European Biosolids & Bioresources Conference & Exhibition

Report for the Working Group: Biochars for Pollution Prevention

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In Brief

I recently represented the Environmental Biotechnology Network's 'Biochar' Working Group (BWG) at the annual European Biosolids & Bioresources Conference & Exhibition (https://european-biosolids.com). The conference took place on 19-20 November 2024 in Manchester. It covered a broad range of topics, within the fields of biosolids management, circular economy, advanced thermal conversation (ATC) technologies and biochar, with more than 300 attendees from the bioresource and biowaste processing sector (both industry and academia) from Europe, North America, Australia and Asia. My main interest was to capture progress in the water sector related to ATC and biochar production, and applications for different purposes. Biochar is recognised as a greenhouse gas removal technology and it has been suggested that application of biochar to agricultural soils may provide agronomic benefits alongside carbon sequestration.

The benefits of this Conference for EBNet cannot be overstated. I strongly believe that this conference helped me and EBNet to develop new links and collaborations with researchers and industry representatives worldwide, facilitating broader benefits to the wider EBNet community. The conference summarised much of the ongoing UK research in the field of ATC technology and biochar, and the general conclusion was that immense progress had been achieved in the past few years, and that industry/stakeholders are keen to implement ATC within their biosolid management. Additionally, biochar is gaining momentum in the UK, which is reflected through its implementation not only as a soil amendment but as an adsorbent in water treatment, and its use in construction/building materials..

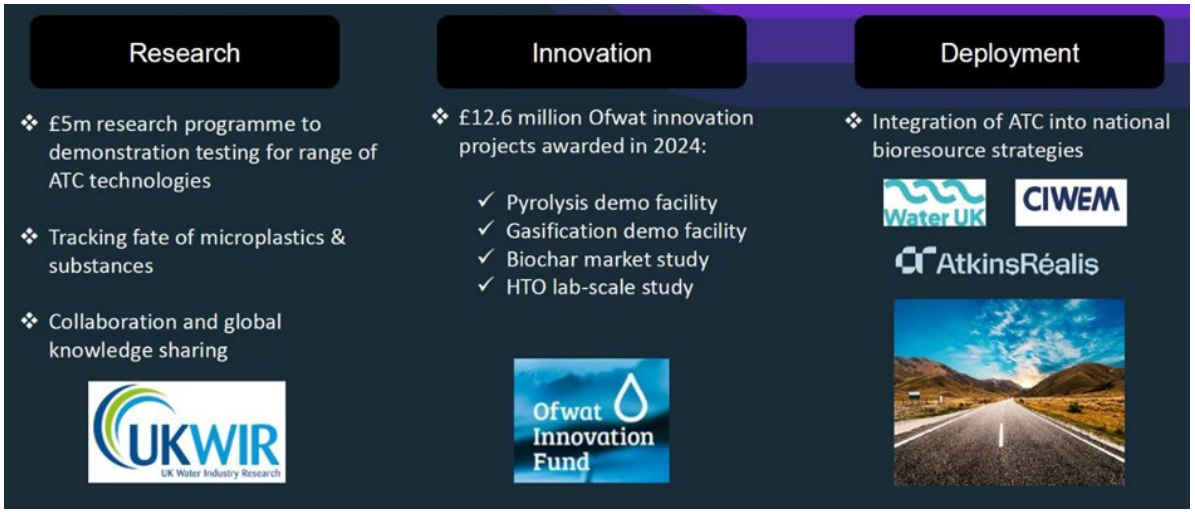

Figure 1. UK outlook for ATC and biochar (source: Stephen Riches, Atkins Réalis)

The conference content has also informed and acted as a preparatory base for the Biochar WG joint workshop which explores how thermal, thermochemical, and biological conversion technologies may be integrated to improve environmental and economic outcomes within waste and biomass valorisation processes.

Main Takeaways (1)

During the two-day conference, the following key points were noted:

FIDRA stated that current agricultural use of biosolids is not managed in an entirely safe and environmentally beneficial way. UK and EU regulations must be updated urgently. Biosolids are expensive to handle/destroy, regulations are tightening, and there is too much volume. One major concern related to the fate of persistent organic pollutants such as flame retardants (PFAS and PFOS) and microplastics. Up- and down-stream biosolids solutions were required, with ongoing commitments to invest in research and innovative new technologies which will achieve safe and clean biosolids or products from it (i.e., biochar). ATC technologies were one of the major topics discussed throughout the conference.

Oda Svennevik from VOW (world-leading Norwegian company in biomass and waste conversion) concluded that pyrolysis without anaerobic digestion (AD) represents the most eco-friendly treatment for biosolids because of its climate change benefits, C-storage (through biochar), energy benefits and potential to reduce contaminants and ecotoxicological impacts. It was highlighted that pyrolysis ≥ 600 °C decomposed flame retardants and that a biochar can also act as an effective PFAS sorbent. Findings are published in the following papers:

- *Sewage sludge biochars as effective PFAS-sorbents* By Katinka M. Krahn *et al*. In Journal of Hazardous Materials. Volume 445, 5 March 2023, 130449.
- *Eco-toxicological and climate change effects of sludge thermal treatments: Pathways towards zero pollution and negative emissions* By Marjorie Morales *et al*. In Journal of Hazardous Materials. Volume 470, 15 May 2024, 134242.

Bill Barber from CAMBI (leading global provider of thermal hydrolysis solutions for biosolids and organic waste management) challenged the ATC processes for their high energy demand and carbon footprint and stated that direct land application of sludge cake from thermal hydrolysis had multiple environmental benefits, including increased digester throughput, boosted biogas production, and minimal waste and operational costs. Also, he highlighted that by moving away from land application, the intrinsic value of biosolids is lost. An interesting point was raised during the discussion, namely that PFAS does indeed pose health concerns in drinking water, however, PFAS in biosolids is very low (when compared to other everyday materials such as food containers, paper products, carpets, sports equipment, electronic components, etc.) and therefore, the strong focus on PFAS in biosolids is unjustified.

The FIREFLY project (funded by the OFWAT Innovation catalyst) outlined the potential use of biosolids for simultaneous aviation fuel and biochar production using hydrothermal liquefaction (HTL). The process successfully reduced PFAS levels in the produced biochar.

Christian Wieth from AquaGreen (a Danish engineering company, specialising in biosolid pyrolysis) made an interesting statement about biosolid-based biochar production costs. Alongside the rapid evolution of pyrolysis units in the past few years (which has driven production costs down), if biochar is used for water treatment (e.g., PFAS removal from water through filtration), further cost reductions could be achieved because biochar could replace expensive activated carbons (which can cost up to £4000/tonne). This could lower the effective 'cost' of biochar production 10-fold.

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Main Takeaways (2)

Ross Wilson from Scottish Water and Grant Hemple from Atkins Réalis presented data on the new Alloa based Resource Recovery Facility operated by Scottish Water. The facility aims to ask if new technologies can be retrofitted to WWTPs and will assess the benefits, impacts and market for the recovered resources. The facility focuses on 5 different materials/technologies.

- Screenings – project with Carbogenics (pyrolysis to biochar).
- Grit – project with Brewster Brothers (no technical intervention required).
- Cellulose – project with Purgatoria and Icabus (fermentation to green chemicals).
- Algae – project with Greenskill Environmental Technology and James Hutton Institute (photobioreactor for algae production).
- Biocrude Oil – project with Circlia (HTL technology) and Strathclyde University.

The Microplastics & Advanced Thermal Conversion Project also presented. This project is part of the Chemical Investigations Programme (CIP) and is funded by UK water and sewage companies. CIP is administered by UK Water Industry Research (UKWIR), which is responsible for facilitating and shaping a research agenda, developing the programme, the management of research, and the dissemination of findings. The project is part of CIP4, which builds on research from previous investigations, specifically the observation that 99% of microplastics within wastewater effluents partition into sewage sludge.

The project aims to enhance understanding of ATC, to explore the ability to remove microplastics and other key substances (such as flame retardants), from all outputs and develop understanding of the wider environmental impact from a transition to ATC strategies and away from currently deployed strategies. Additionally, in 2024, OFWAT awarded four ATC-themed projects a total of £12.6 M in Round 4 of the Innovation Challenge. Figure 1 shows the structure of these projects.

Finally, DEFRA recently carried out an evidence assessment of the impacts of biochar application to UK agricultural soils. This was a follow up to a report published in 2009. It concluded that biochar is an effective method for sequestering C in a stable form and may be used as a GHG removal strategy, however, in temperate regions (such as the UK), there is limited evidence that biochar can improve soil quality and crop yield. Effects are variable dependent upon application rate, soil type and chemical and structural properties of the biochar. Further research on ATC processes and biochar is needed.

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