Green methanol for shipping and industry: €10.4 M. for "*Leuna100*" project

- **Consortium of two Fraunhofer institutes, DBI-Gastechnologisches Institut Freiberg, Technical University of Berlin and C_1 makes industrial history at the Leuna site (near Leipzig)**
- **German Ministry of Transport promotes ecological re-invention of 100-year-old methanol production process**
- **Use of the green fuel saves gigatons of CO_2**

Berlin/Leuna, 15 August 2023 – The Berlin-based climate tech start-up C_1, together with its partners the Fraunhofer Institute for Wind Energy Systems IWES, the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, DBI-Gastechnologisches Institut gGmbH Freiberg and the Technical University of Berlin, announces the launch of the "*Leuna100*" project. The goal of the project is the scalable production of market-ready green methanol for marine and aviation applications. Methanol is seen as key to defossilizing these industries and to free them from their dependence on oil. To achieve this, the consortium of experts is relying on the new C_1 catalysis process to produce green methanol. The project is funded by the German Federal Ministry of Digital Affairs and Transport (BMDV) with a total of € 10.4 M. over the next three years.

Shipping alone is currently responsible for emission of around 1.1 billion metric tons of CO_2 (around three percent of global CO_2 emissions) as well as other air pollutants that are harmful to health, such as sulfur and nitrogen oxides or particulate matter. Replacing fossil oil with regenerative marine fuels can save more than a gigaton of CO_2 every year. For container ships, green methanol is currently gaining traction as a climate-neutral fuel alternative.

A new method for the economical production of green methanol

Today's production of methanol is based on a century-old, well-engineered and emissions-intensive manufacturing process based on fossil natural gas or coal. C_1 has developed a new, highly efficient catalyst that revolutionizes this process. This enables the cost-efficient production of green methanol from non-fossil feedstocks such as biomass or CO_2. The process

will facilitate a methanol economy in which the utilized carbon is used in a continuous cycle instead of generating additional CO_2 emissions.

“In 1923, the world's first commercial methanol facility was built in Leuna. We are now continuing this success story by completely reinventing the methanol production process at the same location exactly 100 years later”, explains Dr. Christoph Zehe, who is responsible for the project as co-founder of C_1. “We are hereby paving the way for the efficient use of renewable raw materials to produce green methanol on an industrial scale and are providing an important contribution to the development of the Leuna Chemical Park as a future location for green chemistry.“

Project "Leuna100" to ramp-up green methanol production in the market

For the market rollout of the e-methanol process, individual process steps - and in particular their coupling into a process chain - need to be optimized and upscaled. The goal of the project is to realize the overall process of electricity-based synthesis gas generation and a radically re-developed methanol synthesis process under real conditions for the first time worldwide.

"The climate crisis is enforcing an unprecedented and ambitious reduction in CO_2 emissions. Germany and the EU have established fixed targets for the transport sector and quotas for renewable fuels. However, sectors that are difficult to electrify, such as shipping and aviation, have no technically established method to meet this in an economic and scalable way. Regenerative fuels based on green hydrogen and CO_2 offer an alternative, but are not yet ready for market ramp-up. This is the exact point where 'Leuna100' comes in, by innovating the complete process chain from CO2 to methanol and establishing the most favorable process for the production of green methanol", explains Dr. Kai Junge Puring, project manager at Fraunhofer UMSICHT.

Michael Seirig, department head of hydrogen laboratories and field tests at Fraunhofer IWES, adds: *"The 'Leuna100' project addresses a central challenge: There is currently a great deal of momentum in the field of renewable fuels, with many individual innovations. What's missing is connecting them to truly enable a large-scale market ramp-up. Many steps in renewable fuel production can be electrified to convert to renewables. In practical terms, however, defossilization of production requires not only the enabling of individual sub-steps, but also coupling and load-serving operation as a whole. Here, the BMDV funding creates an opportunity to implement this. With the Hydrogen Lab Leuna, Fraunhofer IWES also offers a unique research infrastructure for testing H_2 and PtX technologies on an industrial scale and under real conditions – so we have optimal conditions for the project."*

The *“Leuna100”* project starts in August 2023 in the Leuna Chemical Park, and will run for three years. It is funded with a total of 10.4 million euros by the German Federal Ministry for

Digital and Transport as part of the Funding Programme Renewable Fuels. The funding guideline for the development of renewable fuels is coordinated by NOW GmbH and supported by the project management agencies VDI/VDE Innovation + Technik GmbH and Fachagentur Nachwachsende Rohstoffe e. V.

Background:

C_1 provides the new catalyst as well as the reactor for the homogeneous catalysis of methanol, which was developed in-house and realized with the company OilRoq from Halle (Saale). This will be paired with two different technologies for the CO_2-based generation of synthesis gas as feedstock: Fraunhofer UMSICHT is supplying a new low-temperature co-electrolysis, DBI-Gastechnologisches Institut gGmbH Freiberg is using a reverse water gas shift industrial plant. Fraunhofer IWES provides the on-site location and infrastructure at Hydrogen Lab Leuna and evaluates the load flexibility of the components and the overall process. The Technical University of Berlin is developing an efficient operating concept based on a dynamic overall process model and is creating application-oriented mathematical methods for evaluating and optimizing load-flexibility.

In addition to the potential of electricity-based and load-flexible use of synthesis gas generation, a central innovation is homogeneous catalysis for methanol generation itself. In contrast to the past and for the first time in the world, it is not a two-dimensional surface reaction with solid catalysts (heterogeneous catalysis), instead a three-dimensional, scalable reaction in the liquid phase (homogeneous catalysis) is used, initiated by C_1. Not only is this highly selective, more scalable and suitable for load-flexible operation, it also offers cost advantages regardless of plant size.

The CO_2 used originates from industrial process emissions. With the integrated end-to-end process chain, "*Leuna100*" creates the prerequisite for RED II-compliant production of green methanol. The final evaluation of the methanol produced for its suitability as marine fuel and for further processing into kerosene ensures its applicability.

Footage of the research facility and other material is available here: Dropbox.

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About C_1

C1 develops new, climate-friendly chemical production processes by rethinking chemical reactions from the atomic level all the way up to the production scale. The chemical processes are designed with the help of quantum chemical simulations and implemented in proprietary production technologies. In doing so, the Berlin-based company develops and scales exclusively on the basis of renewable raw materials and energy. From the first steps in the development of a production process, all processes are designed to enable a closed carbon cycle. In this way, C1 supports industry on its way to net-zero.

C1 was founded by Dr. Marek Checinski (chemist), Dr.-Ing. Ralph Krähnert (chemical engineer), Dr. Christoph Zehe (chemist) and Christian Vollmann (tech entrepreneur). Dirk Radzinski (tech entrepreneur), Dr. Jürgen Hambrecht (former CEO BASF) and Dr. Udo Jung (BCG) sit on the supervisory board. Prof. Matthias Beller (Leibnitz Institute for Catalysis LIKAT) supports as scientific advisor.

Existing investors include Planet A Ventures, Square One Ventures, Maersk Growth and experienced industry managers such as Jim Hagemann Snabe, chairman of the supervisory board of Siemens, or Prof. Wolfgang Reitzle, most recently chairman of the supervisory board of Linde. More information: https://www.carbon.one/

About DBI-Gastechnologisches Institut gGmbH Freiberg

DBI-Gastechnologisches Institut gGmbH Freiberg is a non-profit institution active in the field of application-oriented R&D. The status of an affiliated institute of the TU Bergakademie Freiberg results in considerable synergies. Especially in the field of transfer of process engineering from laboratory to pilot plant scale, DBI-Gastechnologisches Institut gGmbH Freiberg is leading in several projects. Here, it can draw on a large number of successfully completed and ongoing R&D projects and a broad spectrum of staff expertise, including in engineering (planning project engineering, P&ID flowsheet generation, electrical planning, process safety, automation). This is supported by R&D expertise in the

field of synthesis gas generation, with DBI-Gastechnologisches Institut gGmbH Freiberg having several test rigs available for investigating reaction engineering processes as well as corresponding analysis technology. These can be used to suit the task, depending on the process conditions. More information: https://www.dbi-gruppe.de/

About Fraunhofer UMSICHT

Fraunhofer UMSICHT is pioneering the way to a sustainable world. With our research in the areas of climate-neutral energy systems, resource-efficient processes and circular products, we make concrete contributions to achieving the 17 Sustainable Development Goals (SDGs) of the United Nations. We develop innovative, industrially feasible technologies, products and services for the circular economy and bring them to application. The focus is on the balance of economically successful, socially equitable and sustainable developments
More information: https://www.umsicht.fraunhofer.de/

About Fraunhofer IWES

Fraunhofer IWES secures investments in technological developments through validation, shortens innovation cycles, accelerates certification procedures, and increases planning accuracy by means of innovative measurement methods in the wind energy and hydrogen technology sectors. At present, there are more than 300 scientists and employees as well as more than 100 students employed at the nine sites: Bochum, Bremen, Bremerhaven, Görlitz, Hamburg, Hanover, Leer, Leuna and Oldenburg.
More information: www.iwes.fraunhofer.de

About Technische Universität Berlin

The Process Dynamics and Operations Group at TUB is intensively engaged with modeling, simulation, and optimization of design and operation of a multitude of processes in chemical process engineering. Typically, economic efficiency, energy efficiency, and sustainability are in the focus of the research work. In addition to process systems engineering, fundamental research in the field of fluid dynamics and separation efficiency, as encountered in thermal separation processes, represents a further core competence. Additionally, intensified processes are developed and investigated in detail. For example, novel concepts for homogeneous catalysis in innovative switchable solvent systems (microemulsions) as well as novel reactor and operating concepts for heterogeneous catalysis are brought to process maturity. More Information: https://www.tu.berlin/dbta