

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 CO₂ 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.

Activity Synopsis

This highly active WG benefited from the legacy of the earlier BBSRC-funded Anaerobic Digestion Network ([ADNet](#)), with many EBNet members involved in this field.

WG members carried out a wide range of activities nationally and internationally, including presentations at a workshop in Alaska on [Renewable energy from AD in remote and off-grid applications](#), hosted by the National Renewable Energy Laboratory (NREL); involvement in IEA Bioenergy Task 37 [initiatives](#); and participation in numerous [conferences](#) and [events](#). Network co-Manager Angela Bywater also provided active links to the UK's Anaerobic Digestion and Bioresources Association ([ADBA](#)), and to various related committees and working groups.



The WG hosted five webinars with leading international speakers, two of them jointly promoted with other NIBBS; one organised by the Water Biofilms WG in conjunction with the National Biofilms Innovation Centre ([NBIC](#)); and one with IEA Bioenergy [Task 37](#) and ADBA.

ACTIVITY SYNOPSIS ctd

Webinar [Advances in Anaerobic Membrane Bioreactors](#)

Webinar [Granular Activated Carbon Biofilms for Biomethanation from Wastewater](#) led by [WB WG](#)

Webinar [CO₂ 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](#)

EBNet funded two Proof-of-concept (POC) projects and four Business Interaction Vouchers (BIV):
POC202112 [Real-time monitoring of Anaerobic Digestion microbial community as a foaming risk prediction method](#)

POC202207 [Pure biomethane – rather than biogas – from a single waste stream](#)

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 an [assessment](#) of CO₂ Biomethanation as an enabling process for carbon recycling, funded by the Carbon Recycling Network with additional support from EBNet; and a small [study](#) on Food waste in conjunction with Royal Holloway College. Other highlighted work with external organisations includes support and contributions to the RASE [Farm of the Future Report](#), a DESNZ workshop on [Residual Biogas Measurement](#) as a potential tool for emissions estimation, IFEAA reports on [On-farm AD and methane capture](#); and various 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 in collaboration with three other EBNet WGs.

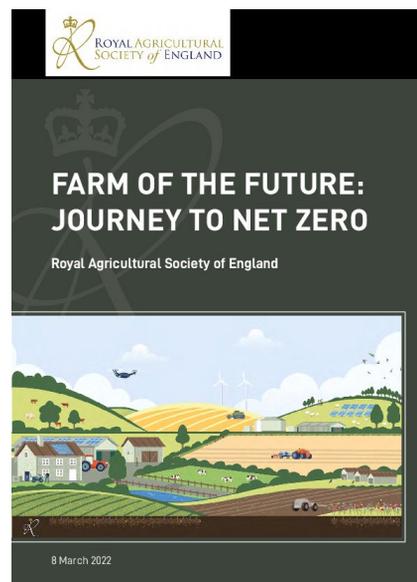
AD was the most frequent topic at ECR events, and the Network funded four international [Travel Bursaries](#) for ECR from Leeds, Cranfield, Surrey and Newcastle, as well as UK conferences and a placement. Outreach included 10 'EBNet Corner' [articles](#) in ADBA's twice-yearly magazine with Angela Bywater as co-ordinating author.

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 UK](#). *Processes*, 10(6), p.1202.

For more information see the WG [Webpage](#), [News](#) tag and YouTube [Playlist](#)





Dr Dana Ofiteru
Newcastle University
POC202112



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 CO₂, 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 concern 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



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 CO₂. 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 CO₂.

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-CH₄ in one compartment and bio-CO₂ 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 CO₂ 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.

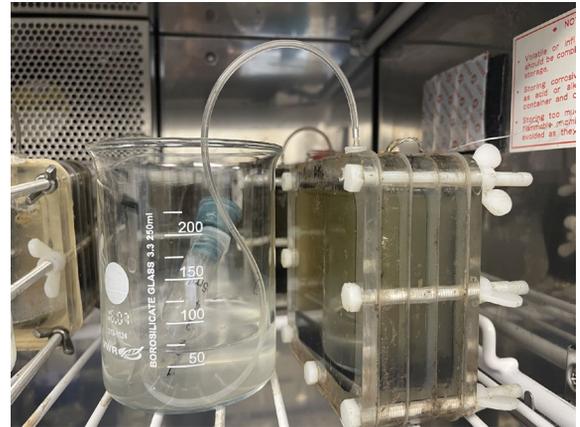


Fig.1. MEC-AD reactor set-up. Top: Stand-alone AD reactor with tubing to collect methane. Bottom: MEC-AD reactor separated by a CEM membrane with tubing to collect gas from the AD side and connected to a Pico logger for voltage measurement.



“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 methane production technologies.”

- Dr Elizabeth Heidrich, Newcastle University



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

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



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

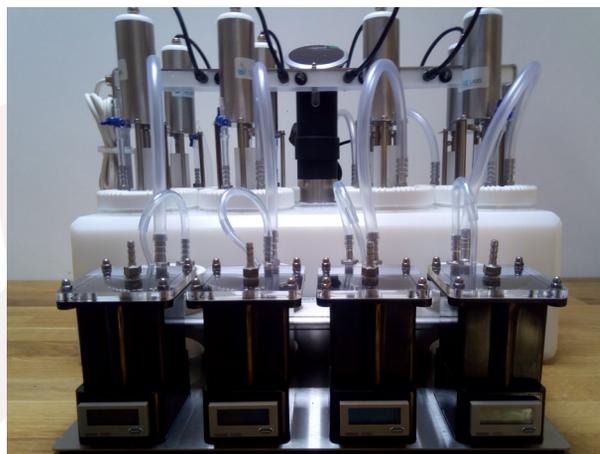
The results of the work are being incorporated into advice and support offered to CJC Labs' customers on use of the flowmeters. Useful insights include:

- 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



CO₂ 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

CO₂ 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.

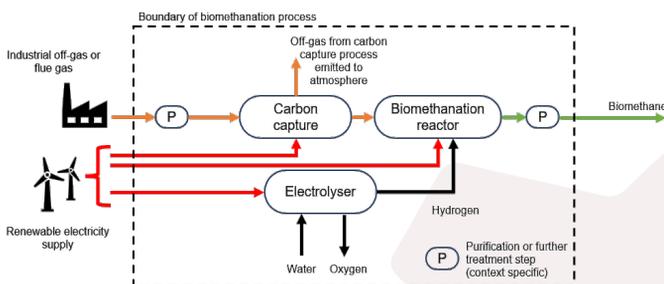


Figure 1. The biomethanation process.

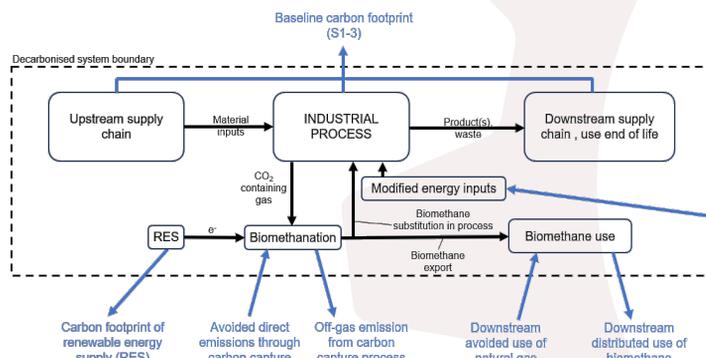


Figure 2. Generalised methodology for carbon footprint calculation.

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.

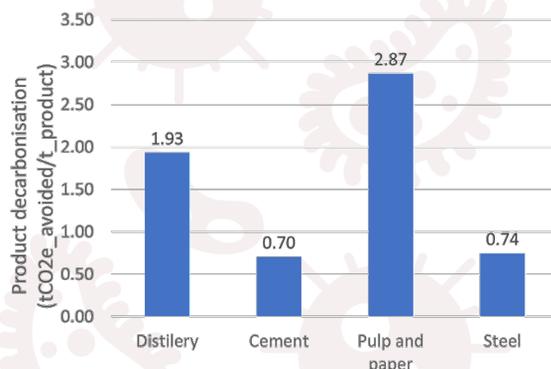


Figure 3. Product decarbonisation results for the four industries considered



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-Apráiz, 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 **cheaper**, 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](https://doi.org/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
Arne Seifert, Krajete GmbH
Mark Walker, University of Hull
Dyon Whiteley, WASE
Dr Yue Zhang, University of Southampton

Also contributing

Yadira Bajon-Fernandez Cranfield University
Sonia Heaven, University of Southampton

Workshop Facilitator

Mark Walker, University of Hull

Assisted by:

Louise Byfield, EBNet

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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Biotechnology and
Biological Sciences
Research Council



EBNet
Environmental Biotechnology



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 (CO₂ 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

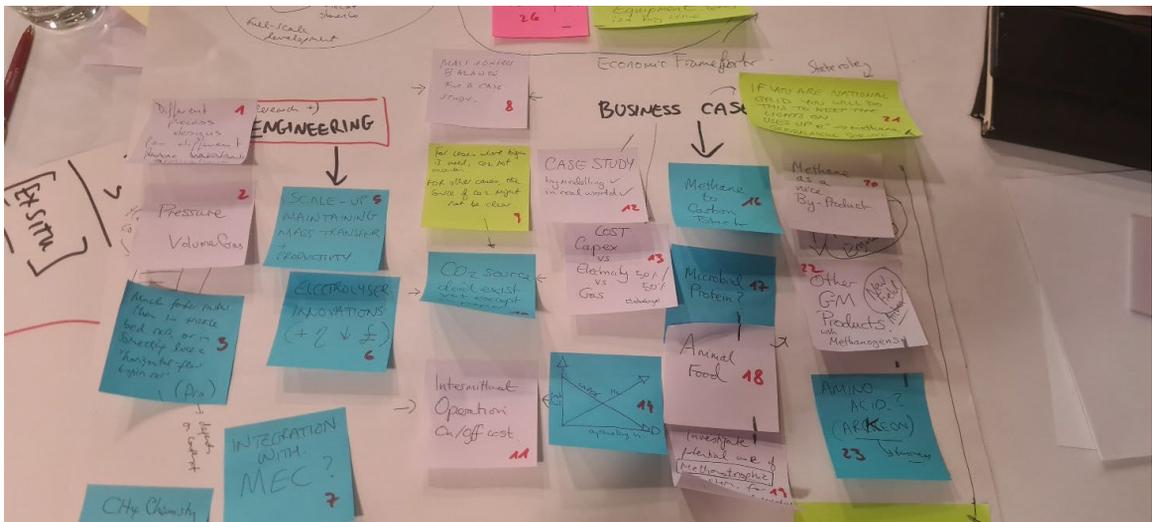
The workshop was structured into a number of sessions where table-groups of participants were set a series of collaborative tasks relating to the development of New Biomethane. The workshop agenda is provided in Appendix 1. Tasks generally required the production of schematic diagrams, and these were 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)



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 Drosig, 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 Bioreources Association (ADBA).

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. <https://ebnet.ac.uk/>

‘I am an Environmental Biotechnologist because...’

Selected examples from EBNet ECR Conferences in 2023 and 2024

I am an environmental biotechnologist because my research focuses on anaerobic digestion of organic wastes to produce biogas and bio-fertilizer. I am optimising dry AD of high-solid organic wastes by engineering percolate composition.

Nnenna Chukwuekezie, Cranfield University

I am an environmental biotechnologist because I believe that leveraging microbial technologies can provide sustainable solutions for critical environmental issues, ultimately contributing to a cleaner and healthier planet.

Obaidullah Mohiuddin, Newcastle University

My project is focused on the experimental and modelling evaluation of biochar effects on anaerobic digestion of food waste and biomethanation of hydrogen. As a researcher, I hope that I can contribute to the future clean energy by improving biogas production yields and methane content, and more stable anaerobic digestion process.

Wenjun Peng, University of Sheffield

I am an early career researcher, working in a chemical engineering department on biohydrogen production from food waste. My main focus is on pretreatment of food waste to enhance the biohydrogen yield. Thus, trying to pave a way to minimise landfilling and associated environmental pollution to maintain sustainability.

Ardasha Pradhan, University of Bath

I am an environmental biotechnologist because of the role microbes currently play in waste disposal, and the role they can play in a more sustainable world. Whereas waste disposal is currently a net source of GHG emissions, there is scope to optimise operations and become a net sink by displacing fossil-based fuels and fertilisers.

Zachary Thompson, Newcastle University

My work is primarily devoted to biomass conversion through biochemical and thermochemical methods. Due to ever-increasing waste production along with population growth, it is better to use biomass to decrease the amount of waste and increase energy production.

Arian Shabruhi Mishamandani, University of Huddersfield

I am an environmental Biotechnologist because some of the most environmentally beneficial and cost-effective solutions come through utilising living systems.

Nicholas Davison, University of Reading

I am a biotechnologist working on waste to energy. I have experience on agricultural waste conversion into bioalcohols and platform chemicals. I am also working on biogas through anaerobic digestion.

Ali Nawaz, University of Huddersfield

'I am an Environmental Biotechnologist because...'

Selected examples from EBNet ECR Conferences in 2023 and 2024

I am an environmental biotechnologist because I have a passion for renewable energy solutions. My focus lies in Anaerobic Digestion Modelling and Control, as I firmly believe in the transformative potential of this alternative energy source to enhance our world.

Benaissa Dekhici, University of Surrey

I am aiming to reduce the environmental impact of land spread poultry litter by using anaerobic digestion, ammonia side stream stripping and electrocoagulation to aggregate nitrogen, phosphates and potassium into a stable, bioavailable fertiliser.

Deborah Hall, Harper Adams University

I am an environmental biotechnologist because I care about a liveable world for our children and grandchildren.

Amin Zarei, University of Surrey

I work with environmental bacteria for sustainable and scalable outputs. Sometimes the environment itself has the solution, we just need to look thoughtfully!

Manpreet Bagga, Newcastle University

My research is focussed on anaerobic digestion modelling to help develop a surrogate model which captures the synergistic effects of feedstocks by incorporating microbial communities and applying data driven approaches for control. This will result in developing a tool for AD sites via the AI for Net-zero project to use with key decision making while considering a balance between profits and emission reductions.

Rohit Murali, University of Surrey

I am an environmental biotechnologist because I am passionate about leveraging biotechnology to address pressing environmental challenges. With a focus on sustainable solutions, my work aims to innovate and optimize biological processes for cleaner water, efficient waste treatment, and a healthier planet. By integrating engineering principles with biotechnological advancements, I strive to contribute to a greener, more sustainable future.

Yasmine Aissaoui, University of Southampton

I am a doctoral researcher, focusing on unlocking the potential of high lignocellulosic biomass to generate renewable energy through anaerobic digestion. My research also involves the use of novel microbubble plasma pretreatment technology to enhance biogas production. I am passionate about developing innovative and sustainable methods for harnessing biomass's energy potential, contributing to the transition to a greener future, and combining engineering principles with environmental awareness to address global challenges such as energy security and climate change, ultimately achieving the net zero target.

Pranesh Kannappan Karthikeyan, Loughborough University



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Cite as: EBNet, 2026. Anaerobic Digestion WG Report.
Environmental Biotechnology Network.
<https://ebnet.ac.uk/wg-details/wg-ad/>

For more information see the WG [News](#) tag and YouTube [Playlist](#)

