

NovaCO₂: Renewable Fuel via Electrochemical CO₂ Reduction

The Idea

Global fossil CO₂ emissions reached a record 38.1 billion tonnes in 2025, while atmospheric CO₂ levels are around 50% above pre-industrial levels. Reducing emissions is critical, yet the chemical and fuel industries will continue to require carbon as a raw material. NovaCO₂ turns this challenge into an opportunity by using CO₂ as the carbon source and renewable electricity to convert it to valuable carbon monoxide (CO), a key intermediate for syngas, methanol, and fuels.

Electrode design is central to the performance and feasibility of electrochemical CO₂-to-CO conversion. For industrial applications, electrodes must combine low cost, high CO selectivity, high current density and long-term stability. Current catalyst design largely follows two routes: noble metals such as Ag and Au, which are selective but costly at scale, and metal-free heteroatom-doped carbons, where N, S or other elements are introduced to create catalytic sites, adding complex synthesis and composition-control steps. The core question is: **Do we actually need to add a metal or a dopant to make an electrode selective for CO₂-to-CO conversion?**

NovaCO₂ challenges these conventional design strategies and understandings. We start from lignin as an abundant, renewable and low-value carbon-rich by-product and engineer the carbon structure. By controlled structural modification, we generate defective carbon sites without Ag, Au, other metal catalysts or heteroatom doping. Instead of adding an expensive catalytic component, we create catalytic functionality within an inexpensive carbon precursor. Our proof-of-concept achieves more than 90% Faradaic efficiency toward CO in an industrially relevant flow-cell configuration.

Therefore, NovaCO₂ supports the green transition by using CO₂ instead of fossil carbon as feedstock, renewable electricity to drive the conversion, and low-value lignin to create a high-value electrode material, contributing to UN Sustainable Development Goals 7, 9, 12 and 13.

The value addition for business

The global transition toward Power-to-X (PtX), renewable hydrogen and sustainable carbon utilization is creating a rapidly growing need for low-cost CO₂ conversion technologies. Europe is emerging as a key hub for PtX development, with Denmark particularly well positioned through its established PtX infrastructure and industrial ecosystem. European Energy's Kassø plant, for example, produces e-methanol for major customers, while companies such as Topsoe develop advanced electrolysis technologies. NovaCO₂ can contribute to this ecosystem through a low-cost, metal-free, lignin-derived electrode for CO₂ conversion. DTU's proof of concept and ongoing patent preparation (TRL 3) provide the research and intellectual-property foundation. The next step is validation with electrolyzer, CO₂-utilization and PtX companies in Denmark and across Europe. Beyond Europe, technology could address the global challenge

of converting CO₂ into useful products using renewable electricity, while valorizing lignin-rich waste streams. At scale, NovaCO₂ could reduce the cost and fossil-carbon footprint of CO₂ utilization, support circular carbon economies, and create opportunities for European manufacturing, licensing and technology deployment. The long-term ambition is to develop NovaCO₂ into a globally deployable platform for sustainable CO₂ utilization, linking renewable electricity with captured CO₂ and abundant biomass-derived carbon resources to produce value-added chemicals and fuels.

Business plan

NovaCO₂ is an early-stage technology with a go-to-market route through the DTU spin-out NovaCO₂ pre-start-up (NovaCO₂.com). We will first validate the large-scale electrode performance with electrolyzer and PtX companies, then commercialize B2B through electrode sales, licensing and joint-development agreements. The electrode will be priced per m². A final price cannot yet be fixed because it depends on lignin cost, carbonization energy, fabrication, production scale and electrode lifetime. These costs will be quantified during scale-up and benchmarked against commercial electrodes, with the target of a substantially lower cost. NovaCO₂ will lead customer engagement and sales to electrolyzer manufacturers, integrators and PtX developers.

Market and competitors

NovaCO₂ targets emerging CO₂-electrolysis electrodes for renewable CO production. The downstream global CO market is estimated at USD 5.57 billion in 2026. NovaCO₂ operates at ambient temperature and uses low-cost lignin-derived, metal-free, undoped carbon, targeting lower catalyst cost and simpler thermal operation. As an early-stage component technology, an initial < 1% market share is realistic since NovaCO₂ will first target validation with electrolyzer manufacturers, while licensing through NovaCO₂ enables wider adoption.

Other grants and next steps

NovaCO₂ pre-start-up received a DKK 150K DTU Discovery Grant, which supported the initial proof of concept. No external funding has yet been received, and DTU is currently preparing the patent application. Further funding will support electrode and flow-cell scale-up, long-term stability testing, manufacturing optimization, and preliminary techno-economic and life-cycle analyses over the next 6–12 months. We will also validate the technology with an industrial partner and define the licensing route through NovaCO₂. These results will support subsequent funding applications for company development and pilot-scale demonstration.