20th June 2024

Clean Hydrogen Partnership supported REFHYNE project successfully concludes, developing and operating a 10MW PEM electrolyser in Germany.

REFHYNE is a first-of-a-kind project at the forefront of the effort to supply green refinery hydrogen for Europe. Supported by the European Commission's Clean Hydrogen Partnership, the project has installed and operated Europe's first 10MW PEM electrolyser and will conclude successfully on the 30th June 2024.

The project began in January 2018 with the aim to validate the business model for using electrolytic hydrogen as an input to refineries and prove the revenues available from the replacement of hydrogen produced through steam methane reforming and the generation of greenhouse gas quotas. These revenue streams will become even more relevant as the German regulation on renewable fuels of non-biological origin is changing on 1st July 2024. This ambitious project has worked to improve the state of the art in all aspects of a business case for hydrogen production for refinery applications, in addition to exploring and assessing the business model for green hydrogen in other settings, including for mobility.

As the REFHYNE project concludes, it has delivered on most activities and objectives set out at the commencement of the project. Despite significant challenges, such as the impact of the Covid-19 pandemic and subsequent European energy crisis on the build and development phase of the project, the REFHYNE consortium has managed to overcome these issues to deliver a successful project.

The first-of-a-kind nature of the project resulted in the need to overcome barriers and bridge knowledge gaps between industrial partners during the design phase, providing the opportunity for partners to deviate from traditional industry rules. Strong collaboration and an emphasis on supporting the project team allowed for a successful transition from design into manufacturing, despite delays due to the impacts of Covid-19. The impact of this pandemic on the REFHYNE project should not be understated, as travel restrictions and national lockdowns impacted the delivery of this multi-national project well into the execution phase.

Despite external challenges, the REFHYNE project built a collaborative, cross-functional team including all necessary disciplines from all participating companies that has been essential for

the success of the project. This culminated in the inauguration of the electrolyser taking place on 2nd July 2021, making it the first plant to use this technology at such a large scale in a refinery. The commissioning was then finalised after two years by mid-2023.

The final phase of the project has seen the successful operation of this ITM produced system, the gathering of operational data and further dissemination of emerging project results. The project has held several roundtables and workshops with stakeholders across the hydrogen value chain to demonstrate the business case and share project results.

A final event was held on the 19th June 2024 to commemorate the end of the project and share results and outputs with a targeted group of invited audience members. The project will also publish a public final report setting out the key lessons learned during project operation from a technical, economic and environmental perspective. This report will be available by September 2024.

REFHYNE has been a flagship project for the industrial decarbonisation sector, testing and validating the business model for the use of green electrolytic hydrogen in a refinery setting. Despite the challenges faced, the project has successfully met its key aim of developing and operating a 10MW PEM electrolyser in a real-world industrial setting. REFHYNE has already led to significant improvements in both the construction and operations of new multi-MW size electrolysers. This project will continue to pave the way for other such projects in the sector, and its success is thanks to the collaboration of project partners and the support of the Clean Hydrogen Partnership.

Quotes from REFHYNE

Eli Aamot, Executive Vice-President, Sintef: Hydrogen technology in Europe has matured a lot over the past 15 years and is now scaling up. We are proud of contributing to the realization of one of Europe's largest electrolysis plants—a milestone for Europe's green transition. While electrolysis technology is now mature, some system challenges still remain. An important message from this spearhead project is that we are now at a point where entire value chains can plan to integrate hydrogen into their processes and logistics.

Mireala Atanasiu, Head of Unit Operations and Communication, Clean Hydrogen Partnership: It is great to see the successful conclusion of one of our largest electrolyser development and demonstration projects. REFHYNE brought together key players in the hydrogen sector and successfully developed the largest high-pressure PEM electrolyser within a major refinery. Integrating the electrolyser within the refinery led to significant improvements in its design and

certification, advancing the European electrolyser industry as a whole. The Clean Hydrogen Partnership is proud that this landmark project has successfully promoted green hydrogen production technologies in the EU's energy and environmental policies.

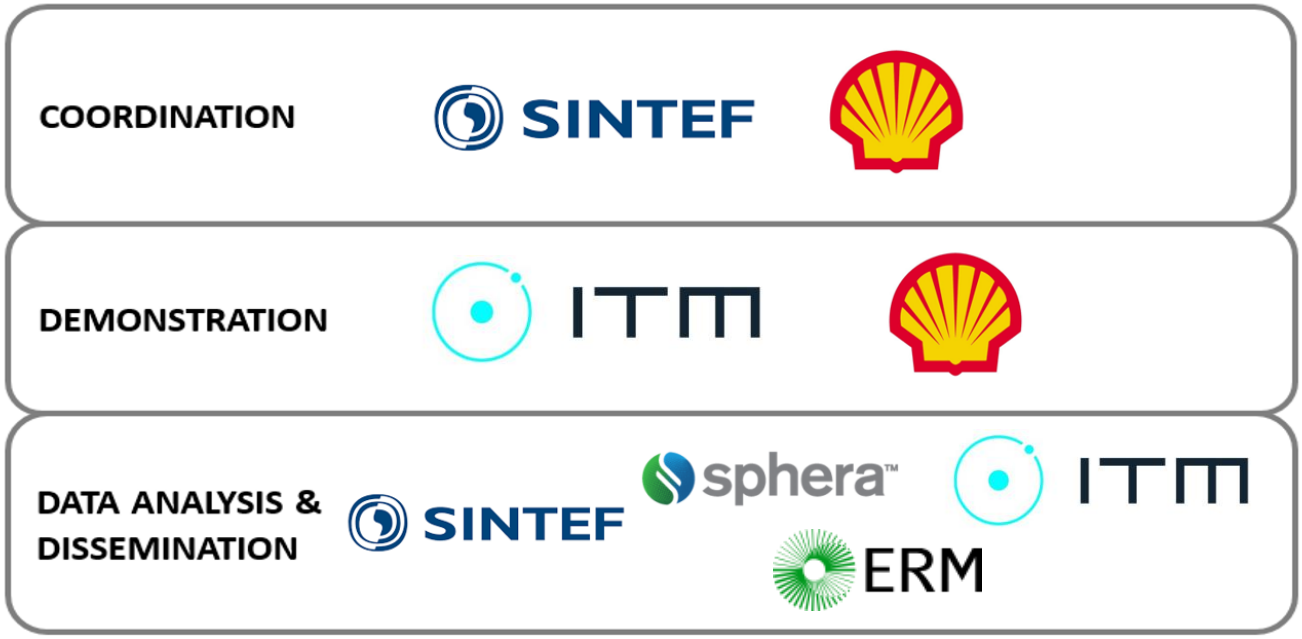
Michael Dolman, Partner, ERM: The REFHYNE project has demonstrated the production and use of green hydrogen in a working industrial setting and has provided valuable experience of how innovative technologies can perform in the real world. We are grateful for the opportunity to have collaborated with all partners involved on this ambitious project and thank the Clean Hydrogen Partnership for their support of the REFHYNE initiative.

Wolfgang Krueper, Wolfgang Krüper, Project Manager R 3 Baseoil, former Project Manager REFHYNE, Shell*:* REFHYNE has been an important interim milestone for Shell stepping into the producing of green hydrogen as a starting point for future decarbonization of the Energy & Chemicals Park Rheinland. We have made significant progress understanding challenges and complexity implementing a first of a kind technology. Learnings from the REFHYNE project have been key developing larger electrolyser projects within Shell. Further policy support is required to ensure frame conditions for economical viable business cases for renewable hydrogen generation in Germany. Less complexity for renewable power sourcing and longer-term planning certainty for the next decade would be key to accelerate a growing renewable hydrogen economy.

Dr Simon Bourne, Chief Technology Officer, ITM Power: We are proud of the successful conclusion of the REFHYNE project. This groundbreaking initiative has demonstrated the viability and potential of green hydrogen production in a refinery setting at an industrial scale. The achievements of the project, which saw much of the work take place during the global pandemic, highlight the dedication of all partners involved, and ITM’s ability to deliver electrolyser projects even during the most testing of circumstances. Furthermore, the data gathered from REFHYNE shows ITM’s market leading stack performance together with extreme operational flexibility. REFHYNE has been a true lighthouse project that has made a substantial contribution to the industry.

Dr. Michael Baumann, Sustainability Consulting Manager, Sphera: The realisation of the REFHYNE electrolyser has shown that hydrogen electrolysis based on certified green electricity has the potential to reduce greenhouse gas emissions of various applications. Sphera's analyses show, for example, that green hydrogen contributes to a reduction in greenhouse gas emissions from refineries.

Acknowledgements



Clean Hydrogen Partnership

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