EBNet
Environmental Biotechnology

UKRI Engineering and Physical Sciences Research Council

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ENVIRONMENTAL BIOTECHNOLOGY NETWORK

AI and ML in the Bioeconomy WG

AI & ML in the Bioeconomy (AI&ML WG)


Led by Dr Oliver Fisher and Prof Rachel Gomes, University of Nottingham

The bioeconomy continues to grow, offering an alternative to fossil resources and facilitating the transition to net zero, circular economy and/or industrial symbiosis. However, bioprocesses have complex dynamics and are subject to disturbances, which makes modelling them challenging yet necessary for process understanding, model-based optimisation and scale-up. This is further compounded when utilising waste-based feedstocks, which have variable composition and characteristics in time and space. Artificial intelligence (AI) and machine learning (ML) represent solutions for tackling emerging challenges in bioprocesses, such as resource specification and availability, parameter dimensionality, nonlinearity, risk mitigation, and complex metabolisms. Multivariate data analysis, deep learning, reinforcement learning, and other novel machine learning techniques start to complement and replace traditional data analysis approaches to accelerate bioprocess development and application.

As AI and ML are increasingly deployed within the bioeconomy, it is important to understand the social impact of their use. This WG also aimed to understand the equality, diversity and inclusion considerations of using AI and ML to progress bioprocesses development and application.

ACTIVITY SYNOPSIS

This WG ran a very popular webinar in early 2024: *Unlocking AI and Machine Learning's Potential for Environmental Biotechnology*, which led directly to a Perspectives paper co-authored by the WG Leads and presenters. Group members also worked on the £1.4M EPSRC grant on *Artificial Intelligence Enabling Future Optimal Flexible Biogas Production for Net-Zero* led by the University of Surrey. Several publications ensued, including joint papers with members of the Process Integration & Sustainability Assessment (PISA) WG. Stakeholder inputs from activities with the PISA and AD WGs are now being taken forward by the BiofuelAi start-up incubated at the University of Surrey

WG Publications

Breaking barriers to modelling biotechnologies with machine learning
Fisher, O. J., Short, M., Zhang, D., Guo, M., & Gomes, R. L. (2025). Resources, Conservation and Recycling, 215, Article 108071. https://doi.org/10.1016/j.resconrec.2024.108071

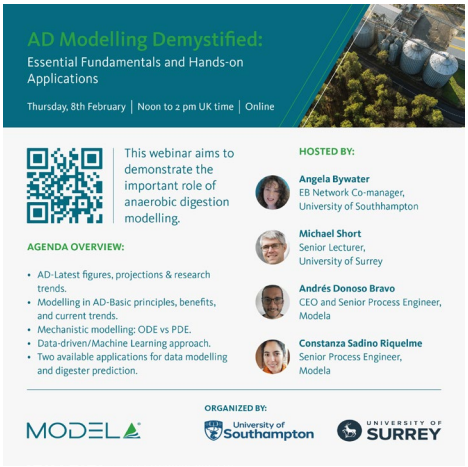
Anaerobic digestion site-wide optimisation and decision-making: An industrial perspective and review
Murali, R., Bywater, A., Dolat, M., Dekhici, B., Zarei, M., Hilton, L., Sadhukhan, J., Zhang, D. and Short, M., 2026. Renewable and Sustainable Energy Reviews, 226, p.116402.

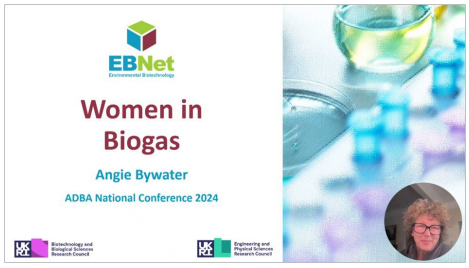
ACTIVITY SYNOPSIS ctd

EBNet Network co-Manager Angela Bywater gave a presentation on demystifying AD modelling, in conjunction with the AI4AD project.

Outreach activities include a publication in the Anaerobic Digestion and Bioresources Association magazine: **Get Ready for the AI Boost**, by Angela Bywater, AD & Bioresources News, Issue 58, Winter 2024, extracted *here*.

And *not* a direct WG output but, for a bit of fun which nevertheless has a real point, see a **post** and **short video** on AI, AD and EDI…





WG Publications ctd

Publications by WG members involved in the AI4AD project

Dynamic feed scheduling for optimised anaerobic digestion: An optimisation approach for better decision-making to enhance revenue and environmental benefits. Dolat, M., Murali, R., Zarei, M., Zhang, R., Pincam, T., Liu, Y.Q., Sadhukhan, J., Bywater, A. and Short, M., 2024. *Digital Chemical Engineering*, *13*, p.100191.

Optimal feed scheduling and co-digestion for anaerobic digestion sites with dynamic demands. Dolat, M., Murali, R., Zhang, R., Zarei, M., Zhang, D., Zhang, D., Sadhukhan, J. and Short, M., 2024. In Computer Aided Chemical Engineering (Vol. 53, pp. 1705-1710).

Novel Life Cycle GHG Formulations of Anaerobic Digestion Systems Aligned with Policy
By: Zhang, R., Sadhukhan, J., Zhang, D., Short, M., McKechnie, J., Liu, Y., Bywater, A., Murali, R., Dolat, M., Zhang, D. and Zarei, M. http://dx.doi.org/10.2139/ssrn.4837715

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‘I am an Environmental Biotechnologist because...’

Selected examples from EBNet ECR Conferences in 2023 and 2024

My research is focussed on anaerobic digestion, helping to 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 via the AI for Net-zero project for AD sites 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 care about a liveable world for our children and grandchildren.

Amin Zarei, University of Surrey

I am an environmental biotechnologist because I have a passion for renewable energy solutions. My focus lies in Anaerobic Digestion Modeling 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 simulating and optimising integrated recovery process systems via computational modelling and mathematical optimisation.

Yiying He, King's College London

I am a doctoral researcher and my primary focus revolves around monitoring and evaluating the effectiveness of wetlands in treating stormwater. I will use sensors for monitoring and hybrid models and digital twinning for evaluation. My research aims to understand the complex interplay between factors affecting wetlands performance, ultimately aiming to enhance their operational efficiency.

Chinedu Ekechukwu, University of the West of England

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.

Uzma Uzma, University of Glasgow

Computer scientist, machine learning and applied AI for earth observation and monitoring. My topic is AI-Enhanced Remote Sensing for Monitoring Water Quality and Anthropogenic Impact.

Vasudha Darbari, University of Hull

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https://ebnet.ac.uk/wg-details/wg-ai-ml/

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