WATER SERVICES
ASSOCIATION OF AUSTRALIA

BIOSOLIDS TO BIOCHAR:
AN OVERVIEW OF THE CIRCULAR APPROACH TO CARBON MANAGEMENT IN THE AUSTRALIAN URBAN WATER INDUSTRY

Biosolids are a key resource from the urban water industry. The current and future management of biosolids requires an all options approach to sustain the beneficial use and value-add potential. However, regulatory changes and increasing risks to the quality of biosolids are require an adaptive response.

New technologies and approaches are being explored across Australia, to potentially solve this shared challenge, while also creating a unique and expanding the economic market.

This overview presents case studies of the different approaches taken by Australian water utilities and councils in developing biosolids to biochar. The highlighted projects will significantly reduce waste in the water industry, support local circular economies and reduce the environmental impacts of biosolids.

LOGAN CITY COUNCIL – BIOSOLIDS GASIFICATION FACILITY

Following the success of initial trails in 2020, Logan City Council together with project partners Pyrocal and Downer, full scale operation of the biosolids gasification facility is now underway at the Loganholme Wastewater Treatment Plant. The facility bakes biosolids through exposure to extreme temperatures which produces syngas (a type of biogas). The syngas is cycled back to heat the remaining biosolids for conversion into biochar. The biochar product has been deemed suitable for agricultural purposes.

The A$28 million biosolids gasification facility was developed by Logan City Council's water business Logan Water. The project received A$6 million in funding from the Australian Renewable Energy Agency (ARENA) as part of its Advancing Renewables Program.

The initiative forms part of the Council's target of achieving carbon neutrality for its operations by the end 20221. The biosolids gasification facility will help achieve this by:

- Recovering energy from waste
- Reducing energy consumption
- Sequestering carbon and binding heavy metals which reduces carbon emissions (up to 6,000 tonnes per year)
- Destroying persistent organic pollutants and micro and nano-plastics to comply with environmental regulations[1].

Biochar Product from the Logan City Council Project.
Source: Logan Water

[1] https://www.wsaa.asn.au/publication/towards-resilience-climate-change-and-urban-water-industry-australia-and-new-zealand

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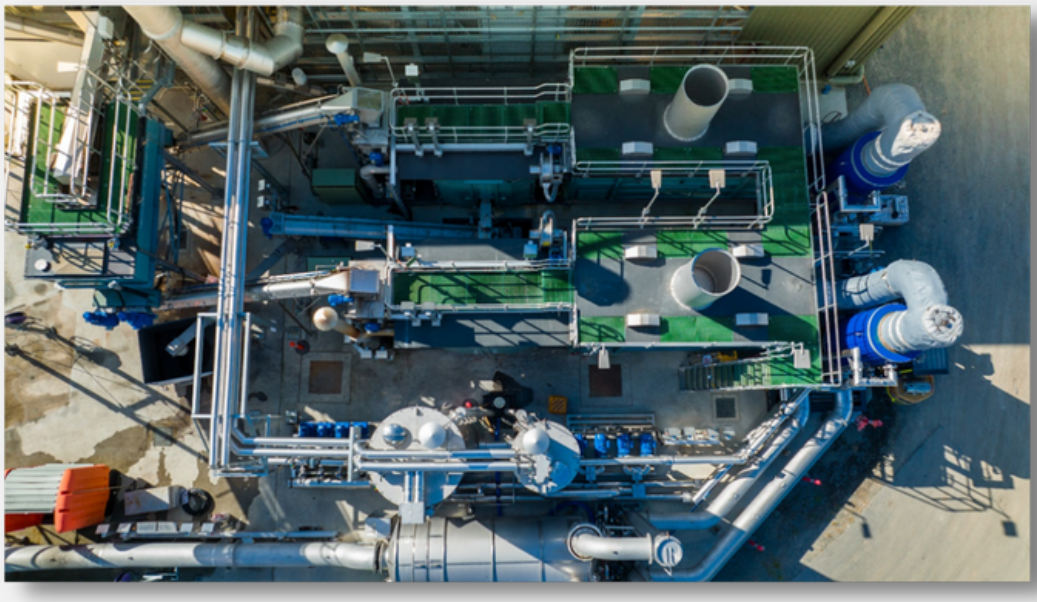
LOGAN CITY COUNCIL – BIOSOLIDS GASIFICATION FACILITY

The facility will significantly reduce the cost of biosolids disposal. It is expected to increase operational cost savings, and together with the sale carbon credits, to provide the City of Logan with an annual return of up to A$1 million. This excludes the opportunity of a new revenue stream that is to be generated from the sale of biochar itself.

Aerial View of Loganholme WWTP.
Source: Logan Water



Aerial View of Gasification facility at Loganholme WWTP.
Source: Logan Water

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PYROCO – A COLLABORATION TO GO CIRCULAR FOR BIOSOLIDS MANAGEMENT

A collaboration between South East Water, RMIT University, Intelligent Water Networks (IWN), and Greater Western Water has seen the development and demonstration of a novel pyrolysis technology.

The unique pyrolysis technology (PYROCO) has been developed and patented by RMIT for the transformation of biosolids into biochar. The patent is for a new type of hyper-efficient reactor as part of the PYROCO technology. The initial project was supported through funding from South East Water, RMIT, and IWN.

The collaborators in this project embarked on a "bottom-up approach" building up progressively from industry insights and basic laboratory experiments to developing the technology, studying biosolids pyrolysis at multiple scales. The aim was to develop an innovative pyrolysis technology (PYROCO) to convert biosolids to biochar as a commercially viable alternative for biosolids management.

Building upon this research, RMIT developed the unique pyrolysis technology (PYROCO), a 0.5 tonne per day pilot plant. The plant was constructed and successfully trialled recently at the Greater Western Water Recycled Water Plant, Melton. The technology has been developed and refined in collaboration with South East Water and IWN.

The technology, uses high temperatures to destroy pathogens and other emerging contaminants in biosolids creating biochar, allowing farmers and the wider agriculture industry to reuse 100% of the product. The technology has a unique integrated combination of a gas-producer, fluid bed pyrolysis reactor, heat exchanger and combustor. This means that the gases used by the pyrolyser are produced from the biosolids themselves, creating their own source of energy, making the process energy neutral other than a gas source for start-up. The extremely effective heat transfer creates a high-quality product, and the gases and oils produced are combusted to create the energy that drives the pyrolysis and drying reactions. The integrated technology creates a highly compact design, which will be made mobile to be able to service multiple treatment plants.

The next phase is the design, construction, operation, and study of a commercial scale 6 tonne per day Demonstration Production Plant. This 2-year phase will provide the opportunity to optimise the plant design, study its performance and operational costs, study the market and applications of the materials, helping to revolutionise the use and management of biosolids across the water industry.

Pilot plant of PYROCO at Melton Recycled Water Plant.
Source: https://www.rmit.edu.au/news/all-news/2021/jul/biosolids-tech-trial

Assessing the final test product with project partner representatives.
Source: https://southeastwater.com.au/about-us/news/biosolids-to-biochar/

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ICON WATER – MAXIMISING BENEFITS FROM BIOCHAR

The ability to effectively market biochar requires a further demonstration of its benefits in its application to agricultural and horticultural practices. Icon Water together with state agencies, CSIRO and Australian National University (ANU), initiated an investigation to quantify these benefits. This work has subsequently been further advanced, with delivery partners, AECOM and GHD.

The initial findings have provided confirmation of the potential market across horticulture, silviculture, and agriculture sectors. Of these sectors, the highest market value was found to be the application to the horticulture market in potting mixes. The application in silviculture was assessed to be lowest risk with the potential to utilise all the biochar that Icon Water could generate from its biosolids.

The initial study concluded that biochar application is expected to improve the condition and thus productivity of soils for the Canberra region.

Further investigation is currently underway to improve the nutrient access from biochar. The ability for phosphorus recycling from biosolids is a key strategy to address risks from phosphorus shortages and further maximise the benefits for biochar application. Conversion of biosolids into biochar production can increase the potential for phosphorus recycling compared to incineration. While implementing pyrolysis for biosolids treatment is of value this could be enhanced further to ensure key nutrients, such as phosphorous, are available for plant uptake. Currently, phosphorus in biochar is typically not available for plant uptake. The investigation in partnership with Australian National University is to assess pre-treatment of biochar feedstock to increase nutrient recovery and uptake availability.

Biochar from Icon Water biosolids being used in potting mix trial. Source: https://www.environment.act.gov.au/__data/assets/pdf_file/0011/1394471/a-review-of-the-benefits-of-biochar-and-proposed-trials.pdf

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THE POLICY IMPERATIVE

Currently, 75% of biosolids in Australia are used in agriculture through land application. Utilities have been applying biosolids to agricultural land for over 100 years. This had led to significant outcomes from the recycling of nutrients and increased soil health leading to increased food production.

The application and beneficial use of biosolids in this way is being threatened by increasing use of specific chemical and compounds which persist and pose a risk to human and environmental health. Examples include the detection of PFAS compounds used in household products (pots, pans, rain-jackets etc) and microplastics from synthetic clothes entering our sewerage systems and impacting on the quality of biosolids. As presented above, gasification & pyrolysis technologies are available to destroy PFAS & microplastics in biosolids to produce biochar. This provides a valorisation pathway with emerging potential.

Biochar production offers the ability to establish a nutrient-carbon trade-off as biosolids are converted and carbon is sequestered. Notwithstanding the ongoing benefits of sustainable land application methods, the production of biochar will have a role to play in managing incidences of contaminated biosolids and growth of new markets for carbon capture. The case study of Logan City Council is an example of the delivery of these benefits in preparation for stricter regulatory control.

The stricter regulatory control is taking form in the development of the PFAS National Environmental Management Plan (NEMP) version 3. It includes a focus on biosolids with increased limitations on PFAS concentrations. The implications of the proposed guidelines (yet to be release at time of this publication) will need to be considered in terms of the limits it imposes on land application and effective management of biosolids. While this may promote the further opportunity for increased and scaling of biochar production, this must be balanced against the need for ongoing and effective nutrient recycling.

No doubt biochar will have a future role to play as part of the "all options" approach to managing biosolids. The ability to sequester and store carbon is key attribute of its market potential. In this regard, opportunities to improve the current approach being adopted through the Emissions Reduction Fund warrant further development. The Soil Carbon method, which relies on the biochar being reused (i.e. through land application) presents an onerous process for the utility. The approach that is needed is to account for the production of biochar as the point where carbon is sequestered. Ongoing engagement is being had with the Clean Energy Regulator as the onus is currently on industry to demonstrate a working method given biochar is not recognised under the Carbon Capture, Utilisation & Storage method being developed.

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KEY AGENCIES INVOLVED IN BIOSOLIDS AND BIOCHAR

Australian and New Zealand Partnership

The Australian & New Zealand Biosolids Partnership (ANZBP) is a member-based collaboration of utilities, consultants, academics, and government bodies committed to the sustainable management of biosolids.

www.biosolids.com.au

ARC Training Centre for Transformation of Australia's Biosolids Resource – To advance fundamental and translational biosolids research, resulting in both the high-quality interdisciplinary training of new, industry-ready researchers, and novel applications and new market opportunities for the Australian biosolids industry.

www.transformingbiosolids.org.au

Australia New Zealand Biochar Industry Group (ANZBIG) – An advocacy group to facilitate and assist companies, governments and institutions in the effective production and use of Biochar. This cluster industry group will focus to streamline Biochar education, research, collaboration, and commercialisation activities to provide better outcomes for Australia and New Zealand.

www.anzbig.org

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For more information about these projects and associated references and utility contacts please email Jason.Mingo@wsaa.asn.au