



CCm Q&A

What is CCm Technologies?

CCm Technologies is an award-winning clean tech company which optimises resource use through Carbon Utilisation (CCU) and carbon capture solutions, including the production of net zero carbon fertilisers (see Sustainable Markets Initiative's RE:TV short video [here](#) for further information). CCm's innovative and collaborative solutions allow a wide range of businesses to generate commercial value from captured carbon and other agricultural and industrial waste streams while also delivering improved sustainability.

Based near Oxford, CCm Technologies was established in 2011 by four founding directors, all of whom still work for the company at board level: Gordon Horsfield CBE, Pawel Kisielewski, Professor Peter Hammond and Richard Morse. It is a member of the Sustainable Markets Council, an initiative of HRH The Prince of Wales with the support of the World Economic Forum. The company has also received the Solar Impulse Foundation Efficient Solutions Label.

How do CCm Technologies' resource optimisation solutions work?

CCm's technology uses captured carbon dioxide from industrial power generators ranging from low CO₂ concentration flue gas from any combustion process to high purity CO₂ from biogas separation procedures. This captured CO₂ is used to stabilise a wide variety of materials (such as ammonia and phosphates) from agricultural and industrial waste streams and use these to create new fertilisers products with significantly lower carbon and resource footprints than those products conventionally have.

CCm's full-scale demonstration plant has been fully operational for over two years and producing significant quantities of ultra-low-carbon footprint fertiliser materials in solid and liquid formats. The process at the centre of CCm's fertiliser production system combines an organic fibre, ammonia and CO₂. The fibre is coated in ammonia which serves to capture CO₂ by absorption. The CO₂ in turn stabilises the ammonia and allows it to be converted into a more useful form. At this stage, further nutrients, such as nitrogen and potassium from anaerobic digestion, can be added from other waste or recycled materials either to utilise a particularly abundant feedstock or to achieve a particular formulation.

What are the environmental benefits of CCm's technology?

1. Utilisation of waste streams – promoting a circular economy

CCm's systems produce high value, high performance materials from low or negative value inputs or feedstocks: the waste component of CCm's fertiliser is up to 90%, including components which could otherwise have ended up in landfill or discharged into water courses. The utilisation of existing resources reduces a) the demand for finite elements such as phosphorus, and b) the reliance on highly energy-intensive processes, which are usually involved in fertiliser production. It also allows low value materials and wastes held within anaerobic digestion or similar operations to be transformed into substantial resources with real value, providing a financial as well as environmental incentive for sustainability.

This recycling potential for waste streams has particular applications for three key UK sectors: anaerobic-digestion based water and wastewater operations, food manufacturing and processing, and agriculture. Key waste 'feedstocks' that can be drawn from these industries include carbon, nitrous

and sulphurous oxides, fibrous and particulate organic waste streams, and phosphate and ammonia-rich solid and liquid waste streams.

For example, with regards to wastewater treatment, the CCm process is able to use nutrient-rich sludge digestate or centrate – a waste stream from the dewatering process – as the source of ammonia. This reduces and possibly eliminates the cost (environmental and financial) of transporting sludge and biosolids to land, while creating a completely new revenue stream through the sale of fertiliser. A separate application in the sewage sector extracts valuable nutrients such as phosphorus and ammonia from effluents, which are a major pollution risk when discharged into watercourses, and instead recycles these into biogenic fertiliser products.

2. Reduction of carbon emissions – contributing to the UK's net zero target

Current agricultural practices result in the production of approximately 10% of all UK greenhouse gases, as well as specifically increasing both ammonia and phosphate emissions and water pollution. While a reduction in coal-fired power stations enabled the UK to reduce emissions by 16% annually from 2012-2016, decarbonisation of other sectors, such as agriculture, has been significantly lower and must now be a major focus for action.

By targeting the massive carbon footprints associated with conventional fertiliser production, which it can reduce by more than 90% depending on the formulation in question, CCm's technology can contribute meaningfully to the UK's objective of net zero carbon by 2050.

Carbon savings associated with CCm's fertiliser production result from:

- The **direct capture and utilisation** of waste CO₂ during the production process
- The replacement of high-intensity inputs (i.e. the energy-intensive production of large volumes of ammonia, phosphates and carbon dioxide) by recovered ones, which produces a **large avoidance of primary carbon use**
- The retention of carbon-based materials within the fertiliser matrix ensures **high levels of carbon retention** and storage in the soil, contributing to the restoration of soil organic carbon and overall fertility.

Through a combination of the above, a standard CCm unit producing approximately 10,000 tonnes of fertiliser could generate carbon savings of approximately 40,000 tonnes CO₂e per year. The deployment of 50 units in the UK could therefore result in emissions avoidance equivalent to removing around 375,000 cars off the road each year, meaning CCm products are not only low-carbon but in many cases climate-positive.

3. Ensuring high yields and low costs alongside environmental benefits – facilitating farmers' sustainable transition

Extensive trials over six years over six years have demonstrated that CCm's products are industry-matching, meaning that farmers can select a lower-carbon option without threatening their yields or paying more.

Recent independent trials of CCm's fertilisers versus current commercial fossil fuel-derived equivalents demonstrated similar yield and protein quality outcomes with around 10% less nitrogen and phosphate applied. While equalling or outperforming conventional products in terms of yield (crop biomass enhanced by up to 38% - Lake et al. (2019)) and protein quality, CCm fertilisers vastly exceed them in environmental performance. In addition to the emissions reduction and recycling opportunities outlined above, field trial data has demonstrated additional environmental benefits, including:

- Enhanced nutrient delivery which targets phosphate and potassium balance at source to prevent over-application.

- Enhanced bio-floral and faunal activity – c. 20% increases in microbial activity, directly contributing positively to overall soil health.
- Enhanced soil water and nutrient retention (of up to 62% - Lake et al. (2019)) close to the root ball of the plant, contributing to lower nitrogen and phosphate run-off and therefore reducing pollution of water.
- Increased retention of carbon in soil, contributing to improved soil health.
- Soil pH increases of c.1 unit – beneficial effects on soil ecosystem services, particularly in respect of water quality.
- With regards to wastewater treatment, CCm's process is able to use nutrient-rich sludge digestate or centrate (a waste stream from the dewatering process) as the source of ammonia, reducing and possibly eliminating the environmental and financial cost of transporting sludge and biosolids by road to land.

CCm's technologies are sufficiently advanced that they can be deployed immediately and the supply chains and delivery mechanisms that currently supply UK agriculture can be used to deliver them (e.g. CCm pellets can be manufactured with exactly the same dimensions and characteristics allowing farmers to retain existing equipment and be assured that there will be no difference in spreading accuracy).

By drawing on end-of-use materials as substantial inputs and involving a low-energy manufacturing process, CCm has created a range of materials whose sale price is directly competitive with existing products and which is financially viable on a standalone basis without reliance on government subsidies or incentives.

For all of these reasons, farmers do not pay a higher cost or risk losses in yield by taking a sustainable approach and choosing a zero carbon fertiliser using CCm's process.

How will CCm's technology be used by PepsiCo?

In September 2020, PepsiCo and CCm signed a deal to implement CCm's carbon utilisation and removal process technology to use captured carbon dioxide to stabilise ammonia from the waste streams of PepsiCo and its supply chain.

Specifically, CCm's technology will be used to manufacture low-carbon, nutrient-rich fertilisers using potato peel waste from the crisp production supply chain, which will go directly back into the fields growing potatoes for Walkers crisps, helping to close the loop and improve soil health. By increasing the recovered resource input, use of the fertilisers is expected to reduce Walkers' carbon emissions from growing potatoes by 70% and could set them on the path to carbon-negative potato production over the next decade.

CCm's specialist equipment will first be installed at the Walkers factory in Leicester next year, with a joint ambition to deploy the technology further European potato processing facilities and potentially to expand to other crops such as oat and corn.

Currently, waste carbon dioxide is recovered from beer fermentation, the largest and cleanest source of food grade carbon dioxide in the UK. The fertiliser trialled on this year's crop used Walkers potato offcuts alongside CO₂ captured in the beer brewing process. As the technology is rolled out to Walkers supplier farms more broadly, PepsiCo will be looking at ways to source the carbon dioxide from its own supply chain.

The Sustainable Markets Initiative

The Sustainable Markets Initiative and Council, of which CCm Technologies' CEO Pawel Kisielewski is a member, was established in 2019 by HRH The Prince of Wales and the World Economic Forum. Its objective is to accelerate the global transition to sustainable markets and decarbonisation. The initiative is calling on governments, businesses, investors and consumers to take the urgent and

practical steps required to transition to more sustainable practices which address the climate and biodiversity crises. To facilitate and catalyse this effort, The Prince of Wales is convening a series of global industry and sector roundtables.

