NET-ZERO INDUSTRIES MISSION

Project Title	Flue2Chem
Industry Partner	Unilever, SCI, BASF, Croda, JM, P&G, Reckitt, CCUI, CCSL, Tata Steel, Confederation of Paper Industries, Holmen, UPM, CPI, LanzaTech, University of Surrey, University of Sheffield
Industry Sector	Chemicals & Refining Other Energy Intensive & Hard to Abate sectors
Technology Pathway (Primary)	Carbon capture & storage / utilisation
NIM Pillar	Technology Demonstration
Source	NIM Awards 2025
Description	Flue2Chem is a £4.4 million collaborative R&D project funded by Innovate UK to demonstrate how carbon dioxide (CO2) emissions from UK industry can be used as a feedstock for the chemical sector, reducing reliance on fossil carbon. The project brought together 12 commercial organisations, two universities, the High Value Manufacturing Catapult, a trade association and a charity, all supported by the UK government. This included competitors across the value chain working together to test the feasibility of renewable-carbon supply chains. The project captured CO2 emissions from paper mills and converted them into platform chemicals such as ethylene oxide and long-chain fatty alcohols. These intermediates were then transformed into surfactants and formulated into everyday consumer products such as laundry detergents and surface cleaners. In addition, the surfactant was used as a stabiliser in paint coatings, showing applicability beyond consumer goods. This proved that renewable-carbon chemicals can match fossil-based equivalents in quality and performance. A life cycle assessment confirmed the potential for reduced environmental impacts, while a techno-economic analysis evaluated commercial viability and identified key barriers. Most importantly, Flue2Chem shows that collaboration across industry, academia, and government can accelerate innovation and deliver solutions to one of the hardest-to-abate industrial sectors. It stands as an exemplar of challenge-led, cross-sector R&D driving the transition to net zero.
Innovations Employed	The Flue2Chem project established an integrated value chain converting captured industrial CO into surfactants for consumer products. It combined multiple CO conversion pathways, including biological and thermo-catalytic processes, enabling comparative data collection and integration with downstream formulation and performance testing. Notable achievements include: (1) the scale-up of a new solid-based sorbent carbon capture technology from lab scale to 1 tonne per day, (2) BASF's industry-first development of a catalyst capable of converting CO directly into ethanol, and (3) the University of Sheffield's development of a new catalyst to produce long-chain alcohols from CO through direct conversion. The key advantage over the state of the art was demonstrated across the whole supply chain. A large cross-sector consortium, including competitors at different

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	points in the value chain, worked together to deliver a shared demonstration to the UK parliament in June 2025.
Dimension of Novelty	**New for the Company** **New in Country** First UK project to demonstrate an integrated value chain from CO capture to consumer chemical products. **New on the international market**
Innovation Collaboration	**In house** UK, Germany **Cooperation with scientific institution** University of Sheffield, University of Surrey, Imperial College London
Intellectual Properties	A key IP outcome from Flue2Chem is BASF's pending patent application on CO2-to-ethanol technology, marking an industry-first development. Intellectual property was otherwise governed by a consortium agreement, with background IP retained by partners and non-exclusive licenses granted within the project.
IP Links	
Timetable & Progress	Development commenced in 2022 The Flue2Chem project commenced development in 2022 and reached completion in March 2025.
Financing (Public/ Private)	**Public funding** Funded by the UK government, Innovate UK through the Transforming Foundation Industries fund.
Finance Links	
Project Phase TRL	TRL 5 The project covered the full spectrum of TRL, from low levels from academic partners (University of Sheffield: CO2 direct to fatty alcohols), mid-levels from industry partners (BASF: Fischer Tropsch, CO2 to ethanol)), and high TRL from some already existing commercial pathways (Croda: ethoxylation).
Problems to be Solved and Risks to be Managed	Flue2Chem faced interconnected technical, knowledge, and supply-chain challenges. Technical risks included deploying a single CO2 capture unit at two paper mills to secure sufficient feedstock, as well as developing selective catalysts to convert CO2 (rather than CO) into platform chemicals. Knowledge gaps on environmental impact were addressed through life cycle assessment, while techno-economic analysis identified barriers to commercial viability. Supply-chain risks arose from coordinating multiple partners at different TRLs, while also managing relationships between competing entities in a pre-competitive environment. The project also navigated changes in business scope among some partners during delivery, as well as regulatory restrictions around CO2 capture, which required exemptions from SEPA.

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Preliminary or Final Results Achieved	Flue2Chem successfully produced surfactants from CO, which were formulated into consumer products including detergents, surface cleaners, and paint coatings, matching the performance of fossil-derived alternatives. Life cycle assessment confirmed their potential to reduce environmental impact, while techno-economic analysis highlighted economic challenges associated with low production scale and hydrogen costs. Key learnings include the importance of integrated supply-chain coordination, scaling renewable energy, establishing distributed manufacturing hubs, and developing UK pilot and commercial-scale facilities.
CO2 Emissions Reduction Potential - Implementation and Future Market	In 2019, the petrochemicals supply chain accounted for approximately 2.6 billion tonnes CO2 equivalent per year, around 5.7% of fossil carbon extracted. Without intervention, this could double every 10 years, potentially reaching 10–15 billion tonnes CO2 per year by 2050. Cleaning products and cosmetics account for around 10% of this total, equivalent to roughly 0.26 billion tonnes CO2 per year. Life cycle assessment indicates that renewable-carbon surfactants developed in Flue2Chem could reduce product emissions factors from about 4 kg CO2/kg to 1.4 kg CO2/kg, suggesting substantial mitigation potential in this sector. In the UK, implementation would depend on integrated hubs combining CO2 capture, conversion, and hydrogen supply. Internationally, the model is transferable but requires supportive policy, renewable energy build-out, and competitive economics. The project provides a credible pathway to displace fossil carbon in chemicals with significant long-term potential.
Market Positioning	Flue2Chem demonstrates that captured CO can serve as a technically viable feedstock for chemicals, with the potential to displace fossil carbon in surfactants and other products. While immediate commercialisation is limited by economics and infrastructure, the project lays the foundation for a future low-carbon chemical industry. It provides insights for policymakers and industry stakeholders on how to develop integrated CO-to-chemical hubs, supporting the transition toward net-zero chemical production both domestically and internationally. Building on this momentum, future UK-based projects on low-GHG alcohol ethoxylate surfactant production are now being actively explored.
Project Location	UK
Project & Technology Links	https://www.soci.org/flue2chem
Technology Links	https://www.youtube.com/watch?v=_tgljx0D9rg