waste behaviour that:

- Reduces waste;
- Improves recycling rates; and
- Raises awareness about the environmental impacts around food production and food waste.

Using Royal Holloway as a case study, the main aim is to identify key drivers including institutional issues that influence students' behaviour surrounding food waste and to investigate the use of 'Nudge Theory' as well as 'Lean Systems Thinking' in conjunction with process modelling techniques to shift behaviour through positive reinforcement.

FOOD WASTE AUDIT

Waste from one of the self-catered student halls at Royal Holloway was analysed through several food audits. Mixed recycling largely contained items meant for recycling and the general waste bin had a high degree of cross-contamination. Unopened unexpired food packets and chocolates were found in it, along with recyclable items, hinting at possible lack of awareness as to correct disposal of aforementioned items. Across bins, incorrect garbage bags were used, again hinting at lack of access to recycling practices to be followed.

On average, there was a waste of **66 grams** per meal per student. This amount is higher than what has been measured in other campuses in other countries. (Leal-Filho et al, 2023):

- China: 30gr
- Nigeria: 42gr
- Portugal: 43 gr
- **Royal Holloway: 66gr**
- The US: 400grt

Leal Filho, W., Ribeiro, P. C. C., Setti, A. F. F., Azam, F. M. S., Abubakar, I. R., Castillo-Apraiz, J., ... & Borsari, B. (2023). Toward food waste reduction at universities. Environment, development and sustainability, 1-22.

> *"I find it easy to throw out food waste but still feel **guilty** when doing it…We **do not have a compost bin**…I like [going food shopping with friends] since it feels more like a fun trip…I bring my own food to campus because it is **cheape**r, and I know I will like it. I just order takeaways occasionally, as I want to lose weight…I have pasta most nights as I have always enjoyed it, it is **cheap and easy to cook**…I cooked quite a lot, so I had to share [the food] with my friend to prevent waste…I bought lunch from the food truck on campus…It is my favourite place because they give you the most food… which I feel is worth the money"*
>
> **(Excerpts from students' diaries, 2024)**

FOOD DIARIES

Student food diaries highlighted that many students were conscious about the importance of preventing food waste or appropriately recycling it. Several things could get in the way of good intentions:

- Busy schedules leading students to forget to use the food they buy to prepare
- Lack of and physical appeal of recycling facilities
- Takeaways as opportunities to socialise

PROJECT LEGACY

The internal project team continues sharing the campus vision and receiving valuable feedback. The campus is taking proactive action to reduce food waste. There are several initiatives that range from improving the planning and preparation of menus to providing continuous information and messaging to students and to support them. There are also initiatives to trial composting and on-site food growing.

More info at

https://www.royalholloway.ac.uk/research-and-education/departments-and-schools/business-and-management/somebodys-food-project/

Reference

Piadeh, F., Office, I., Behzadian, K, Rizzuto, J. P., Bywater, A., Córdoba-Pachón, J. R., Walker, M. A critical review for the impact of anaerobic digestion on the sustainable development goals. J. of Env. Man., 349 (2024) 119458,10.1016/j.jenvman.2023.119458

NEW BIOMETHANE:

Exploring future pathways and technologies for biomethane production beyond biogas upgrading

Preliminary Report of the EBNet workshop on novel and emerging sources of biomethane production

Jointly hosted by the Environmental Biotechnology Network working groups in Anaerobic Digestion, Anaerobic Fermentation, Bioelectrochemical Systems and Bioinformatics

The Leonardo Royal Hotel, Birmingham, 15-17th January 2025

Workshop participants
Angela Bywater, University of Southampton
Michael Chesshire, Lutra Ltd.
James Chong, University of York
Peter Coleman, DESNZ
Gavin Collins, University of Galway
George Fudge, WASE
Stefano Giacalone, BMA
Miao Guo, King's College London
Elizabeth Heidrich, Newcastle University
Lauren Hilton, Future Biogas Ltd
Ciara Keating, University of Durham
Richard Kershaw, Yorkshire Water
Chloe Langley, BBSRC
Joe Mann, AD Ingenuity LLP
Chris Moorin, Future Biogas Ltd.
Matt Reilly, University of York
Jhuma Sadhukhan, University of Surrey
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Assisted by:
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Cite as: EBNet, 2025. Preliminary Report of the EBNet workshop on novel and emerging sources of biomethane production. https://ebnet.ac.uk/resources/.

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UKRI Biotechnology and Biological Sciences Research Council
EBNet Environmental Biotechnology
UKRI Engineering and Physical Sciences Research Council

INTRODUCTION

On 15-17th January 2025 four EBNet Working Groups (WG) co-hosted a workshop bringing together key individuals in the field of novel biological pathways to produce 'New Biomethane'. The aim of the workshop was to assess new technologies and sources and put them in the context of national & international decarbonisation of energy and adjacent sectors. The event was attended by 20+ individuals with a range of backgrounds and expertise including representation from academia, industry, research funders and government.

WORKSHOP SCOPE

The scope of the workshop was defined to include the production of biomethane from novel or emerging processes and/or sources such as conversion of biomass through bioelectrical processes or CO2 biomethanation. This meant that conventional biogas upgrading (CO_2 scrubbing or removal from biogas), or production of methane/syngas from thermal biomass processing were outside of the scope. For the purpose of the workshop, mainly for convenience in terms of the scope, biomethane included any methane produced through a biological process, independent of the carbon source (i.e. biogenic or fossil).

WORKSHOP OVERVIEW

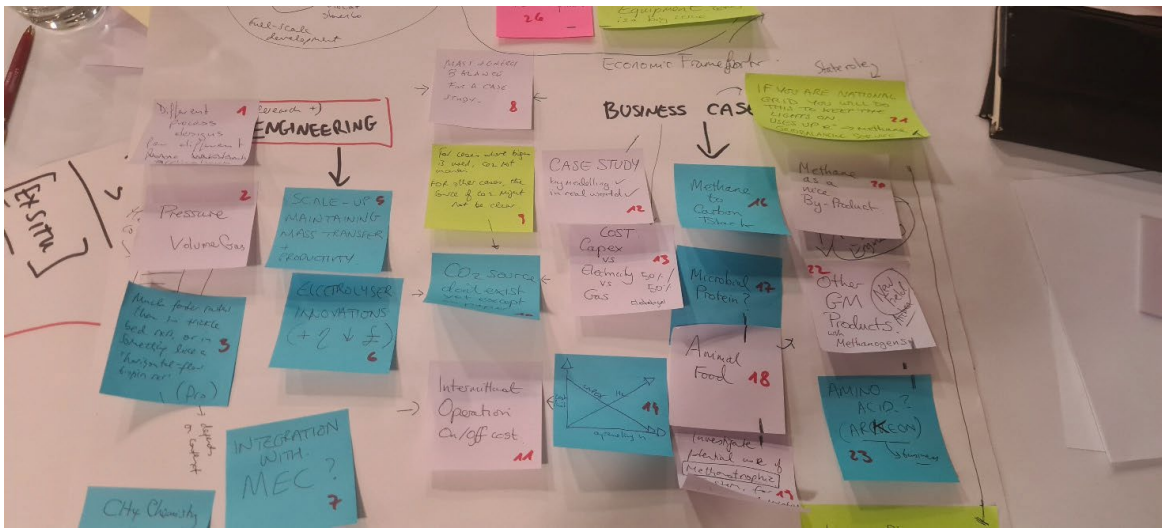
The workshop was structured into a number of sessions where table-groups of participants were set a series of collaborative tasks relating to the development of New Biomethane. The workshop agenda is provided in Appendix 1. Tasks generally required the production of schematic diagrams, and these were photographed to record the workshop outputs. To record individual views on these diagrams, a voting system using colour 'dots' was used to express characteristics such as 'most/least important' 'unclear/needing more explanation' etc., which were also recorded as part of the workshop outputs.

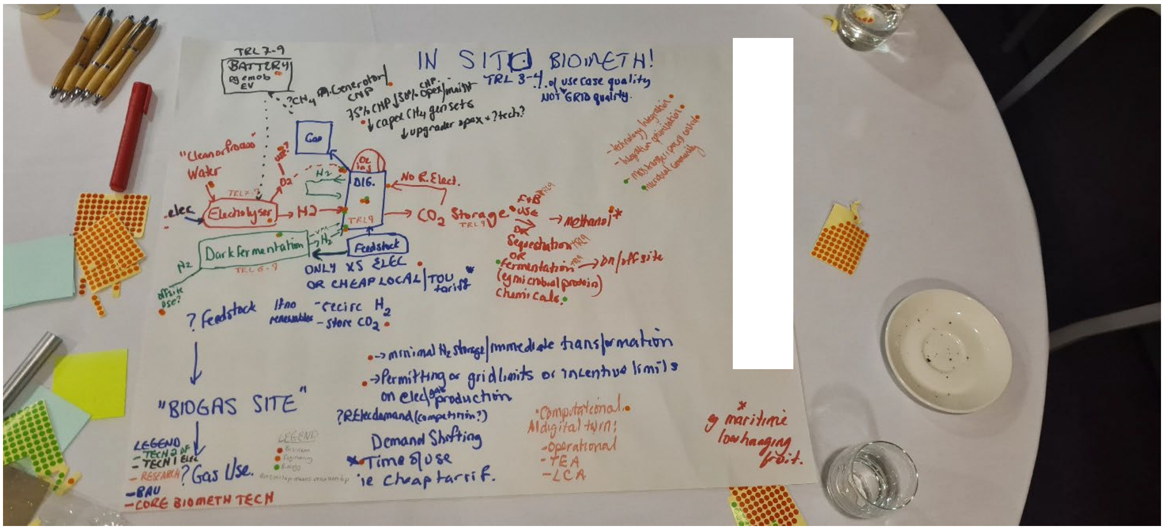
Examples of the diagrams produced during the workshop are shown in Appendix 1. These will be analysed, digitized and summarised in the final report of the workshop. In addition, subsets of the data will be presented at conference(s) including the upcoming Carbon Recycling Network Conference on 10-12th March 2025. Outputs will also be used as the basis for a strategy document for circulation to relevant bodies and individuals (e.g. funding agencies and government and regulatory bodies), and will include technology development roadmaps, systemic integration opportunities and impacts of at-scale deployment of the chosen technologies.

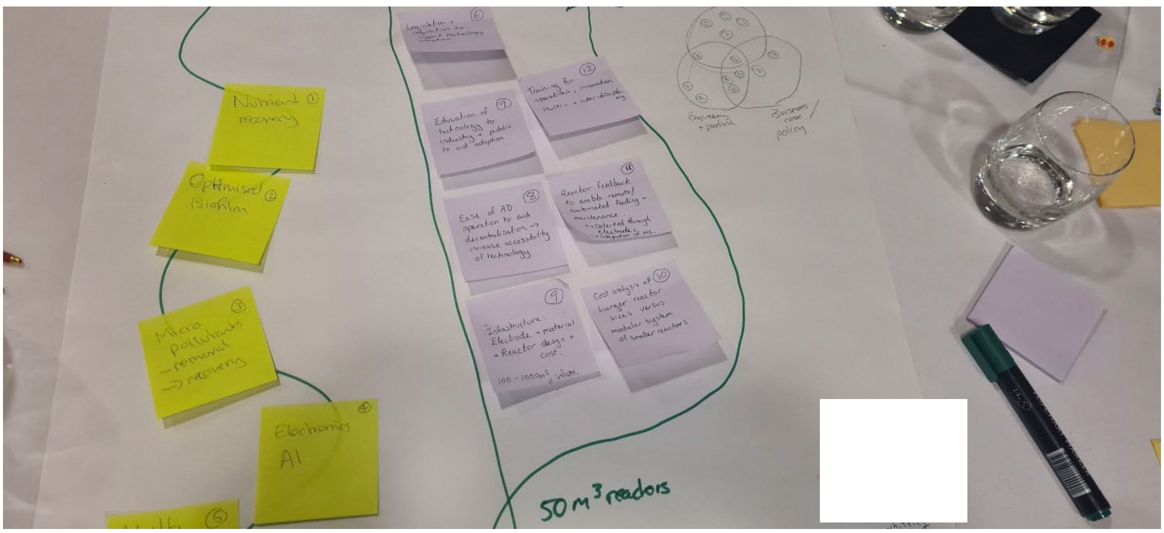
APPENDIX 1 – WORKSHOP AGENDA

Date	Time	Activity
15/01/2025	1200	Lunch and registration
	1330	Session 1 - Workshop scope and participant introductions
	1500	Break
	1530	Session 1 - Extended introductions
	1700	End of Day 1
	1900	Dinner
16/01/2025	0930	Session 2 - Technological pathways and innovation requirements (Task 1)
	1100	Break
	1130	Session 2 - Technological pathways and innovation requirements (Task 2)
	1300	Lunch
	1400	Session 3 - R&D/innovation pathways (Task 3)
	1530	Break
	1600	Session 3 - R&D/innovation pathways (Task 4)
	1730	End of Day 2
	1900	Dinner
17/01/2025	0930	Session 5 - Stakeholders and applications (Task 5)
	1045	Break
	1100	Session 5 - Stakeholders and applications (Task 5)
	1130	Group discussion and summary of next steps
	1200	Lunch

APPENDIX 2 – SELECTED EXAMPLES OF RAW WORKSHOP OUTPUTS (Individual's names are redacted)




IN SITU BIOMETH!
TRL 7-9
BATTERY
Gas
DIG.
Electrolyser
Dark fermentation
Feedstock
No R.Elect.
Storage
Methanol
ONLY XS ELEC
OR CHEAP LOCAL
? Feedstock
"BIOGAS SITE"
LEGEND
-BAU
-CORE BIOMETH TECH
? Gas Use.
Demand Shifting
Time of use
ie cheap tarrif.
-Operational
-TEA
-LCA
maritime
low hanging fruit.


Nutrient recovery
Optimised biofilm
Micro pollutants
removal
→ recovery
Electronics
AI
50 m³ reactors


TRL
MEC
BBSRC
NERC
EPSC
EU FUNDING
MARKET RESEARCH
INNOVATE UK
OFFWAT
UKWIR
VCT
PRIVATE INVESTMENT FUNDS
Finance £
Societies
DESNZ
DSIT
DEFRA
Environment Agency
HSCE
Regulations + LEGISLATION
ACADEMIA
INDUSTRY Pilot Trials
KTP
TRADE SHOWS
R+D
Customer
TRL 1-9

Opportunities in Biogas – a IEA Task 37 perspective

Webinar Wed 5 March 13-14:00 UK time

This webinar includes a general introduction to IEA Bioenergy's Task 37, its outputs and work programmes, and an example of a recent study highlighting application of anaerobic digestion in the food and beverage sector.

IEA Bioenergy
Technology Collaboration Programme

Dr-Ing Jan Liebetrau is current Task 37 Lead and General Manager at Rytec GmbH, Germany . His main expertise is in project development and feasibility studies of AD processes and landfill gas collection and treatment plants, methane emissions from biogas plants and landfill operations and management of research activities. Special focus is on biological methane oxidation.

Bernhard Drosg, Dipl-Ing Dr Is Head of the Research Area 'Biochemical Technologies' at BEST - Bioenergy and Sustainable Technologies GmbH and Senior Scientist at BOKU University of Vienna, Austria. He has represented Austria in IEA Bioenergy Task 37 since 2010 and has 17 years of experience in biogas research and development.

Session chaired by

Andrew Brown, Technical Support Manager at Anaerobic Digestion and Bioresources Association (ADBA).

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ADBA Anaerobic Digestion and Bioresources Association

Joining information

Register on Eventbrite

Or sign up via EBNet's Anaerobic Digestion Working Group led by Dr Mark Walker, University of Hull

IEA Bioenergy Task 37 'Energy from Biogas'

Task 37 is an international working group which covers AD of biomass feedstocks including agricultural residues (e.g. manure and crop residues), energy crops, organic-rich waste waters, the organic fraction of municipal of solid waste (OFMSW) and industrial organic wastes. Task 37 addresses the whole biogas production chain from feedstock collection and pretreatment to biogas upgrading, biofertiliser application and process chain sustainability.
https://task37.ieabioenergy.com

Anaerobic Digestion and Bioresources Association

ADBA was established in September 2009 to represent the UK's AD and bioresources industry. Today it represents over 300 organisations, spanning AD operators, equipment suppliers, finance specialists, farmers, academics, waste management companies, gas distribution networks and more specialisms. Through lobbying activities, meetings with government officials, working groups, high profile industry events, educational material and more, ADBA aims to facilitate the AD industry's growth.
https://adbioresources.org

Environmental Biotechnology Network

EBNet is one of six Phase II Networks in Industrial Biotechnology and Bioenergy (NIBBs) set up in 2019 with support from the UK's Biology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences (EPSRC). Its strategic aim is to bring together natural and social scientists and engineers to move discovery science towards practical application in creating and optimising engineered microbial systems for environmental protection, bioremediation and resource recovery.
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