

# Carbon Recycling

## Making our Future Sustainable

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The world relies on fossil fuels not only as an energy source but also to make plastics, synthetic fibres, and an array of everyday chemicals. Fossil resources, however, are finite and their use causes environmental pollution and giga-tonne emissions of greenhouse gas (GHG). With increasing concerns over climate change there is a growing need to replace fossil fuels with alternatives which are clean, cheap, and sustainable.

Researchers at the **UKRI BBSRC/EPSC Synthetic Biology Research Centre – Nottingham (SBRC-Nottingham)** are taking a novel approach by using bacteria to recycle carbon waste into useful products. Using cutting-edge molecular techniques and advanced synthetic biology they have engineered bacteria (e.g. *Clostridium* spp. and *Cupriavidus* spp.) to be mini factories that synthesise useful chemicals from greenhouses gases in a process called “gas fermentation”.

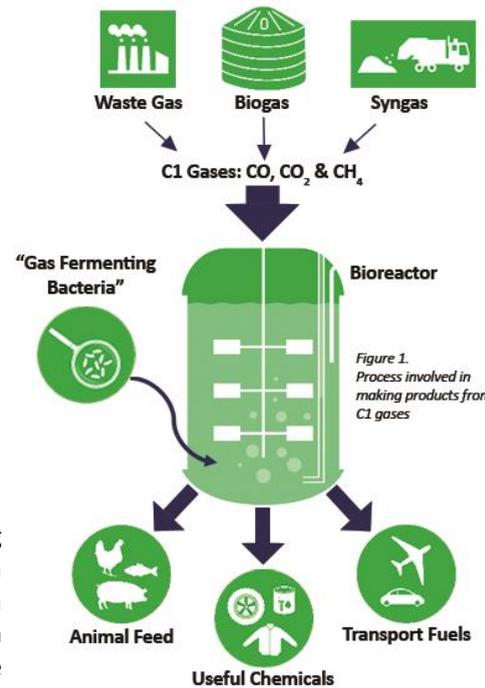
**The Carbon Recycling Network** is one of six Networks in Industrial Biotechnology & Bioenergy (NIBB) funded by the UKRI BBSRC to encourage the UK growth in Industrial Biotechnology. The network goal is to create a vibrant community of researchers, which will unravel the biological, chemical, and process engineering aspects of carbon recycling through the re-use and exploitation of single carbon (C1) greenhouse gases. The focus is on the exploitation of gas fermentation, primarily using chemoautotrophs. The Network also seeks to explore the potential of anaerobic digestion (AD) as a gas fermentation feedstock generator and has funding for research projects, conferences, studentships, workshops and outreach.

To join the Network visit:  
<https://carbonrecycling.net/>



**SBRC-NOTTINGHAM** is a UKRI BBSRC/EPSC funded, [Synthetic Biology Research Centre](#) led by Professor Nigel P. Minton at the University of Nottingham, UK. SBRC-Nottingham aims to provide new technologies in the form of engineered bacteria and processes that together can be used at scale by industry to transform our energy intensive economy into a sustainable and more carbon neutral bioeconomy. The Centre is collaborating with industry such as [LanzaTech](#) and [Deep Branch Biotechnology](#) to optimise and commercialise the production of low carbon fuels, everyday chemicals and animal feed using gas fermentation.

For more information visit:  
<https://sbrc-nottingham.ac.uk/>



### LANZATECH: A CARBONSMART™ SOLUTION

The [LanzaTech](#) process uses naturally occurring gas-fermenting bacteria from the acetogen family. These organisms use gases, specifically carbon monoxide, carbon dioxide and hydrogen as their only source of carbon and energy for life. LanzaTech has harnessed their natural capacity for ethanol production to enable bioethanol to be produced from carbon-rich emissions before they are released into the atmosphere. With 4 commercial facilities in development and construction, LanzaTech uses a variety of waste gases, including refinery, steel and ferroalloy emissions, as well as gases derived from unsorted, unrecyclable municipal solid waste (household waste) and agricultural residues. Since start up in 2018 in China, the first commercial LanzaTech facility has produced over 13M gallons of ethanol and reduced the equivalent of 70k tonnes of CO<sub>2</sub> from the atmosphere, converting waste steel mill emissions to ethanol for fuel blending.



These gas - fermenting bacteria are able to grow on C1 gases, such as carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) derived from “waste gas” from industry; “biogas” from anaerobic digestion and “syngas” from superheated domestic and agricultural wastes (see Figure 1 above).

The gas - fermenting bacteria utilise these gases as a carbon source to produce simple carbon molecules, which can be converted into an array of more complicated carbon molecules. This will enable low carbon fuels, everyday chemicals and even animal feed to be produced at scale without using fossil fuels.

### DEEP BRANCH BIOTECHNOLOGY

Founded in 2018, by a group of ex SBRC-Nottingham PhD students, [Deep Branch](#) is one of the newest and fastest growing companies in the gas fermentation field. Their technology is being used as a means for carbon intensive industries to improve environmental impact and their bottom line. This is best illustrated in the company's ongoing partnership with Drax, the UK's biggest producer of renewable energy. Deep Branch use carbon dioxide from the Drax's bioenergy power plant for their Mobile Pilot Unit to produce 'Proton', a nutritional tailored single cell protein for use in animal diets.

