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WEAVING AND BLENDING

Architectural precast materials, colours and finishes help form a luxurious aesthetic for developer

MANCHESTER AIPORT MSCP

Space-saving design using Deltabeams, hollowcore and precast columns

LIGHT FOR THE PATH AHEAD

Luminescent concrete: a new decorative solution

RIGHT:
The quarter-sized biomass CHP demonstrator plant will be located at Holmsted Farm in West Sussex and will be operational in 2023.

INSET BELOW:
The plant will demonstrate the effectiveness of community-scale greenhouse gas removal and clean energy using sustainably sourced forestry waste.

CONCRETE, CARBON AND CHP

Innovative carbon-capture technology can secure the supply of carbon dioxide and accelerate the UK concrete industry's reduction of greenhouse gas emissions. Naser Odeh of Ricardo reports.

Following the Paris Agreement and subsequent report by the Intergovernmental Panel on Climate Change in 2018, carbon removal from the atmosphere, through nature-based solutions such as afforestation, and engineered solutions such as biochar and bioenergy carbon capture and storage (BECCS), is now high on the agenda in order to help achieve net-zero targets by 2050. It is well-recognised that the deployment of BECCS and carbon capture, utilisation and storage (CCUS) in general will play a key role in off-setting residual emissions from hard-to-decarbonise sectors such as construction, which is, of course, heavily reliant on cement and concrete.

DEMONSTRATOR PLANT

Ricardo, a global, strategic environmental and engineering consulting company, has recently received £3 million from the UK Government to design, install and operate a biomass combined heat and power (CHP) demonstrator plant with a carbon-negative footprint, which will showcase emission-busting technology. The plant will demonstrate the effectiveness of community-scale greenhouse gas removal (GGR) and storage, and clean energy using sustainably sourced forestry waste. It is this captured CO_2 that can be used to accelerate cement hydration and as a consequence be bound in concrete long-term.

The process combines an innovative carbon-capture system developed by Ricardo with hot air turbine technology from Bluebox Energy and pyrolysis technology from Woodtek Engineering. The funding was awarded through the Net Zero Innovation Portfolio (NZIP) under the Department of Business, Energy and Industrial Strategy.

The quarter-sized demonstrator plant, which will be located at Holmsted Farm in West Sussex, will be commissioned and operational in 2023. It will demonstrate not only an innovative GGR technology, which in the full-size system can generate renewable heat and electricity for up to 300 local homes and businesses, but also a realistic carbon-negative technology that can significantly contribute to net-zero targets.

Currently, the main source of CO_2 is steam reforming of natural gas, hence why the cost of commercial carbon dioxide has risen significantly as a result of the gas crisis caused by Russia's invasion of Ukraine. In the UK, the shortages in CO_2 supply for big users – including commercial growers, abattoirs and food and drink manufacturing sites – were widely reported by the national media. By installing a small-scale system, a site that has a high demand for CO_2 can guarantee secure supply, while also gaining heat and renewable electricity, which can be used or exported to the National Grid.

In the UK, carbon emissions from

the concrete and cement industry were 7.3 million tonnes in 2018; approximately 1.5% of the nation's total carbon emissions.

The UK Government has committed to decarbonising all sectors of the nation's economy in order to achieve its net-zero target by 2050. The UK concrete and cement sector, however, has signalled its desire to go beyond net zero and become net negative, removing more CO_2 from the atmosphere than it emits each year. In its *Roadmap to Beyond Net Zero*[1], published in 2020, the Mineral Products Association set out its plan to reach these ambitious goals by optimising the application of existing and emerging manufacturing technologies, including energy efficiency, fuel switching, low-carbon cements and concretes, and CCUS. The roadmap shows that the industry expects 61% of its carbon reduction to come from CCUS, with biomass specifically mentioned as the route forwards.

OPPORTUNITIES

So, what industry challenges around decarbonisation can this CCUS technology help to meet? Concrete naturally absorbs CO_2 throughout its lifetime – carbonation. Carbon curing can be used to accelerate the natural carbonation process and this offers real game-changing opportunities for the UK concrete industry.

A key part of curing is hydration of the calcium oxide in cement. Many solutions speed up and improve curing results. In-situ concrete curing can be enhanced with the right additives on-site, but precast concrete allows more control of conditions including heating, exposure to steam or microwave radiation.

Concrete naturally absorbs atmospheric CO_2 over time. Rather than letting concrete slowly sequester CO_2 over its lifetime, it can be accelerated by exposing concrete to high-pressure CO_2 gas during the early hydration process. By replacing the traditional precast heating system with carbon curing, there is the potential for faster strength development, stronger concrete and long-term storage of captured CO_2. Additionally, by using CO_2 to cure concrete, the need for energy to create heat in precast factories is removed, thus reducing the reliance on burning natural gas or coal. Overall, there are gains in greenhouse gas savings and the potential for achieving negative emissions. Carbon curing can also be applied to in-situ concrete within the delivery truck.

FEEDSTOCK

Carbon-capture demonstrator plants are essential to help make this highly effective and disruptive technology affordable, accessible and a mainstream option for the industry. Initially, the Ricardo demonstrator will use sustainably sourced forestry waste, but in the long term it has the potential to use any waste as its feedstock. Community-scale biomass-based GGR systems can be located closer to the feedstock, thus significantly reducing life-cycle impacts and upstream emissions. Such affordable systems can also be conveniently located at the site of power demand. The system can not only supply commercial-grade carbon dioxide but also renewable heat and electricity.

The UK has a real opportunity to become a leader in commercialising these decentralised small-scale carbon capture systems. It is envisaged that by the second half of the 2020s, the deployment of such systems will accelerate, leading to GGR and significant emission savings, and thus making an important contribution to net-zero targets.

Captured carbon will open up opportunities for the concrete industry to go beyond net zero. This is a very positive development for the concrete industry to embrace. C

Reference:

1. MINERAL PRODUCTS ASSOCIATION, *UK Concrete and Cement Industry Roadmap to Beyond Net Zero*. MPA UK Concrete, London, 2020.