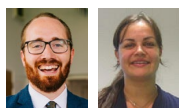


ENVIRONMENTAL BIOTECHNOLOGY NETWORK

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](#)

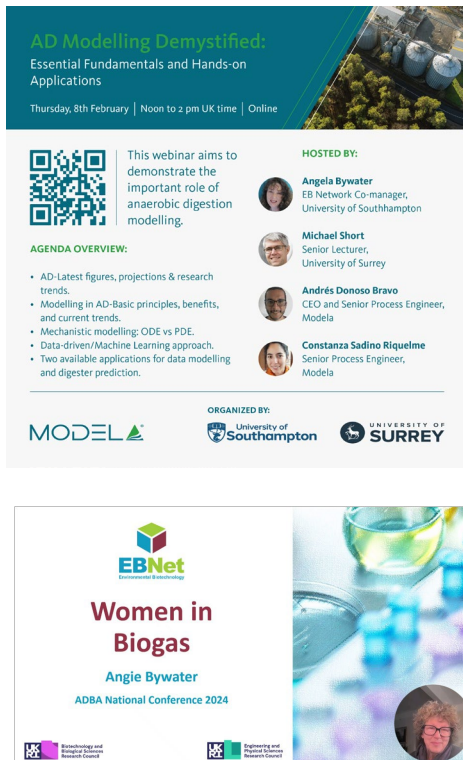
Murali, R., Bywater, A., Dolat, M., Dekhici, B., Zarei, M., Hilton, L., Sadhukhan, J., Zhang, D. and Short, M., 2026. Renewable and Sustainable Energy Reviews, 226, p.116402.

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...



AD Modelling Demystified:
Essential Fundamentals and Hands-on Applications

Thursday, 8th February | Noon to 2 pm UK time | Online

This webinar aims to demonstrate the important role of anaerobic digestion modelling.




HOSTED BY:

- Angela Bywater**
EB Network Co-manager,
University of Southampton
- Michael Short**
Senior Lecturer,
University of Surrey
- Andrés Donoso Bravo**
CEO and Senior Process Engineer,
Modela
- Constanza Sadino Riquelme**
Senior Process Engineer,
Modela

AGENDA OVERVIEW:

- AD-Latest figures, projections & research trends.
- Modelling in AD-Basic principles, benefits, and current trends.
- Mechanistic modelling: ODE vs PDE.
- Data-driven/Machine Learning approach.
- Two available applications for data modelling and digester prediction.

ORGANIZED BY:



MODEL  UNIVERSITY OF SOUTHAMPTON  UNIVERSITY OF SURREY 

EBNet
Environmental Biotechnology

Women in Biogas

Angie Bywater

ADBA National Conference 2024



EB-Net Corner: AI

GET READY FOR THE AI BOOST

From fintech to farming, healthcare to energy, all corners of the economy are celebrating the boost to productivity secured through AI-driven efficiencies. Biogas production will be a big winner too, writes **Angela Bywater**.

Artificial intelligence (AI) and machine learning (ML) are technologies that have revolutionised how we interact with data and processes in various industries. In essence, they are tools or systems used to automate, enhance, and optimise processes across industries. AI refers to the simulation of human intelligence in machines, enabling them to perform tasks like decision-making, speech recognition and problem-solving. Siri, Alexa and ChatGPT are all examples of generative AI.

ML is a subset of AI. ML involves algorithms that allow systems to learn from data and improve their performance over time without human intervention or programming. Combined, these technologies are transforming all aspects of the economy from fintech to farming, healthcare to energy by improving efficiency, accuracy and adaptability.

Integration into Supervisory Control and Data Acquisition (SCADA) systems for anaerobic digesters is an obvious use for AI and ML. Traditionally, SCADA systems are used to monitor and control the operational parameters of anaerobic digesters, such as temperature, pressure and biogas output. The integration of AI and ML could greatly enhance the capabilities of these systems in a number of ways.

- 1. Predictive Maintenance** AI and ML could be used to analyse data from sensors within the digester to predict when maintenance is required, reducing the risk of unexpected failures or breakdowns. By identifying patterns that indicate wear or degradation in system components, these technologies can help operators schedule maintenance proactively, avoiding costly and unexpected downtime. Conversely, AI can identify anomalies in the data that might indicate sensor malfunctions or unexpected system behaviours, alerting operators before minor issues escalate into larger problems.
- 2. Optimisation of Biogas Production** Algorithms could be used to continuously analyse real-time data from the SCADA system to optimise digester performance. For instance, ML models are programmed to learn from historical data and adjust operational parameters (e.g., feedstock composition, retention time, temperature) to maximise biogas production while minimising waste.
- 3. Feedstock Management** AI could help in the selection and management of feedstocks by predicting the most efficient combinations of organic waste materials for biogas production. Furthermore, these algorithms can factor in other considerations such as feedstock variability, environmental conditions, seasonal availability, cost and nutrient composition to suggest the best feedstock strategies, sensitive to local circumstances, including digester off-gas. The system could adjust control and inventory management strategies to ensure optimal performance without human intervention.
- 4. Process Stability and Control** If the correct data is available, AI-driven SCADA systems could monitor the biological processes inside the digester and provide early warnings about potential process instability, such as acidification or accumulation of inhibitors. ML models can also help to understand and relate the complex biological interactions between microorganisms to performance and improve system predictability, allowing for stable and efficient biogas production.
- 5. Energy Management** AI and ML models could be used to forecast energy demand and biogas production to optimise the balance between energy generation and consumption. By predicting future energy prices and demand, AI can help adjust operations to maximise profitability and/or to align with grid requirements.

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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>

'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 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 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 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

I am simulating and optimising integrated recovery process systems via computational modelling and mathematical optimisation.

Yiyang He, King's College London

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/>

