End use of **Clean Hydrogen**

End use of Clean Hydrogen

Low-emissions hydrogen has the potential to replace fossil fuels in hard to abate sectors and enhance national energy security, as such it is expected to play an important role in the low carbon energy future. The Carbon Trust has identified four key areas where the use of low carbon hydrogen can deliver high levels of decarbonisation; firstly in industrial processes such as oil refining and chemical production where carbon intensive hydrogen is already used as a feedstock; secondly in high temperature industrial processes such as steel or glass making for processes where electrification is not more suitable; thirdly in unlocking grid flexibility in a low carbon grid, where hydrogen can provide inter-seasonal energy storage and re-electrification to allow balancing of the grid when demand does not match renewable supply; and finally in hard to abate transport sectors such as long haul aviation and shipping.[1]

Mission Innovation's Clean Hydrogen Mission looks to enhance knowledge sharing and international collaboration in clean hydrogen amongst our 20 member countries (including the European Commission) and collaborating organisations to accelerate innovation. This publication follows an online webinar, co-organised by UK and Chilean co-leads of the Clean Hydrogen Mission with the support of Latin American Energy Organisation (OLADE), to spotlight research and development projects that have successfully driven progress and/or reduced costs for hydrogen end-use applications.

The aim of the event was to foster international academic, business and government collaboration on demand-side research and innovation, in order to promote innovative, commercially viable and competitive end-use applications that result in overall emissions reductions, particularly in hard-to-abate sectors. It also responds to the calls of the Hydrogen Breakthrough Agenda, for the urgent need to increase the global number of demonstration projects for hydrogen end-use in a diverse range of high-value end-use sectors, and to achieve deep and rapid sharing of knowledge from these demonstration projects with the wider stakeholder community.

Ref

1. Carbon Trust. (2023, June 12). Worth the hype? The role of clean hydrogen in achieving Net Zero. The Carbon Trust. https://www.carbontrust.com/news-and-insights/insights/worth-the-hype-the-role-of-clean-hydrogen-in-achieving-net-zero

Project Name
Element 1

Project Location
UK

Lead Organisation
BAM

Project Partners
GeoPura, Flannery Plant Hire, Plantforce, Reynolds Logistics, Skanska, BRE, ULEMC.

End Use sector and Applications
Development and deployment of hydrogen as an alternative fuel for the construction industry.

Project Summary and Objective

Element 1 is a cross-industry consortium led by BAM which will develop the use of hydrogen as a supplement to lower diesel usage on construction sites, following the approval of a £4,872,653 grant from the UK Government.

The project is funded by the Department for Energy Security and Net Zero and brings together expertise from construction (BAM & Skanska), plant hire (Flannery & Plantforce), hydrogen sector (ULEMCo, GeoPura, Reynolds Logistics) and Research and Technical Organisation BRE.

The Element 1 project will drive forward hydrogen manufacturing and supply chain efficiency, including off-site and on-site production, off-grid compression, innovative storage and distribution solutions. The system is designed to accelerate diesel replacement on construction sites, by replacing current engines with those capable of using 30-50% hydrogen, vastly reducing diesel usage and enabling existing plant use over its remaining lifecycle, eliminating the carbon footprint of scrapping machinery before the end of its lifespan.

Running for around two years, the project will provide practical solutions which will be demonstrated on operational construction sites.

How has your project driven progress in research and innovation for hydrogen demand applications, or reduced costs for hydrogen end-use?

Element 1 seeks to completely eliminate the use of diesel as a fuel on UK construction sites by 2040 and addresses this challenge via a scalable, commercially viable and globally applicable low-carbon alternative to red diesel based on the use of hydrogen. Element 1 will demonstrate an end-to-end solution for the manufacture, supply, distribution and use of hydrogen as an alternative to diesel on construction site, powering construction plant and equipment.

Element 1 integrates state-of-the-art technologies with targeted R&D to address gaps in the end-to-end value chain. It will accelerate the replacement of diesel-using technologies whilst enabling existing plant to continue in use over its remaining lifecycle, accelerating progress towards 'net zero'.

What key learnings can other projects take from your experiences?

The project has now converted all four excavators with dual-fuel capability and a predicted diesel displacement of 30% by using the hydrogen fuel system, significantly lowering carbon emissions. At Victoria North, guests were also able to see the on-site hydrogen storage and dispensing.

In addition to fuelling the Element 1 CAT 320 dual fuel excavator, supplied by Flannery, that is working on the site, the hydrogen storage and dispensing system supplied by GeoPura is also powering one of the site offices and welfare facilities using electricity generated by our hydrogen power unit. This means the site can switch off one of its diesel generators, highlighting the holistic carbon reduction results Element 1 can deliver.

With guests on the demonstration day, including Element 1 project partners and DESNZ (Department for Energy Security and Net Zero) representatives, displaying the technology in action on a live site was a huge success. The highlight is the realisation of the project with the hybrid excavator in action, demonstrating how easy they are to operate and refuel in a real-world project, with no extra training required.

Any Relevant Links
https://www.element1project.co.uk/

olade capevLAC etrela IKI Department for Energy Security & Net Zero CLEAN HYDROGEN

Project Name

H2GLASS

Project Location

Europe (Industrial Demonstrators/ use cases in Italy, Slovenia, France, Norway, and UK)

Lead Organisation

SINTEF

Project Partners

SINTEF Manufacturing (Norway), SINTEF ENERGY (Norway), SINTEF Industry (Norway), National Institute of Chemistry, Fraunhofer (Germany), SENER (Spain), CIB UNIGAS (Italy), Technical University of Catalonia (Spain), Stara Glass (Italy), University of Nottingham (UK), Stazione Sperimentale del Vetro (Italy), Norwegian University of Science and Technology (Norway), STAM (Italy), ASTON University (UK), We Plus (Italy), European Aluminium (Belgium), and Steinbeis Europa Zentrum (Germany), Five Industrial Demonstrators from EU Glass manufacturing: Hrastnik1860 (Slovenia), Vetrobalsamo (Italy), Zignago Vetro (Italy), PTML Pilkington (UK) and Owens Corning (France), One Industrial Demonstrator for replicability in alumunium sector: Hydro Havrand (Norway).

End Use sector and Applications

Technology for successful uptake of hydrogen for combustion and heating in the glass, aluminium, and other energy-intense sectors (long-term).

Project Summary and Objective

H2GLASS aims to create the technology, i.e. burners and furnaces that glass manufacturers need to realise 100% hydrogen combustion in their production facilities, while ensuring the required safety and product quality. The developed technology will be combined with Digital Twin techniques for risk-based predictive maintenance, optimised production control, and combustion system control, which makes it first-of-its-kind as Digital Twin applications are not yet used for this use case. H2GLASS technology will be tested in large scale under real conditions by 5 different industrial demonstrators from the European glass manufacturing industry as well as one replicability demonstrator from the aluminium sector.

How has your project driven progress in research and innovation for hydrogen demand applications, or reduce costs for hydrogen end-use?

The ambition of H2GLASS is to demonstrate hydrogen uptake in the glass and aluminium sector by validating H2GLASS technology in real scale furnaces within relevant industrial contexts in operating production lines proving the economic and environmental viability and feasibility of hydrogen. The developed technology will be combined with Digital Twin techniques for risk-based predictive maintenance, optimised production, and combustion system control. Supply of green hydrogen will be ensured by a portable electrolyser, enabling a sustainable, autonomous, and efficient production of hydrogen.

Taken together, this will represent a major step towards decarbonisation in energy intensive sectors in Europe. H2GLASS technology roll-out in the EU will contribute to EU's climate neutrality (SDG13, Climate Action) by reducing CO2 emissions significantly. By replacing their current fuel consumptions with 100% hydrogen, glass and aluminium cast houses in the EU could, using H2GLASS technology, decrease up to 80% CO2 emissions for glass and 100% for aluminium by 2050. Furthermore, commercial exploitation of H2GLASS technologies as well as educational paths and trainings could create at least 10.000 permanent jobs in the glass and aluminium sectors along with 200.000 new jobs in the hydrogen sector in the EU by 2050.

What key learnings can other projects take from your experiences?

H2GLASS is an industry-driven project, giving different stakeholders the opportunity to benefit from the developed results and gain a better understanding of hydrogen combustion processes. The main H2GLASS exploitable result is an end-to-end digitally optimized technology stack that facilitates the gradual integration of hydrogen into high temperature combustion glass manufacturing processes, which could be of interest to other stakeholders from the glass and aluminium sector as well. Measurement devices developed by H2GLASS, such as thermal vision image analysis and UV capture for hydrogen flame analysis are generally of great value for other combustion processes involving hydrogen. The project also addresses overall issues for hydrogen demand applications such as equipment and processes for the generation and supply of (green) hydrogen. Furthermore, H2GLASS will develop digital IT infrastructures for predictive maintenance operations and system control, which will result in tailored services for Digital Twins that can be further developed towards automation and dark factories. Data from real-scale industrial testing could be re-used to train and strengthen models to further improve combustion processes. Finally, H2GLASS will develop new training courses that can be used to qualify and up-skill technicians and engineers working in the glass and aluminium industry.

Any Relevant Links

https://h2-glass.eu/ https://www.linkedin.com/company/h2-glass/

Project Name

Technical Validation of the Dual Green Hydrogen - Diesel System in Heavy Transport Vehicles

Project Location
Región Metropolitana, Chile

Lead Organisation
AndesH2

Project Partners
SACYR

End Use sector and Applications

Heavy transport, emission reduction through dual Diesel-Hydrogen systems.

Project Summary and Objective

This pilot project validated the implementation of a dual combustion Green Hydrogen-Diesel system in a Chevrolet FVR truck. Its objective was to reduce carbon emissions and diesel consumption in heavy transport by using hydrogen as a complementary fuel. Performance tests, calibrations and technical validations were carried out to ensure the efficiency and safety of the system. The project demonstrated a 20% diesel substitution under controlled conditions, marking a step towards the use of hydrogen in real transport applications.

How did your project drive progress in research and innovation for hydrogen demand applications, or reduce costs for hydrogen end-use?

The project used innovative technologies, such as the dual injection system and specialised calibration software, to integrate hydrogen into a diesel engine without significantly modifying the original design. This reduced implementation costs and validated its economic viability in heavy transport. In addition, energy substitution tests showed that each kilogram of hydrogen can replace 3.9 litres of diesel, improving operating economy and reducing carbon emissions. The use of green hydrogen also supports the energy transition to clean sources, showing how commercial applications can leverage these technologies with a clear return in sustainability and energy efficiency.

What key learnings can other projects take from your experiences?

Integration of hydrogen into existing engines can be achieved without complex modifications. Rigorous calibration testing is essential to optimise efficiency and ensure durability of components.

Pilot testing in real-world conditions is key to validate performance in different operating scenarios, including acceleration and gradients. Partial diesel substitution not only reduces emissions, but also improves fuel economy, making it attractive for commercial fleets.

Collaboration with industrial partners, such as SACYR, allowed scaling up the application of this technology to practical scenarios.

Long-term monitoring and analysis, such as assessing engine wear and the impact on the lubricant, is required to maximise confidence in the system.

Any Relevant Links
https://www.andesh2.com/

Project Name

HidroHaul Technology Program: Hydrogen for zero-emission transportation

Project Location

Santiago, Chile

Lead Organisation

IEE Ingeniería

Project Partners

Walmart, MARVAL, Mining3, COPEC

End Use sector and Applications

Logistics/transportation sector, heavy& light mobility, yardtrucks, reefer

Project Summary and Objective

HidroHaul seeks to decarbonize transportation and logistics in Chile, responsible for 25.5% of GHG emissions, by integrating green hydrogen technologies such as fuel cells in trucks, last mile vehicles, yard trucks and refrigerated trailers. Through three stages: technical validation, industrial evaluation and scaling up, the program promotes zero-emission transportation, improving the competitiveness and sustainability of the sector. Its objective is to validate and scale technological solutions, replacing fossil fuels with green hydrogen, generating local capabilities and enabling infrastructure to transform Chilean logistics towards a cleaner and more efficient model.

How did your project drive progress in research and innovation for hydrogen demand applications, or reduce costs for hydrogen end-use?

HidroHaul is driving research and innovation in hydrogen demand applications by implementing advanced H2 technologies for transportation and logistics, such as trucks, last mile mobility, container refrigeration. These initiatives will allow validating their technical and economic feasibility under local conditions, generating operation, safety and maintenance protocols adapted to the Chilean market. The program incorporates the creation of a specialized workshop and a hydrogen refuelling system, thus reducing infrastructure and technical barriers to the adoption of these technologies.

In terms of cost reduction, HidroHaul seeks to generate economies of scale by integrating multiple hydrogen applications in the same logistics ecosystem, optimizing the use of existing infrastructure. For this reason, it takes as a base the Walmart CDi in Quilicura where the hydrogen plant is located. This made it possible to reduce the costs associated with hydrogen supply. Collaborations with OEMs facilitate access to more competitive equipment and technological solutions appropriate to the Chilean ecosystem. HidroHaul will seek to create transferable knowledge, such as scalable business models, reducing uncertainty for future users and encouraging the energy transition in critical sectors of the Chilean economy, such as mining and urban logistics.

What key learnings can other projects take from your experiences?

Testing and experimental data collection will begin mid-year. Our learning so far may be desirable for companies wishing to develop an H2 project:

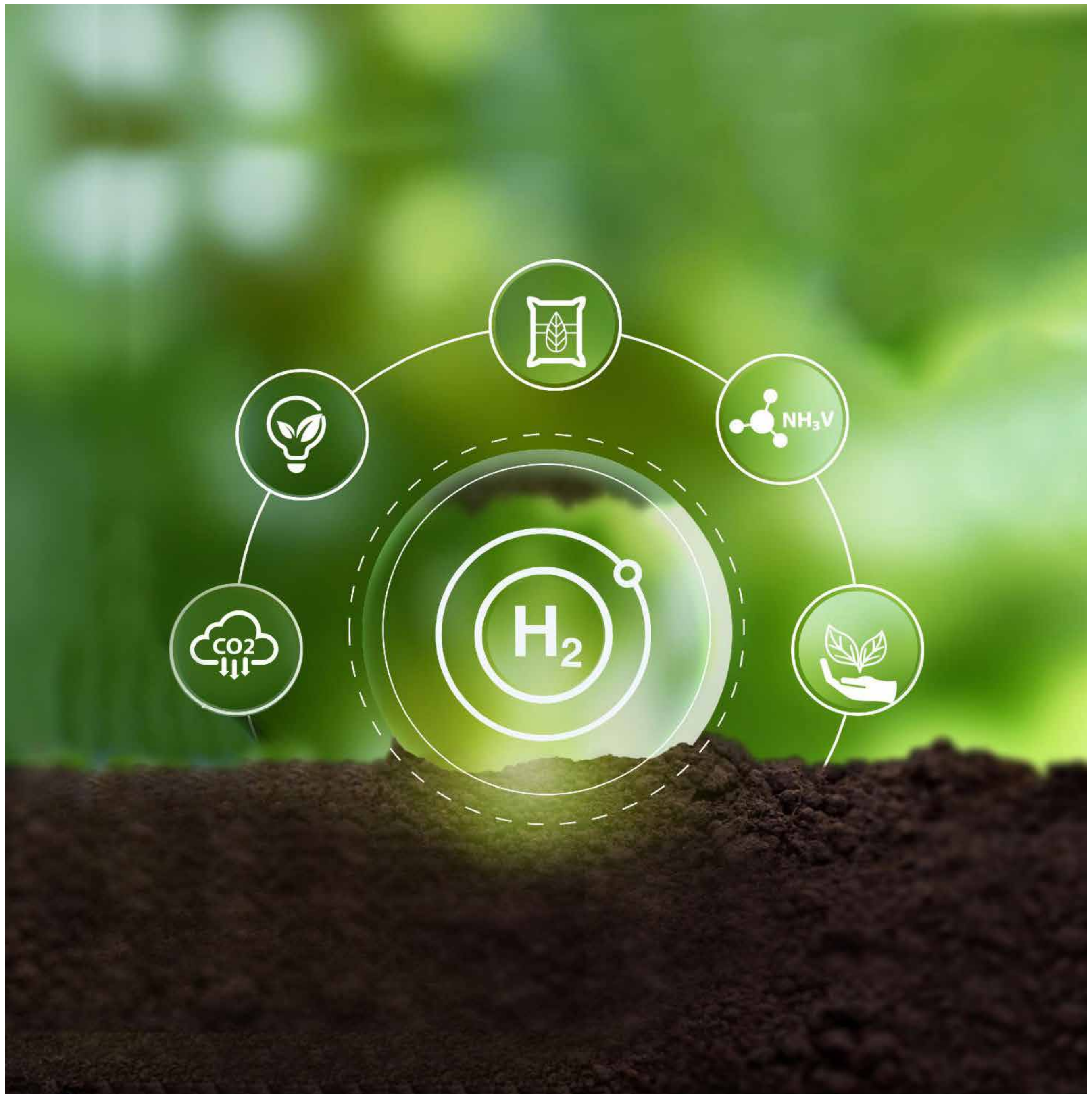
1. Need to build an integrated ecosystem. Companies, even competitors, must work together to create the conditions that enable a future business case. This approach reduces costs, risks and barriers to entry.
2. A technical team, not just graduates, is key to selecting approvable equipment and solving technical problems on site.
3. Local conditions present unique challenges that require prior experience.
4. It is crucial to develop validation projects with a vision of future business, in order to generate the necessary know-how to establish protocols to handle large fleets or volumes of H2.
5. Public-private linkages are fundamental. In Chile, public institutions seek to support hydrogen projects, so establishing relationships with them is crucial to face challenges such as homologation, obtaining permits, and others.
6. The use of public support and leverage mechanisms requires transparency in the management of resources and decisions. Although it adds bureaucracy, it ensures the correct execution of the program and strengthens the credibility of its results.

Any Relevant Links

https://www.iee.cl/hidrohaul/

Project Name

COMASA H2V



Project Location
Región de La Araucanía, Chile

Lead Organisation
COMASA SPA

Project Partners
Corfo, Abastible-Tec, Universidad de La Frontera, Universidad Autonoma, INIA Carillanca, SOFO, FPC Tissue SpA, Adfert.

End Use sector and Applications
Green Fertilizers for Agriculture

Project Summary and Objective

COMASA H2V uses ash from agricultural and forestry waste, combined with green ammonia, produced in situ from green hydrogen, and captures CO2 from biomass combustion to create a new fertilizer. This experimental development project, winner of the 2023 call of CORFO's technology program for the use and adoption of hydrogen in Chilean industry, will install a pilot plant in La Araucanía to produce 18,000 tons of green fertilizer per year. This circular economy project seeks to revalue waste, promote industrial symbiosis and transform the fertilizer market from southern Chile to the world.

How did your project drive progress in research and innovation for hydrogen demand applications, or reduce costs for hydrogen end-use?

The COMASA H2V project has driven research and innovation by integrating key players from the public, industrial, agricultural and academic sectors, generating new applications of green hydrogen in sustainable fertilizer production, a crucial step in addressing global challenges in agriculture. This approach maximizes the efficiency of hydrogen by applying it directly to innovative industrial processes.

In addition, the project reduces costs for end users through local production in La Araucanía, taking advantage of available resources and offering an alternative to the price volatility of conventional imported fertilizers. This approach not only increases food security, but also promotes sustainable agricultural practices, benefiting both the environment and farmers.

Our technology transfer model, based on licensing and strategic alliances, drives mass adoption, reducing costs through economies of scale. In parallel, the development of specialized reactors and the integration of innovative additives reinforce the competitiveness and viability of green hydrogen. COMASA H2V demonstrates how green hydrogen can transform environmental liabilities into productive assets, creating sustainable solutions for the agricultural sector and generating positive local and global impact.

What key learnings can other projects take from your experiences?

The COMASA H2V project offers key lessons that can guide other projects in sustainable innovation. First, it highlights the importance of integrating actors from the public, private and academic sectors from the early stages. These strategic alliances have facilitated the development of potentially disruptive technologies, access to resources and validation in real environments, accelerating the innovation process.

Another key learning is the implementation of a technology transfer model that combines licensing, industrial collaboration and support services. This approach promotes mass adoption, ensures scalability and economic sustainability of the project.

In addition, local production is a key strategy to reduce costs, mitigate price volatility and generate positive social impact. By locating our pilot plant in La Araucanía, we have demonstrated how leveraging local resources can strengthen regional value chains.

Finally, the project highlights the importance of prioritizing the circular economy, transforming environmental liabilities into productive assets. Turning waste biomass into green fertilizers not only generates significant environmental benefits, but also greater market competitiveness. This innovative approach can be replicated by other projects, amplifying their social, environmental and economic impact.

Any Relevant Links
https://youtu.be/7_yr1GmRMQ0?si=gw7YZATjXiYMY8ul

Project Name

AmmTower: Decarbonisation of industrial burners using a self-contained hydrogen fuel gas generator

Project Location
Surrey, UK

Lead Organisation
HYAMTEC LIMITED
(UK Company number 15924441)

Project Partners
Autoflame Ltd

End Use sector and Applications
Decarbonisation of industrial burners for rotary dryers in asphalt processing.

Project Summary and Objective

The project aims to provide fuel to an aggregate dryer for asphalt production by integrating Hyamtec's innovative AmmTower cracker technology into existing burner plant to allow on-demand hydrogen to displace hydrocarbon fuels and confirm the combustion dynamics are maintained whilst reducing carbon emissions.

Project objectives:

- To design and manufacture an integrated system (AmmTower) from the Hyamtec core cracker technology.
- To commission and install the AmmTower on an industrial burner end user deployment.
- To operate the AmmTower and confirm the combustion dynamics using hydrogen
- To confirm the carbon emissions net reduction from the use of the AmmTower.

How did your project drive progress in research and innovation for hydrogen demand applications, or reduce costs for hydrogen end-use?

More than 50% of global combustion emissions come from hard to abate heavy industrial sectors where significant heat energy is required to support their processes.

In the UK hydrogen pipelines are decades away from being connected to industrial burners. The opportunity to electrify is limited due to the scale of investments and time needed to install and connect new furnaces into existing locations and to the grid. Shipping large amounts of hydrogen can be challenging and costly due to the assets involved in the logistics.

Hyamtec has developed an ammonia cracking technology, which is designed to create a hydrogen rich on-demand cracked gas stream (consisting of 75% hydrogen & 25% Nitrogen) from ammonia (NH3). In the short term this cracked gas stream can be readily blended at low levels with carbon-based fuels to confirm that combustion dynamics are maintained (whilst reducing the emissions from carbon-based fuels), with the intent to shift away from carbon-based fuels entirely.

Using Hyamtec's innovative technology enables end users to decarbonise creating an accelerated transition to clean burning hydrogen in the industrial burners sector.

Hyamtec's innovative industrial solution is cost-effective and positioned to beat hydrogen supply economics today and hydrocarbon fuels from 2030.

What key learnings can other projects take from your experiences?

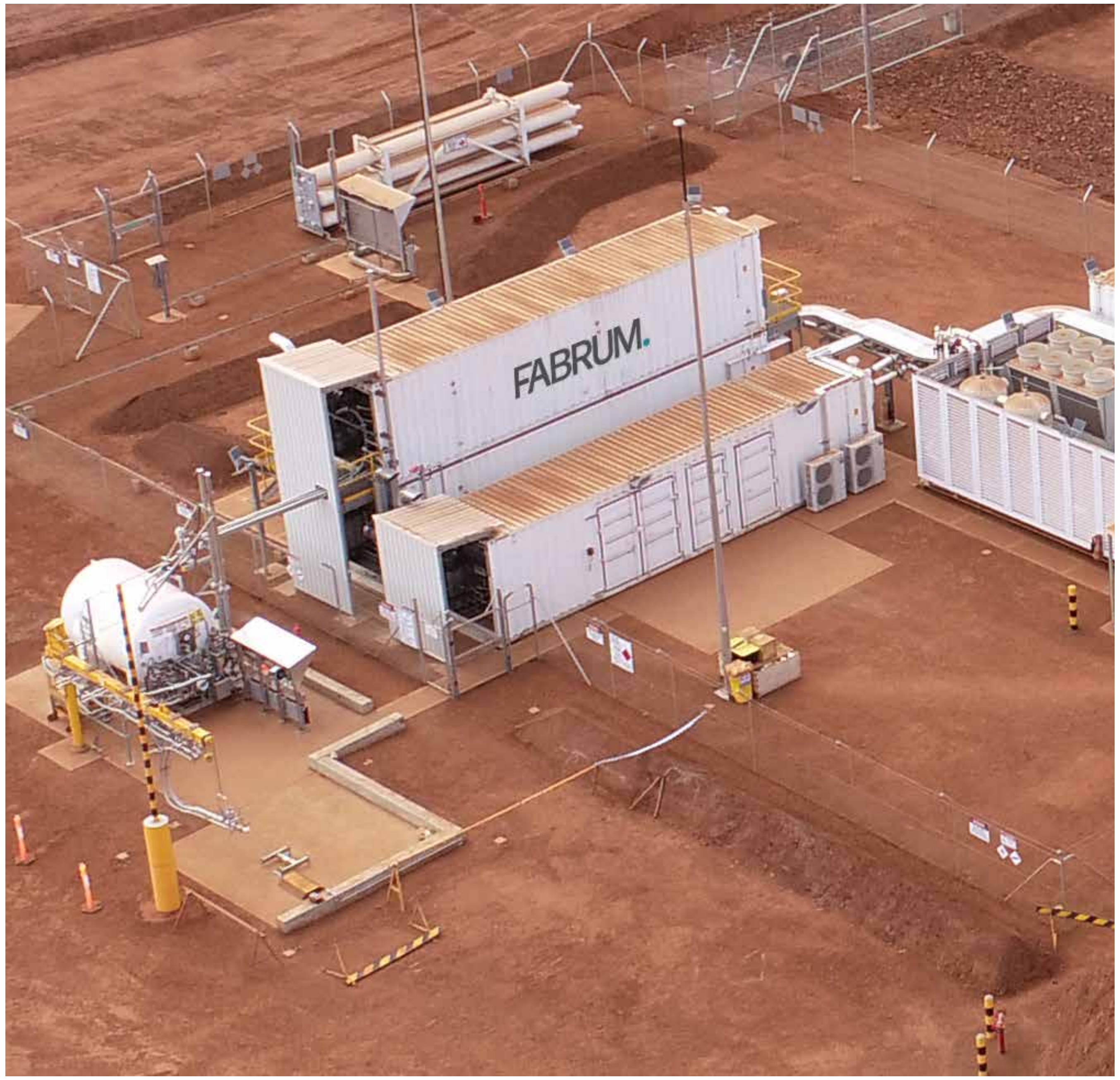
Industry cannot afford to incorporate new technologies on a plant without some level of certainty that the plant would continue to operate and generate revenues. This creates a situation that is limiting the country's ability to catch up with our global net-zero ambitions. Case studies are essential to support the end-users risk profiles and enable invest in new technologies.

Using hydrogen produced by cracking ammonia as a fuel gas enables the same industrial plant to be used which vastly reduces barriers to transitioning to low carbon alternatives for early adopters. Industrial users would understand the economic advantage of shifting to an ammonia-based fuel supply, as well as appreciate the safety and logistical viability of ammonia.

Any Relevant Links
https://www.hyamtec.com/post/hyamtec-launches-ammtower-a-self-contained-hydrogen-fuel-gas-generator

Project Name

Revolutionizing Hydrogen: The World's First Liquefier at a Mine Site



Project Location

WA, Australia

Lead Organisation

Fabrum Solutions Ltd.

Project Partners

Fortescue Ltd

End Use sector and Applications

Mining industry. Use of liquid hydrogen for decarbonization of mining infrastructure.

Project Summary and Objective

The project involves deploying the world's first hydrogen liquefier at a mining site, to prove out de-carbonization of mining infrastructure with onsite hydrogen liquefaction.

The objectives include:

- Demonstrating the technical feasibility and commercial viability of deploying a hydrogen liquefier at point of use.
- Highlighting the commercial challenges and practicalities of deploying hydrogen liquefaction plants in such environments.
- Building knowledge of the technical characteristics of the system, and their impact on the operating efficiency, boil off gas management systems, hazardous area compliance requirements, industrial robustness, and total cost of ownership.
- Gaining key insights from this landmark project and discussing the implications for the future deployment of liquid hydrogen for decarbonization of heavy industry.

How did your project drive progress in research and innovation for hydrogen demand applications, or reduce costs for hydrogen end-use?

The project has significantly advanced research and innovation for hydrogen demand applications by demonstrating the use of on-site hydrogen liquefaction to decarbonize 'hard-to-abate' industry in challenging environments. This deployment at a mining site is a global first, showcasing the technical feasibility of such applications. The project also addresses the technical challenges and practicalities of deploying hydrogen liquefaction plants in these environments.

In terms of reducing costs for hydrogen end-use, the project demonstrates the economic benefits of having hydrogen liquefaction plant at the point of use.

What key learnings can other projects take from your experiences?

Technical Feasibility and Commercial Viability: The project demonstrates that deploying hydrogen liquefiers in challenging environments is both technically feasible and commercially viable. This can encourage similar applications in different sectors.

Zero-Loss System: Liquefying hydrogen at the point of use enables a zero-loss system, significantly impacting the economics of decentralized hydrogen production and liquefaction.

Commercial Challenges and Practicalities: Understanding the commercial challenges and practicalities of deploying hydrogen liquefaction plants can help other projects plan better and mitigate risks.

Impact on Hydrogen Economics: The project shows that decentralized hydrogen production and liquefaction at the point of use can substantially impact the economics of hydrogen as a fuel.

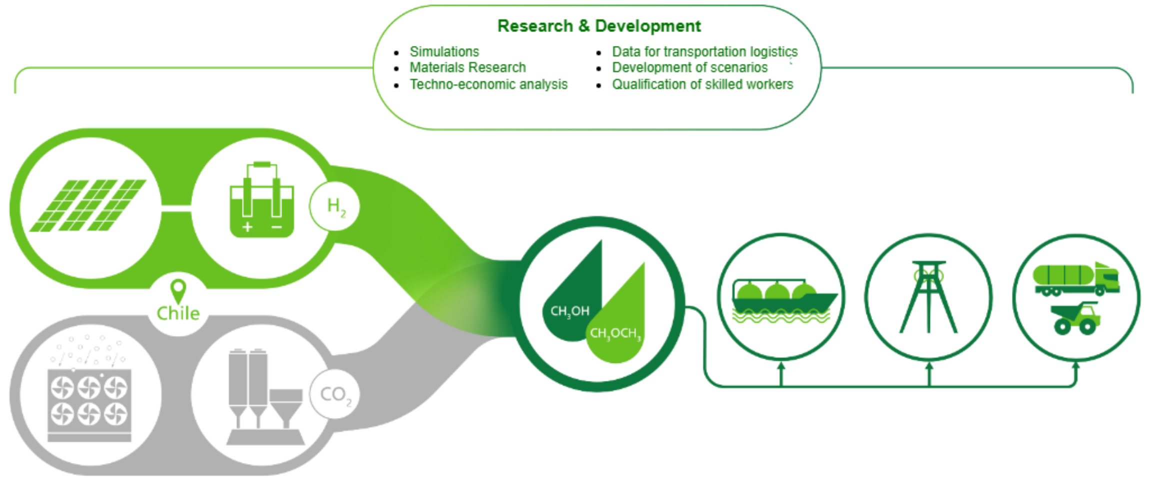
Any Relevant Links

https://www.globalminingreview.com/mining/16082024/fabrum-and-fortescue-commission-australias-largest-liquid-hydrogen-plant-on-a-mine-site/

Project Name

Power-to-MEDME (Methanol and Dimethyl Ether)

POWER-TO-MEDME



Project Location

Antofagasta Region, Chile

Lead Organisation

Fraunhofer IEE with local support from Fraunhofer Chile

Project Partners

Fraunhofer ISE, IEE, IKTS, CAP-CAN, IMM, ISC/HTL, RWTH Aachen, AHK Chile, FIBS RILL

End Use sector and Applications

GAS: LPG infrastructure; MINING: Industrial boilers, heavy-duty vehicles; REFINERY: Production of SAF, Syn DIESEL & Syn Gasoline; Hydrogen Carrier; MARITIME INDUSTRY: Shipping

Project Summary and Objective

The Power-to-MEDME project integrates renewable energy, hydrogen, and CO2 to produce methanol and DME in the North of Chile. The project focuses on the investigation & development of innovative technologies to reduce production costs along the whole value chain. Key objectives include the selection of sites based on GIS analysis, improvement of DME synthesis, integrating solar energy into CO2 capture, optimizing levelized costs by modelling of scale scenarios, Developing of retrofit concepts for mining vehicles, LCA and Business models. The project bridges R&D through laboratory research and industrial-scale implementations, tackling challenges in cost, efficiency, and sustainability, while establishing a roadmap for Chile-German collaboration in advancing the hydrogen economy.

How did your project drive progress in research and innovation for hydrogen demand applications, or reduce costs for hydrogen end-use?

Power-to-MEDME employs a holistic approach to address key barriers in hydrogen end-use applications. It integrates renewable energy with innovative CO2 capture techniques and hydrogen production via electrolysis. The project's pilot facility tests the feasibility of producing methanol and DME with the goal to optimize and improve components, processes and system integration, leveraging solar energy to lower operational expenses.

Key innovations include the use of reactive distillation for DME synthesis, optimization of CO2 capture processes using a Direct Solar Steam (FRESNEL) pilot plant, and the development of retrofit concepts for dump trucks in the mining industry. These retrofit concepts aim to provide cost-effective solutions by utilizing existing infrastructure and applications, enabling the industry to achieve decarbonization goals while minimizing disruption to operations. These advances improve efficiency, reduce energy requirements, and lower operational costs.

Additionally, the project incorporates techno-economic modelling to evaluate cost-effective pathways for scaling up production. By linking R&D to industrial applications such as heating applications based on LPG, Power-to-MEDME demonstrates how hydrogen derivatives can be deployed in sectors such as the LPG and mining sector. Furthermore, it shows that green Methanol and DME have a large export potential for Chile. This dual focus on innovation and practical application reduces costs and accelerates the adoption of low-carbon solutions.

What key learnings can other projects take from your experiences?

Integration of R&D and industrial implementation: Combining laboratory-scale research with pilot plant operations accelerates technology validation and reduces development risks.

Scalability insights: Early integration of techno-economic analyses provides a clear roadmap for scaling up while addressing cost and efficiency challenges.

Retrofit solutions for existing infrastructure: Developing and testing retrofit concepts for dump trucks in the mining industry demonstrates how hydrogen derivatives like DME can be integrated into existing applications, minimizing costs and disruption while achieving decarbonization goals.

Cross-sector collaboration: Partnerships with industry, academia, and government entities foster innovative solutions and shared expertise.

Adaptability to regional contexts: Tailoring technologies to local resources, such as abundant solar energy and industrial CO2 sources, enhances feasibility and acceptance.

Emphasis on sustainability: Incorporating social and environmental considerations, such as lifecycle assessments and social license frameworks, ensures long-term acceptance and compliance with decarbonization goals.

Any Relevant Links

https://www.fraunhofer.cl/es/proyectos/power-to-medme.html

End use of
Clean Hydrogen