

## **CO<sub>2</sub> electrolysis for manufacturing of materials: It all circles back to energy!**

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In 2015, TNO launched VoltaChem, a shared innovation programme to accelerate industrial electrification. A large part of the programme is about direct conversion of CO<sub>2</sub> using electricity. A lot has been achieved in the last 10 years, for example, Zeus; the installation of the largest CO<sub>2</sub> electrolyser in Europe, a whopping 6000 cm<sup>2</sup> of surface area. TNO has also invested in a broad scale of testing and scaling up stations that can accelerate scaling up of electrochemical processes. But the highest TRL that has been reached for CO<sub>2</sub> electrolysis as of today is 4-5. In a fast changing landscape of availability of renewable energy & net congestions, the bottlenecks of technology implementation and scaling-up are far broader than that of technology alone. To scale-up beyond TRL 4-5, one needs a business case that more or less makes sense from an investment perspective, but these business cases today are dominated by price of utilities, something that can not be solved in the domain of technology development.

As such, there is a real question that arises for nations and the EU, what is the earning potential of countries in the domain of CO<sub>2</sub> utilisation considering that cheap green electricity is not a given and several other parts of the industry need electrification even more urgently. In this talk, I will present the techno-economic analyses of various CO<sub>2</sub> conversion routes that have been performed at TNO and talk about the future estimated earning potential of the ARRA region in the domain of CO<sub>2</sub> utilisation. I will also highlight the technological bottlenecks, need of smart combinations downstream and processing hurdles that are experienced in upscaling of electrochemical conversion of CO<sub>2</sub> processes.