Demonstrating sustainable value creation from industrial CO_2 by its thermophilic microbial conversion into acetone

Results of the second year of project implementation

The PYROCO₂ Project has entered its third year of activities, and many results have been achieved by the consortium! Check out the fifth issue of the PYROCO₂ newsletter to uncover the progress made by the partners. Remember to follow PYROCO₂ on LinkedIn and Twitter to be up to date with the project progress at all times!

WP1: FEEDSTOCK PREPARATION AND PROVISION

HIP is continuing to support the setup of the demonstration on campus, ensuring carbon and hydrogen feedstock supply for the demonstrator facility and other key infrastructure.

WP2: FROM FEEDSTOCK TO ACETONE: BIOPROCESS DEVELOPMENT & OPTIMISATION (DEMONSTRATOR)

To optimize the conversion of CO_2 to acetone, WP2 has focused on further understanding bacterial metabolism to provide new generations of strains with improved performance characteristics. The robustness of the process was demonstrated and lead to further, continual scale up of the process, providing important design parameters for further design of large-scale equipment.

In parallel, WP2 hosted and coordinated the 24M meeting, held in Copenhagen, where the whole consortium could reflect on the successes of the past year and plan to push the boundaries for the exciting upcoming year!

Figure 1: The PYROCO2 consortium in Copenhagen for the M24 project meeting

WP3: FROM ACETONE TO MARKETABLE PRODUCTS: CHEM-CAT DEVELOPMENT & OPTIMIZATION

Task 3.5 proposes a novel concept for synthesis: the oxidehydration of a particular compound. Due to toxicity concerns, it is not openly traded and requires on-site production. In this context, a suitable feedstock is chosen for small production sites, where the compound can be generated on-site and on-demand to avoid transport and storage issues. The operating conditions for the oxidehydration process have been defined in both single and tandem reactor configurations. These conditions are suitable to produce the compound based on the chosen feedstock. Both the single reactor configuration (where the catalysts are loaded inside the same reactor) and the tandem reactor configuration (which would be a more classical approach) are efficient. The presence of impurities, even as trace compounds, in the feedstock could potentially affect catalyst performance. The operating conditions defined for the process were validated experimentally. Another achievement has been made by the construction of a continuous reactor.

WP4: OVERALL PROCESS DESIGN, INDUSTRIAL SCALE-UP AND DEMONSTRATION (DEMONSTRATOR)

Following the completion of the demonstrator's basis of design and equipment inventory, WP4 of PYROCO_2 has developed a first realistic 3D model of the plant. This model serves as a visual representation, aiding in optimizing design and engineering, identifying challenges, and facilitating communication among stakeholders. It marks a significant step toward demonstrating the feasibility and scalability of the PYROCO_2 process on an industrial scale.

WP4 has increasingly been working together with WP1 on integrating feedstock supply and options for on-site utilities at Herøya Industrial Park in the demonstrator planning, design, and engineering.

WP5: PROCESS INTEGRATION AND SUSTAINABILITY ASSESSMENT

Within WP5, we work closely with other activities in the work packages to put results in economic, ecologic and social context. Even though all are different in detail, we are developing a common assessment database to share a common base. Here, different relevant scenarios are defined, differing in: Location, Process data base, Process pathway + case, CO_2 source, Utilities system and Temporal scope.

Different process scenarios were modelled and evaluated, both for the demonstrator and for industrial use in potential CCU-Hub. Aside functionality of the process pathway, continuous operation, productive variabilities and integration of gaseous and liquid streams are discussed as relevant factors for economic operation of the PYROCO₂ process. We identified different process cases for further assessment, representing different applications of the PYROCO₂ process and worked on first knowledge-based heat- and material balances to further develop during the project.

With regards to life cycle costing, we outlined a methodology to capture the major cost elements and how they relate to one another. The elements themselves and their relationships will become clearer as the demo site starts to materialize. We also agreed not to test the methodology on the mini-demo site as the costs may differ.

In the environmental Life Cycle Assessment (LCA) project, progress has been made in scoping and defining the system boundaries. These system boundaries were chosen such that integration with social and economic assessment is feasible. Scenarios to assess have been defined in collaboration with others within the work package and with other relevant stakeholders in order to explore the future environmental performance of the PYROCO₂ process concept and its potential product value chains.

As part of the S-LCA (social life cycle assessment), the materiality assessment has been conducted from three perspectives: A bibliographic analysis, stakeholders' engagement, and database review. The first has been finalised, but will be updated on a regular basis, while the other two are ongoing. The database of interest we are exploring are PSILCA and the SHDB. The stakeholders' engagement activities will take the form of (participation to) workshops, focus group discussion and online surveys. The materials of these activities, such as questionnaire and discussion agenda, is being developed. The stakeholder engagement materials and process were presented and discussed with the PYROCO₂ consortium at the M24 project meeting in Copenhagen in September 2023. Constructive comments and remarks were provided and constituted substance for refining the process and the materials of the stakeholder engagement activities that has been planned to be deployed at the ECOMONDO Conference at Rimini, Italy, in November 2023 in the form of in-presence survey.

WP6: EXPLOITATION, REPLICATION, COMMUNICATION AND DISSEMINATION

AXELERA actively participates in WP6, aiming to establish local CCU hubs in the AURA valley region and other promising locations in Europe. To achieve this, AXELERA has implemented a replication methodology considering market insights, CCU technologies, legal frameworks, and funding mechanisms, fostering systematic CCU Hub development. The strategy seeks to assist European clusters efficiently, boosting CCU projects and reducing CO_2 emissions. Additionally, AXELERA has developed an ongoing Toolbox, divided into seven files, providing essential information on the CCU EU market, regulations, technologies, funding, replication strategies, roadmaps, and training resources.

As the leader in dissemination and exploitation, CTECH has actively worked to boost the project's visibility and engage with the Green Deal Projects Support Office. In November 2023, CTECH organized the first PYROCO2 exploitation and replication workshop at Ecomondo. The event began with a presentation of the PYROCO2 project, followed by two interactive questionnaires gathering feedback on market and technology trends, as well as insights from stakeholders on socio-economic implications related to CCUS technologies.

Another significant outcome for WP6 is the development of a strategy for leveraging project results post-$PYROCO_2$ completion, which has been incorporated into the overall exploitation plan. This task was accomplished thanks to the participation of all project Partners.

As future perspective, partners have already planned to present the project in several international events (e.g., IFIB and Ecomondo), which will be presented across all $PYROCO_2$ channels in the coming weeks. Stay tuned!

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