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Pioneering Sustainable CO_2 Conversion to C3 Chemicals and High-Value Lipids for Feed and Food Applications

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The industrial sector is responsible for nearly 20% of global CO_2 emissions, with its reliance on petrochemical feedstocks making it one of the most difficult sectors to decarbonize. Despite significant advancements in scaling the production of 1- and 2-carbon molecules like methanol and ethanol from waste gases and renewable energy, accessing the 3-carbon (C3) chemical space remains a significant technical barrier. The PYROCO$_2$ project addresses this challenge by developing an efficient thermophilic microbial fermentation process that converts industrial CO_2 and green hydrogen into acetone—a versatile C3 building block. This process is designed to be both high-yield and energy-efficient, capitalizing on the flexibility of biological systems. The produced acetone can be further refined using catalytic chemistry into a wide range of petrochemical substitutes, including plastics, specialty materials, and fuels, significantly expanding the CO_2-derived product value chain.

A full-scale demonstrator plant in Norway will showcase the scalability and commercial potential of this process, producing up to 4000 tons of acetone annually from captured industrial CO_2 and green hydrogen. Supported by an interdisciplinary consortium of 19 partners across Europe, this project illustrates a groundbreaking approach to achieving circular carbon utilization at scale.

In addition to the PYROCO2 achievements, SINTEF is leading two cutting-edge projects focused on pushing the boundaries of CO_2 utilization beyond chemicals into high-value biomolecules. These projects have demonstrated the microbial production of omega-3 fatty acids, essential for both feed and human nutritional supplements. Using non-GMO strains, we have achieved lipid accumulation reaching 80% of the total cell mass—a significant breakthrough in microbial lipid synthesis. This result underscores the potential of industrial biotechnology to produce sustainable, bio-based alternatives to conventional feedstocks. The omega-3 lipids produced are suitable for use in feed applications, enhancing nutritional profiles for aquaculture and livestock, while also meeting food-grade standards for human consumption as dietary supplements.

The combination of innovative microbial processes for both C3 chemical and lipid production showcases the expanding versatility of CO_2 as a feedstock, with the potential to transform multiple sectors. These projects not only provide scalable solutions for hard-to-abate industries but also offer environmentally sustainable alternatives to petrochemical-based products.