

Renewable Ethylene via Scalable Electrochemical Technologies for CO₂ conversion

Publieke samenvatting / Public summary

Aanleiding

Achieving full-scale and cost-competitive production of green ethylene is one of the biggest challenges of the (petro)chemical industries, which must explore new technologies based on circular carbon and renewable energy to meet their climate targets. Ethylene is the most produced organic compound in the world, and key intermediate for plastics, textile, e-fuels and several other products. Currently, ethylene is mainly produced via energy intensive processes (e.g., naphtha steam cracking) relying exclusively on fossil sources, both as feedstock and as heat source to reach the required high temperatures for the conversion process. In this context, electrochemical conversion of CO₂ to ethylene is considered the “holy grail” for the chemical industry, i.e. an electrified process able to directly convert CO₂ and water to ethylene using just electricity as energy input. The RESET-CO₂ project aims to advance the development and upscaling of electrochemical conversion of CO₂ to ethylene, by combining strategic knowledge and innovations at all levels: from material development and process design, to system integration and value chain aspects.

Doelstelling

By accelerating the development of the electrochemical conversion of CO₂ to ethylene, the RESET-CO₂ project will contribute to the following overarching goals of: (i) Defossilizing part of the chemical industry, by introducing a fossil-free production route for ethylene, therefore reducing

Projectinformatie / Project information

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Algemene informatie / General information

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dependency on these raw materials. (ii) Reducing industrial CO₂ emissions, by enabling the direct use of renewable electricity and re-use of waste CO₂, therefore contributing to a safer and cleaner environment. (iii) Contributing to a circular carbon value chain, by fixating the recovered carbon into building blocks that can be used for products with long lifecycles (e.g. plastics, textiles) (iv) Fostering new economic initiatives, by focusing on profitable high-tech developments at component-level and by identifying sustainable business opportunities at system-level.

Korte omschrijving

Cutting-edge manufacturing techniques will be used to deposit novel catalyst layers on different types of support and fabricate innovative electrodes with tailored properties. Efforts will be made to ensure these electrodes are produced at moderate costs and with good mechanical and chemical stability, even at higher current densities. The electrode will be integrated in the cell and various configurations, such as zero-gap membrane-electrode-assembly (MEA) architecture, will be explored to optimize ethylene production. Electrochemical testing at different sizes will be performed to gain unprecedented insights into how to upscale the technology and optimize process conditions. A conceptual design will be performed for a novel electrochemical reactor and for the implementation of a full-scale plant. An integrated techno-economic and environmental analysis will be performed and benchmarked against competing green ethylene technologies, and a multi-scale dynamic modelling framework will be used to identify how to optimally operate the technology when powered by intermittent renewables. Several outreach activities will be performed during the project.

Resultaat

The RESET-CO₂ project will focus on (1) accelerating technology development, by manufacturing novel (cathode) catalyst layers and incorporate them into improved membrane-electrode-assembly architectures; (2) providing experimental validation of the technology at increasing geometric sizes and

power scales, up to multi-kW demonstration; (3) filling knowledge gaps in the technology upscaling, by conceptually design the elements of a first-of-a-kind full-scale plant; (4) removing barriers for technology implementation, by carefully assessing advantages/limitations compared to other production routes and how to (optimally) integrate the technology in the (future) energy system and value chain; (5) disseminate knowledge through a variety of communication channels. The ultimate goal is to accelerate the scale-up and develop the necessary knowledge to allow a first industrial-scale demonstrator by 2035.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.

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