



Creating a world fit for the future

Ricardo plc

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Greener together

A collaboration with Bluebox Energy to deliver innovative technology-based solutions that can drastically reduce carbon emissions.





Ricardo's carbon-capture experts are collaborating with Bluebox Energy to deliver innovative new technology solutions that support the transition to a low-carbon future. The consortium has won a national competition to design a commercial, community-scale greenhouse-gas removal system fed by waste from the forestry sector. The system will significantly reduce noxious emissions and enable waste heat and sequestered carbon products to generate revenue streams for industry and local communities and achieve negative emissions.

National government targets are helping drive both public and private sectors to develop strategies and invest in processes and technologies that will enable organisations to deliver a low-carbon future. An example of these targets is the UK's goal of achieving net zero carbon emissions by 2050. Innovation in heat and energy technologies is critical to the achievement of these objectives.

It has become widely accepted in recent years that negative-emission technologies such as biochar and biomass carbon capture and storage (BECCS) are essential for achieving net zero globally. Currently negative-emission technologies such as BECCS are only considered for large-scale emission sources such as power and industrial plants.

Ricardo's aim is to become a world leader in integrating carbon capture with pyrolysis-based combined heat and power ('CHP') systems for commercial, community-scale applications. Pyrolysis is the thermal decomposition of materials at elevated temperatures in an inert atmosphere.

The partnership with Bluebox Energy leverages Ricardo's expertise in carbon capture technologies and world-leading experience in combined heat and power and thermal and thermodynamic analysis, plus system engineering for

efficient thermal energy management. It also draws on Ricardo's 100-year track record in automotive engineering, as well as its expertise in renewable and sustainable energy management for key infrastructure.

Capitalising on hot-air turbine technology

Since 2014, Hampshire-based Bluebox Energy has developed ultra-low carbon CHP solutions for business parks, communities and industrial and farming processes, including a new method to convert heat to electricity using hot-air turbine technology.

A hot-air turbine takes in filtered air and compresses it in a turbo-compressor. This air is heated using energy from a hot gas stream, such as flue gas from the combustion process. The hot



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pressurised air passes through the turbo-compressor and power turbine to produce electricity.

The electrical output from the turbine generator is converted to grid power in a dedicated inverter. The air emerging from the power turbine is still at a temperature of around 400°C so can be used for heating, steam production or direct drying.

In 2019, Ricardo and Bluebox Energy began to explore the potential of biomass pyrolysis as an ultra-low-carbon solution. Bluebox Energy's concept of capturing 50% of CO₂ in biochar (pyrolysis combined with a hot-air turbine CHP system) with the other 50% released into the atmosphere was enhanced by Ricardo's proposition that most of the 50% emitted could also be captured using chemical absorption.

Achieving this would capture 90% of the remaining emissions and thus increase overall CO₂ capture to 95% of total emissions.

Designing a commercial greenhouse-gas removal system

In April 2021, as part of the UK's Department for Business, Energy and Industrial Strategy's Greenhouse Gas Removal Innovation Programme, the Ricardo and Bluebox Energy consortium was selected to develop the BIOCCUS technology.

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Fed by undried, unprocessed waste wood from domestic

timber production, the system will produce four key commercially marketable by-products: biochar, which can potentially be used for soil enrichment or as cattle feed in agriculture and improving anaerobic digester performance; commercial grade CO₂ for utilisation in the construction sector as means of permanent storage, such as low-carbon concrete, electricity and heat. As well as capturing up to 95% of CO₂, the system will deliver positive power and heat generation by supplying homes and businesses with renewable heat and electricity.

This first phase of the project lasts until December 2021 and could potentially lead to the consortium's being selected for Phase 2 to develop a prototype and demonstrate the technology between 2022 and 2024.

This carbon-capture research and innovation project with Bluebox Energy is a further boost to Ricardo's credentials in supporting delivery mechanisms to tackle climate change and meet national net zero targets. The proposed biochar, CO₂ capture system is ultra-low carbon with significant negative emissions: removing CO₂ from the atmosphere as biomass is carbon neutral, on top of which is the capture and permanent storage of resulting CO₂. Successful deployment following the project would mean that an organisation could use decarbonised or net-negative CHP technology to improve its environmental impacts.