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# Successful closing of joint EU project HySTOC utilizing Hydrogenious proprietary LOHC technology for hydrogen storage and transportation in Finland

**Kokkola & Espoo/Finland, Erlangen/Germany, 19 May 2022. The HySTOC EU project initiated in January 2018 and located in Finland has been successfully finished recently by its Finnish, Dutch and German partners. The joint project name is a byword for "Hydrogen Supply and Transportation using liquid Organic Hydrogen Carriers" (LOHC). Its aim was to establish and test an efficient hydrogen value chain utilizing Hydrogenious' proprietary LOHC technology in Finland, from production to use, to facilitate international learnings. Hydrogenious LOHC Technologies, leading the project consortium, announced that this was achieved in all crucial midstream issues.**

The containerized LOHC systems from the German market leader **Hydrogenious LOHC Technologies** for the storage and release of hydrogen from the liquid carrier have proven their qualities as demonstrators within the HySTOC project – in long-term and remote operation, 24/7, at local double-digit sub-zero temperatures, as well with a hydrogen release in a purity needed. The last phase, which started about 12 months ago, was particularly important: The ReleaseBox 10 was operated in Espoo by VTT over 2,000 hours and the quality of the released hydrogen was scientifically tested to ensure a purity according to ISO 14687:2-2019 for use in fuel cells. "Despite the challenges that arose in five years of project duration – not only the pandemic but also the sale of the relevant business unit by the partner where the direct hydrogen filling station application was to take place – the HySTOC joint project has become a very successful one" explains Stefan Naser, Chief Operating Officer of Hydrogenious LOHC Technologies. "Hydrogen in the amount of around 2 tons was stored and released from our LOHC material. We thus benefit from these demonstration project findings for our ongoing upscaling implementations."

The participating **VTT Technical Research Centre of Finland** in Espoo, who was operating the hydrogen release plant and analysing the quality of the re-released hydrogen over several months, gained satisfactory results regarding purity demands and ReleaseBox operation. The project gave hands-on operation experience on LOHC technology and its future implementation. The successful transport of hydrogen within the LOHC liquid was demonstrated between Kokkola and Espoo test sites over a distance of 500 km. The hydrogen quality analysis showed that on average the hydrogen quality fulfilled relevant ISO standard limits, which was a key target of the project.

That also showed the positive output of the so-called pressure swing adsorption (PSA) of project partner **HyGear,** making sure that the hydrogen released from the LOHC is purified to hydrogen fuel standards, for refuelling cars or trucks with fuel cell engines. The hydrogen produced meets the purity specification and by optimising the PSA controls a hydrogen yield higher than 90 per cent was measured during the full operation of the ReleaseBox10.

The other scientific research partner in the project is the German **Friedrich-Alexander University Erlangen-Nuremberg (Institute of Chemical Reaction Engineering (crt))**: The crt also draws a

positive conclusion with view to its research activities during the project. Especially the introduction of a new LOHC material which is more suitable in cold environments and has an improved hydrogen release rate can be mentioned as a major finding. In addition, by integrating an electrochemical hydrogen compressor (EHC) into the hydrogen release process, the hydrogen released from the LOHC can be purified and compressed in one unit. Moreover, the option to use the EHC to draw vacuum within the reactor accelerates the hydrogen release reaction and enables lower reaction temperatures from a thermodynamic point of view due to the chemical reaction equilibrium shift. The results of this combination of LOHC and EHC technology have been published in the widely recognized International Journal of Hydrogen Energy.

Hydrogenious LOHC Technologies' StorageBox 10 was successfully commissioned at the **Woikoski's** hydrogen production site in Kokkola in spring 2021 – despite the local -23 degrees Celsius. Woikoski established the test facilities and assembled the StorageBox/ReleaseBox to both Kokkola hydrogen production site and VTT, Espoo. Woikoski produced the hydrogen for the test, bound the hydrogen to the liquid organic carrier material for the transportation, after which released the hydrogen from the LOHC in the ReleaseBox, for VTT's further testing.

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(1) Successful closing of EU joint project HySTOC utilizing Hydrogenious proprietary LOHC technology for hydrogen storage and transportation in Finland (from left to right: Cornelius Randing and Vinzent Ruf, Project Lead at Hydrogenious LOHC Technologies; Johan Tallgren and Aki Braunschweiler, Project Lead at VTT) © HySTOC project

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## About HySTOC (Hydrogen Supply and Transportation using Liquid Organic Hydrogen Carriers):

The HySTOC project demonstrated the cost-effective transport and storage of high purity hydrogen (ISO 14687:2-2012) in Finland, using Liquid Organic Hydrogen Carrier (LOHC) technology in an unprecedented field test. The project addressed the whole distribution chain from centralized hydrogen loading, transportation up to the on-site release and usage. HySTOC comprises 5 partners (including 2 SMEs, 1 industrial and 2 scientific partners) from 3 European countries (Finland, Germany, The Netherlands). The partners cover the whole value chain from basic research and testing (Friedrich-Alexander University/CRT and VTT) through core technology development (Hydrogenious LOHC Technologies and HyGear) to the end-user that will operate the LOHC-based hydrogen infrastructure (Woikoski Oy). www.hystoc.eu

## About Hydrogenious LOHC

Hydrogenious LOHC adds the missing link to high-performing hydrogen value chains globally. Based on its proprietary and proven Liquid Organic Hydrogen Carrier (LOHC) technology with benzyl toluene as carrier medium, Hydrogenious LOHC allows for superior, flexible hydrogen supply to consumers in industry and mobility across the globe, utilizing conventional liquid-fuel infrastructure. Founded in 2013, the portfolio of the market-leading pioneer and its joint venture companies today includes stationary and mobile (on-board) LOHC-based applications: Hydrogenious LOHC Technologies, headquartered in Erlangen/Germany, offers – within an EPC partnership with Bilfinger – (de-)hydrogenation turnkey plants, Operation & Maintenance and LOHC logistics services – ensuring safe, easy and efficient hydrogen storage, transport and distribution. Hydrogenious LOHC Emirates, based in the United Arab Emirates and a joint venture with Emirates Specialized Contracting & Oilfield Services (ESCO), acts as the regional spearhead in the Middle East since the end of 2021. Hydrogenious LOHC Maritime, established in 2021 jointly with Østensjø Group and located in Norway, develops an emission-free onboard propulsion system with a promising LOHC/fuel cell solution for the global shipping industry. With its >130 staff members and investors AP Ventures, Royal Vopak, Winkelmann Group, Mitsubishi Corporation, Covestro, JERA Americas, Temasek, Hyundai Motor Company, Chevron Technology Ventures and Pavilion Capital, Hydrogenious LOHC is a major enabler and accelerator for the energy transition. www.hydrogenious.net | www.hydrogenious-emirates.ae | www.hydrogenious-maritime.net

## About Hydrogenious LOHC' Storage and ReleaseBox 10

The hydrogenation and dehydrogenation system used in the project (StorageBox19 and ReleaseBox 10) are each 30-foot containers. This plant output class releases about one kilogram of hydrogen per hour from about 20 liters of LOHC material. A 24-hour operation is possible. The release takes place with a compression of 45 bar. From the release box, the hydrogen then enters an intermediate storage tank, which ensures compression to the 350 bar (bus, truck) and 700 bar (passenger car, light commercial vehicle) required for refueling. For refueling stations of large hydrogen truck and bus fleets, larger release plant systems are available in a capacity range of about 1.5 tons of hydrogen per day. These would be connected to correspondingly large underground tanks.

## About HYGEAR

At HyGear, we believe that hydrogen will be the fuel of the future. With state-of-the-art technologies to generate and recycle hydrogen at or near the end users' site, HyGear offers the most optimal and cost-efficient supply with the best reliability and lowest environmental impact. Providing worldwide services in the existing industrial gases market and the upcoming market for hydrogen energy, HyGear is set on a mission to establish local hydrogen sources globally. As a member of the Xebec Group, we are dedicated to help the world transition to a low-carbon future. Together with our affiliated companies, we deliver premium technologies for renewable natural gas, hydrogen as clean future energy carrier, and on-site generation and recycling of industrial gases. With a global network of technical services companies, we are able to provide installation, servicing and maintenance of our equipment worldwide. www.hygear.com | www.xebecinc.com

## About Woikoski

Woikoski Oy, an innovative and forward-looking company, established in 1882, is an independent Finnish family business specialised in the gas industry. We produce gases and work among gas network solutions, services and devices. Furthermore, we offer equipment for the medical sector, as well as welding products and services. Our hydrogen manufacturing has started already in 1913. During 2010 - 2014 we built new European's most effective hydrogen plant at that time, and three hydrogen filling stations, two to Finland and one to Sweden, we also invested in hydrogen transportation units. https://www.woikoski.fi

## About Friedrich-Alexander-Universität Erlangen-Nürnberg & Chemical Reaction Engineering (CRT)

The Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) is one of the few comprehensive universities in Germany with a strong faculty of engineering. The Institute of Chemical Reaction Engineering (CRT) (head of institute: Prof. Peter Wasserscheid) is part of this faculty in the department of Chemical- and Biological Engineering. Since 2009, the Wasserscheid group focuses its research efforts on chemical energy storage technologies, in particular on hydrogen storage using Liquid Organic Hydrogen Carrier (LOHC) systems. The group develops this technology for stationary and mobile applications. CRT's core competence is the catalyst development and the design and testing of novel reactor concepts. CRT has an excellent track record in successful technology transfer and acts at the interface between fundamental engineering research and R&D towards technical commercialisation. www.crt.tf.fau.de

## About VTT

VTT Technical Research Centre of Finland Ltd is a state owned and controlled non-profit limited liability company established by law and operating under the ownership steering of the Finnish Ministry of Employment and the Economy. VTT is impact-driven and from its wide multi-technological knowledge base, VTT can combine different technologies, produce information, upgrade technology knowledge, and create business intelligence and added value for its stakeholders. VTT has a staff of 2100 and turnover 254 M€ (2021). VTT receives approximately one third of its total income directly from the Finnish government. This allows VTT to carry out high-risk strategic research and to invest in research and technology infrastructures, which are necessary to generate the knowledge and expertise required for fulfilling VTT's public mandate. VTT fuel cell research supports industry product development by maintaining a development platform comprising of a large selection of research facilities, a selection of developed modelling tools and expertise encompassing different technologies throughout the entire business chain. The main research areas today are PEMFC and SOFC, including systems, applications, demonstrations, stacks, components, and materials. In addition, the fuel cell research is closely connected with the work on electrolysis and hydrogen quality. VTT is a member of N.ERGHY Research Grouping. https://www.vttresearch.com/

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Clean Hydrogen Partnership

Co-funded by the European Union

## About the Clean Hydrogen Partnership

The Clean Hydrogen Partnership is supporting research and innovation (R&I) activities in hydrogen technologies in Europe. It aims to accelerate the development of advanced clean hydrogen applications ready for market, across end-use sectors such as energy, transport, building and industry, while strengthening the competitiveness of the clean hydrogen value chain. The members of the partnership are the European Commission, fuel cell and hydrogen industries represented by Hydrogen Europe and the research community represented by Hydrogen Europe Research.