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Executive Summary

22

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TABLE OF CONTENTS

DAY ONE

bp Reimagining Energy Showcase 06

Hydrogen's Role Towards Achieving Sustainable Energy Goals. Can Hydrogen Respond to SDG7 Affordable & Clean Energy? 06

A European hydrogen market: where are we and what still needs to be done? – perspectives from the UK, the EU and the Netherlands. 07

Human Capital for the Energy Transition 08

Electrolysis Technologies 09

A world premiere in hydrogen technology by BEH2YDRO 09

Spotlight Session: Geopolitical Impacts of Hydrogen in the Global Energy Transition 09

Hydrogen Production Technologies 10

Hydrogen Scaling Up & Deployment Technologies 10

Waste to Hydrogen 11

Spotlight Session: Making Leak Detection Easy and Safe 12

Spotlight Session: Full Conversion to Hydrogen fueling: Metrobus Crawley depot 12

Hydrogen Transportation & Distribution 12

Spotlight Session: SME's Role in the Hydrogen Future 13

Hydrogen & Mobility 14

Hydrogen and Derivatives – Opportunities For Sellers and Buyers 15

DAY TWO

bp Reimagining Energy Showcase 17

From Production to End-use: The Implementation of Integrated Hydrogen Projects 17

Australia Technologies & Innovations in Hydrogen 18

TU Delft H2 Dream Teams 19

Hydrogen & Renewables 19

Fuel Cells & Batteries 20

Changing the game: In conversation with leading hydrogen startups 21

Spotlight Session: Industrialization of Hydrogen Technology – Scaling up a Heavy Duty Fuel Cell Production 21

The Outlook for Hydrogen 22

Spotlight Session: Hydrogen Refuelling Challenges 22

Spotlight Session: How Green Hydrogen Stays a Solution (instead of a new problem) 22

Spotlight Session: Industrial Process Heat Without Combustion 23

Hydrogen in Hard to Abate Sectors: Decarbonisation 23

Fuelling the Fourth Propulsion Revolution 24

Hydrogen Industrial Applications 24

Hydrogen Health and Safety Technologies 25

THera™ : the new Tenaris technology for all hydrogen applications 25

Low-carbon hydrogen for hard to abate industries 26

NOTE ABOUT THE AUTHOR

William Bowling is a PhD student from the **Sustainable Hydrogen Centre for Doctoral Training** at the **University of Nottingham**, with a background in Mechanical Engineering, his research is focused on sustainability in transportation with a specific aim to improve the combustion of ammonia in internal combustion engines. As part of his PhD study, Will also looks across the broader hydrogen economy developing an appreciation for policy and socio-economic barriers to innovation especially in the energy transition.

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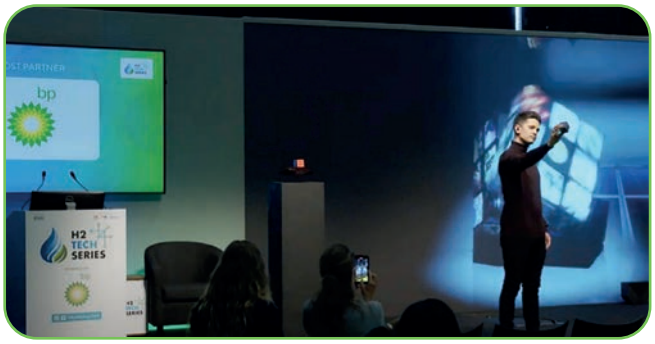
H2 Tech Series Day One

H2 TECH SERIES DAY ONE

bp REIMAGINING ENERGY SHOWCASE

Host partner **bp** begins day one of the World Hydrogen Summit with an introduction to the global energy transition and the challenge that is the climate change puzzle. They describe the challenge that high carbon businesses face today and some of the routes in which the process of "greening" these businesses can be supported by policy and regulations such as carbon pricing, investment, and innovation. bp's own ambition is to become a net zero company by 2050 or sooner by increasing investment in low carbon, developing offshore wind, growing their renewables pipeline, hydrogen, and carbon capture businesses. Looking to hydrogen specifically bp's ambition is to secure a 10% share of the low carbon hydrogen market in key geographies by 2030. Already bp are working with partners in building multiple major hydrogen developments around the world.



HYDROGEN'S ROLE TOWARDS ACHIEVING SUSTAINABLE ENERGY GOALS. CAN HYDROGEN RESPOND TO SDG7 AFFORDABLE & CLEAN ENERGY?

WOMEN IN GREEN HYDROGEN

Rosa Puentes Fernandez, Interoperability Adviser - Hydrogen and Gas Quality **ENTSOG** begins the panel session with a presentation introducing Women in

Green Hydrogen with a question, Why Women in Green Hydrogen? She continues to explain that just one in five speakers at green hydrogen conferences are women, a statistic that is shared across the energy sector with women being underrepresented in all levels and even more significantly in executive positions. Women in Green Hydrogen was set up to challenge these statistics, by creating a network that connects women around the world to share knowledge, best and worst practices to form a movement that demands women's visibility in the sector. They have created a public expert database of women in hydrogen, alongside a successful mentorship programme that connects senior women with those in the earlier stages in their careers. Women in Green Hydrogen are not just virtual, with multiple events planned and previously hosted across the globe.

Panel Chair, **Ann-Kathrin Lipponer**, Policy Officer for Hydrogen and Synthetic Fuels **Ministry of Economic Affairs, Innovation, Digitalization and Energy** of **North Rhine-Westphalia** begins the panel discussions with introductions to each member who provided short presentations to start the panel.

- **Nienke Homan** – CEO of **Impact Hydrogen**, Board Member of **Green Hydrogen Organisation**, and Board Member of **Sustainable Hydrogen Club** highlights the part that green hydrogen plays not just in the global energy transition but also as a tool to transform socioeconomic systems to ensure prosperity for all via hydrogen valleys or ecosystems.

H2 TECH SERIES DAY ONE

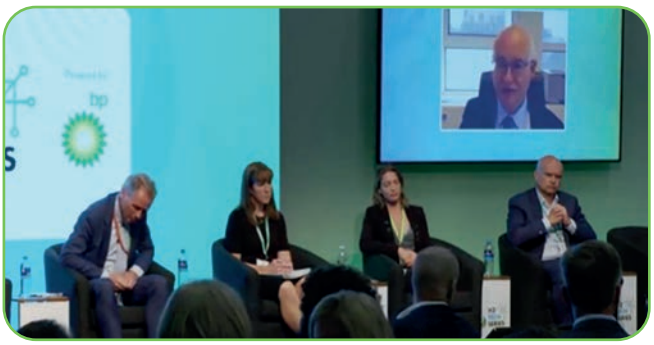
- **Anne Melchers** – Senior Policy Officer of the **Dutch Ministry of Economic Affairs and Climate Policy** presented a summary of the Netherlands current progress in the green hydrogen space, discussing future steps that the government will take to continue developing their own hydrogen economy.
- **Victoria Munro** – Manager for Hydrogen and Advanced Development at **H2X Global** delved deeper into SDG7 highlighting the disadvantages between rural and urban populations when considering access to electricity and proposes hydrogen is already a cost competitive solution in various remote areas.

The panel was focussed on green hydrogen with discussion around what kinds of renewable energy sources should be utilised for the production, as well as considerations for decarbonisation of the transportation sector and how the entire green hydrogen economy can be levered to support sustainable energy ecosystems at the point of use and at the point of production. The final question asked the panellists to consider how the SDGs fit into their current roles.

A EUROPEAN HYDROGEN MARKET: WHERE ARE WE AND WHAT STILL NEEDS TO BE DONE?

UK GOVERNMENT

Introduced by the chair of the session, **Hyung-Ja De Zeeuw**, Senior Energy Transition Specialist **Rabobank**, this talk begins with an interesting, pre-recorded excerpt from **Dr Tudor Contantinescu** - principal advisor to the director general for energy at the **European Commission**. In this excerpt he summarises the European commission's initiatives and thoughts on the challenges that we face with the energy transition, discussing the European Green Deal, "Fit for 55" legislative package and hydrogen strategies. Further alterations to these strategies are detailed as a result of the war in Ukraine, including the increased ambition for renewable hydrogen production from the previous 5.6 million tons to 10 million tons by 2030. The need to enhance efforts to improve certification and standards is also highlighted, to make sure that these targets are achievable and the global market for renewable hydrogen is aligned at every level.



Panel Chair, **Hyung-Ja De Zeeuw** begins the panel discussions with introductions from each member who begin with the question – "What is your role in the hydrogen economy?"

- **Han Feenstra** – Hydrogen International Programme Manager, **Dutch Ministry of Economic Affairs and Climate Policy**, provides an in-depth discussion of the routes in which the Dutch government have been enabling the hydrogen economy by developing policies.
- **Stef Murphy** – Director of Hydrogen and Industrial Carbon Capture, Department for

H2 TECH SERIES DAY ONE

Business, Energy and Industrial Strategy, **UK Government**, highlights the UKs ambitions for hydrogen as detailed in both the energy security strategy and the hydrogen strategy.

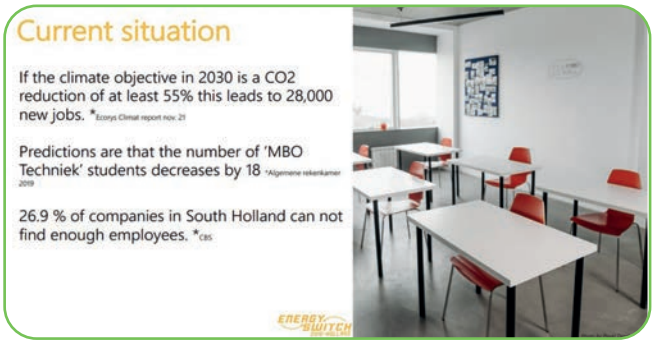
- **Karen De Lathouder** – CEO Netherlands, **bp**, discusses bp's ambitions for hydrogen in the Netherlands including the decarbonisation of existing operations with the H-Vision project as well as the H2-fifty 250 MW hydrogen electrolyser project.
- **Lex de Groot** – Managing Director, **Neptune Energy**, introduces the ambitions of Neptune Energy to become a beyond net zero company with negative emissions by 2030 with CCS and hydrogen production via their Poseidon project.

"What are we waiting for?" is the first challenge put towards the panel, with discussions into what action each party is taking to ensure they are continuing to push forward into the hydrogen space. Infrastructure, regulatory framework, and legislation is identified as key features in accelerating development, although it is highlighted that the developments are already going ahead with some projects being viable even without government subsidy. Another topic discussed is the importance of imported hydrogen, local centralised and decentralised production.

HUMAN CAPITAL FOR THE ENERGY TRANSITION

TU DELFT

This talk consists of three different perspectives discussing the challenges with human capital at various levels of granularity, initially with the national perspective discussing the new Netherlands GroenvermogenNL growth fund, then moving to regional approaches detailing the Energy Switch project and finally



Greenvillage, a field lab. The regional approach, presented by **Jacqueline Van Krieken**, Project Lead for **Energy Switch** South Holland, discusses the current shortage of human capital needed to meet the targets for the energy transition. The project is specifically focused on lateral entrance in the labour market, working to help those in different industries move across and retrain for the energy transition sector.

Lidewij van Trigt, Project Manager for **the Green Village**, presents the fieldlab for sustainable innovation, a place where scientists and businesses to work together and innovate in the real world. The project works on three main areas; sustainable construction and renovation, the future energy system and climate adaptive cities, with developments such as "Hydrogen Street" - a 100% hydrogen gas grid, "H2@Home" - a hydrogen heated home and "EAH" – energy autonomous house, a house utilising solar, fuel cells and electrolysers to operate isolated from the grid throughout the year.

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ELECTROLYSIS TECHNOLOGIES

R2 INTELLIGENT TECHNOLOGIES GMBH

Dr. Helmut Lademann, Managing Director at **R2 Intelligent Technologies** GmbH, presents safety instrumented systems for water electrolysis drawing from lessons learned from over 30 years of experience in the chlor-alkali electrolysis industry, one of the largest chemical processes in the world. He highlights the need for per cell voltage monitoring to prevent short circuits and subsequent safety incidents.

Summary/Takeaways

- During the last 30 years of technological evolution in the Chlor-Alkali industry a painful learning process took place, how to operate large bipolar electrolyzer safe.
- Meanwhile, R2's patented EMOS® Safety became state-of-the-art as Safety Instrumented System for Chlor-Alkali, chlorate and hydrochloric acid electrolyzer.
- EMOS® Safety is also for large bipolar water electrolyzer the only way to operate them safe.
- Of course, same as for Chlor-Alkali, single cell voltage information can be used also for much more than safety, like smart maintenance and optimization of operating conditions.
- The information about individual cell performance allows longer utilization of better performing components, while underperformer can be replaced earlier to improve overall power consumption.
- Cell aging can be correlated with operating conditions to optimize the balance between lifetime, power consumption and capacity according to the current production requirements.

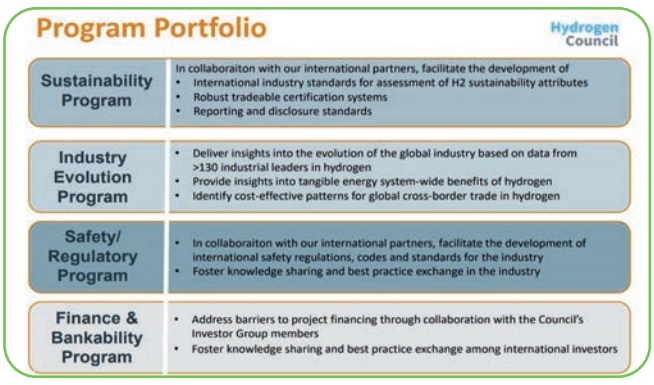
A WORLD PREMIERE IN HYDROGEN TECHNOLOGY BY BEH2YDRO

LED BY BEHYDRO

Roy Campe, CTO of **CMB.TECH** premieres a megawatt spark ignition internal combustion engine run on 100% hydrogen, discussing the development routes taken including single cylinder engine testing for optimisation, full scale production. Confined to a shipping container, the engine achieves an energy conversion of 67kg/MWh of hydrogen with no exhaust treatment. In terms of applications, **CMB.TECH** are developing a hydrogen powered tugboat in the port of Antwerp as well as another project in Japan, they are also looking to apply their technology to inland water barges. Away from marine, BeHydro has already kickstarted a project to convert a locomotive to operate on hydrogen, as well as looking into power generation opportunities.

SPOTLIGHT SESSION: GEOPOLITICAL IMPACTS OF HYDROGEN IN THE GLOBAL ENERGY TRANSITION

Led by **Hydrogen Council** this spotlight session with **Daria Nochevnik**, Director for Policy and Partnerships at the **Hydrogen Council**, focuses on unlocking hydrogen potential and accelerating deployment. The session begins with an introduction to the Hydrogen Council and its four main program portfolio themes; sustainability, industry evolution, safety and regulatory, and finance and bankability. Daria continues to detail an underlying theme of unlocking the social value of the hydrogen economy including a project in partnership with World Business Council for Sustainable Development to produce an SDG roadmap for hydrogen. Another project involved the creation of a policy toolbox to provide a pathway to guide how policies can evolve over time based on the development of the hydrogen markets and economy. The presentation continues to detail key areas in which the Hydrogen Council believes policy will be able to support the uptake of hydrogen such as in carbon pricing schemes, common international standards and certification systems as well as factoring in the social value.



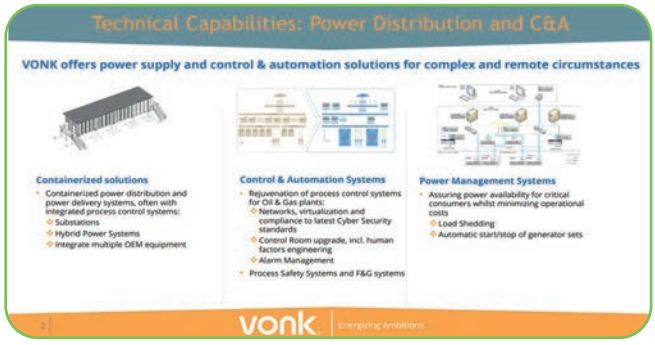
H2 TECH SERIES DAY ONE

HYDROGEN PRODUCTION TECHNOLOGIES

PRF GAS SOLUTIONS

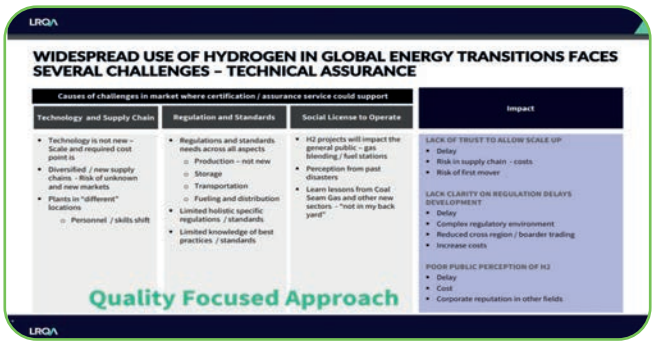
Hugo Antunes, Hydrogen Project Engineer at **PRF Gas Solutions**, introduces the companies story and their current advancements across the hydrogen value chain, including the installation of the first hydrogen refuelling station in Portugal. Hugo goes on to present various hydrogen projects that PRF have been involved in; a project enabling the injection of green hydrogen into a natural gas grid, a portable hydrogen refuelling station entirely contained in a 20ft container, a fixed hydrogen refuelling station in Madrid and various automation systems including monitoring and preventative maintenance systems.

VONK



Bart De Vries, Business Development & Sales Manager at **Vonk**, shares insights that the company has on power suppliers for electrolysers, often referred to as transformer rectifiers including some of the challenges they see when scaling electrolysers and solutions that they have found. He draws comparisons from completed projects with the Max Planck Institute in Munich, powering plasma physics research requiring 55,000 amps of current, as well as an example from the uranium enrichment industry.

LRQA



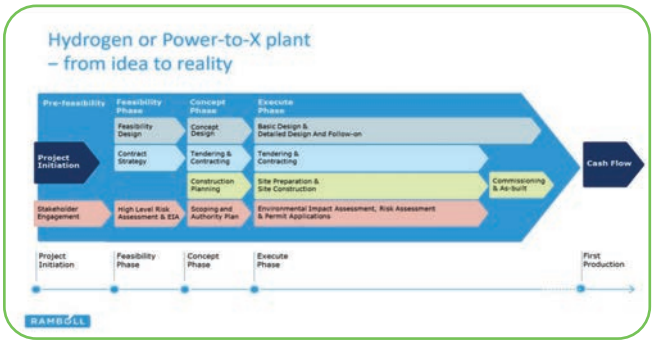
Leanne Halliday, Corporate Account Manager at **LRQA**, presents an introduction to LRQA as well as a discussion into the quality, risks and issues in the hydrogen supply chain. Considering the risks for the expansion of the hydrogen economy, three main areas are specified; technology and supply chain, regulatory and standards framework and social license to operate.

HYDROGEN SCALING UP & DEPLOYMENT TECHNOLOGIES

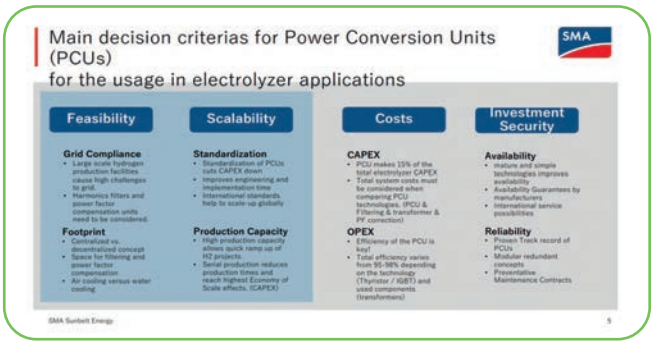
RAMBOLL

Eva Ravn Nielsen, Chief Advisor for Hydrogen & Power-to-X at **Ramboll** begins this session with a presentation "From PowerPoints to Power Plants" – five steps for realising large-scale hydrogen projects. Starting with a brief introduction to Ramboll, Eva moves into summarising power-to-X, a pathway to decarbonising sectors that cannot easily be electrified.

H2 TECH SERIES DAY ONE



The talk focuses on large scale decarbonisation projects and the considerations that we must take during these projects including pre-feasibility studies, partnerships across the whole value chain, site selection processes and much more.

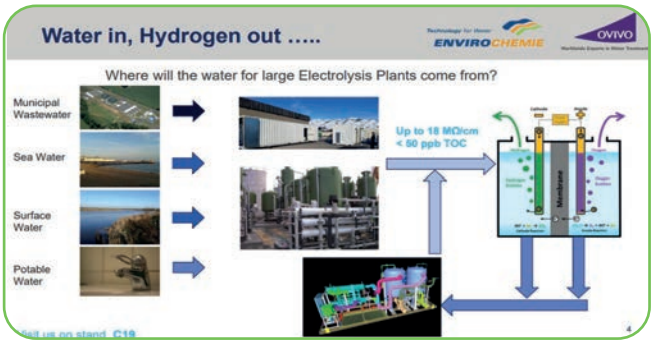


SMA SUNBELT ENERGY GMBH

Fabian Jochem, Head of Strategy at **SMA Sunbelt Energy Gmbh**, continues the discussion around scaling up with a focus on power supply for electrolysers including some of the issues with connecting GWs of load onto local electric grids. Detailing the importance of the considerations taken when planning these projects at scale, highlighting the main decision criteria needed for power conversion units for electrolyser applications.

OVIVO UK LTD

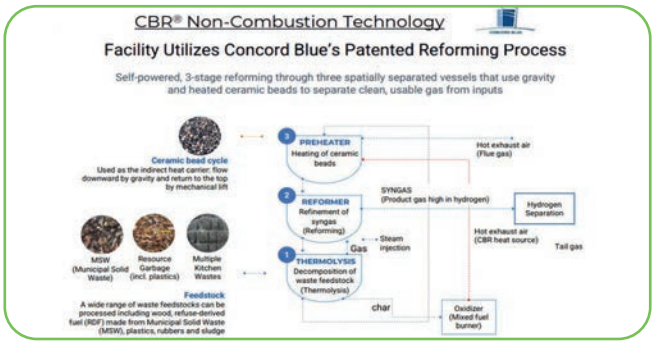
Chris Bell, Pure Water Product Manager at **Ovivo UK Ltd**, changes the perspective discussing the supply of water to large scale electrolysers. The current solutions for MW scale electrolysis can be containerised and



easily fit into the majority of sites, however when expanding to GW scale this will require significantly larger facilities. These facilities are using tried and tested methods and are within the realms of possibility, however there are challenges when considering the original source of the water.

WASTE TO HYDROGEN

CONCORDE BLUE



Charlie Thannhaeuser, Founder and Inventor of **Concord Blue**, introduces the Concord Blue Reformer which converts any type of waste into a hydrogen rich syngas including biomass waste, agricultural, plastics and many others. This technology focuses on maximising the output of hydrogen without the need for fossil fuels in the process and has been subject to a number of independent technology reviews including from Fichtner, Lockheed Martin and AECOM. Charlie goes on to detail some of the 10 projects completed and operational to date, both commercial facilities and research facilities.

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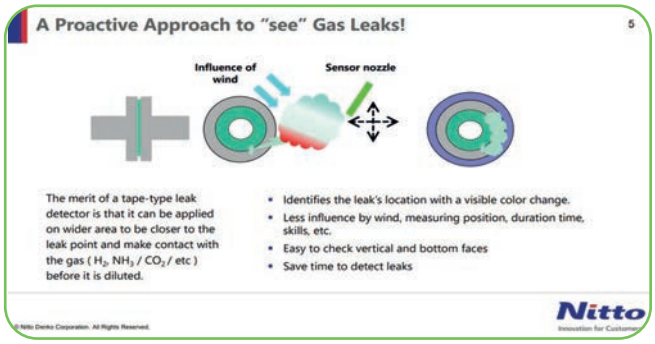
SPOTLIGHT SESSION: MAKING LEAK DETECTION EASY AND SAFE

NITTO AMERICAS



Nahid Mohajeri, Advanced Polymer Technology General Manager at **Nitto Americas**, introduces a new technology for leak detection with hydrogen. Nitto have produced an adhesive tape that will change colour when exposed to hydrogen, initially developed with NASA during the shuttle programme, the product is able to passively detect and locate hydrogen leaks. Other products that use similar techniques include an adhesive patch as well as an ammonia detection tape working with similar principles. In the future Nitto are looking to develop carbon dioxide detection tape that will be available soon.

SPOTLIGHT SESSION: FULL CONVERSION TO HYDROGEN FUELLING: METROBUS CRAWLEY DEPOT

AIR PRODUCTS

Erwan Bruneau, H2fM Product Manager Europe at **Air Products**, begins the talk with some of the history of Air Products experience with hydrogen projects as well as detail of the customer offering including support and maintenance schemes. The main topic of the talk is around the Metrobus Crawley depot conversion, a full fleet and bus depot hydrogen conversion that is currently being undertaken and expected to open in December 2022. One of the challenges highlighted for bus operators was supply of hydrogen within specific fleet windows to ensure specific timescales for maximising uptime.

HYDROGEN TRANSPORTATION & DISTRIBUTION

RESATO HYDROGEN TECHNOLOGY

Rob Castien, CEO at **Resato Hydrogen Technology**, opens the Hydrogen Transportation and Distribution talks with the company's mission, to be a worldwide technology leader for hydrogen refuelling systems. The company has three main targets to focus on; flawless refuelling experiences for the customers, the best business tools for the owners of the stations and company wide sustainable operations. He goes on to highlight the various solutions that Resato offers including a small-scale business fleet refueller as well as a larger scale refuelling station.

H2 TECH SERIES DAY ONE

ATLAS COPCO

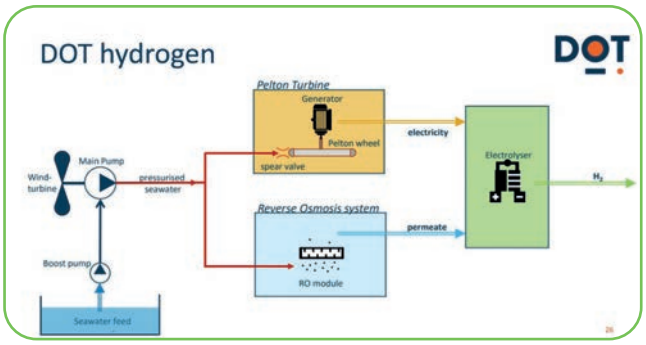
Daniel Patrick, Applications Lead in New Energy & Hydrogen at **Atlas Copco**, presents the different transportation options for hydrogen as well as the case for liquid hydrogen for transportation and turbomachinery's role in hydrogen liquefaction. The focus continues along the lines of hydrogen refuelling stations, with the perspective being on how to deliver hydrogen to said refuelling stations over land.

ROYAL NLR-NETHERLANDS AEROSPACE CENTRE

Roel Van Benthem, Lead Engineer in Hydrogen and Thermal Systems at **Royal NLR-Netherlands Aerospace Centre**, presents their take on hydrogen research in aviation, beginning with drones and moving up to large scale passenger aircraft. NLR is positioned as an intermediate between the initial ideas and research at universities and the wider market, helping research organisations commercialise their ideas and apply them into industry settings. One of the wider programmes that NLR hosts is "Climate-Neutral Aviation", with many demonstrators including piloted hydrogen powered aircraft.

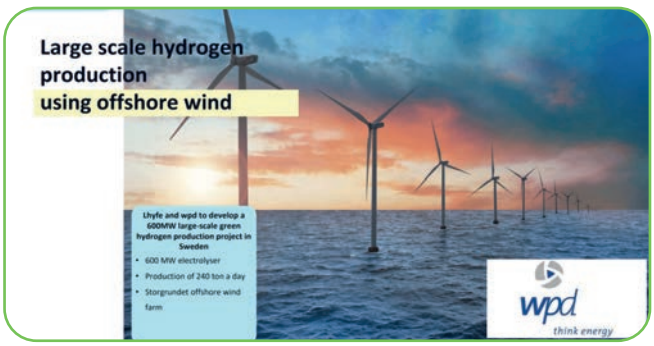
SPOTLIGHT SESSION: SME'S ROLE IN THE HYDROGEN FUTURE

DOT



Jan Van der Tempel, CEO, **DOT**, introduces his adaptation of the offshore wind turbine from an integrated turbine with an electrical generator in the top, to a sea water pump solution which decreases the turbine weight by 50%. The system uses four turbines each pumping seawater to a centralised station that uses standard hydrodam technology to generate electricity, however further developments led the company to use to high pressure water that was output and filter it to produce primary water for use in electrolysers. This project is a proven concept, and the next step is for another turbine to be built in the port of Aqaba, Jordan to provide primary water.

LHYFE



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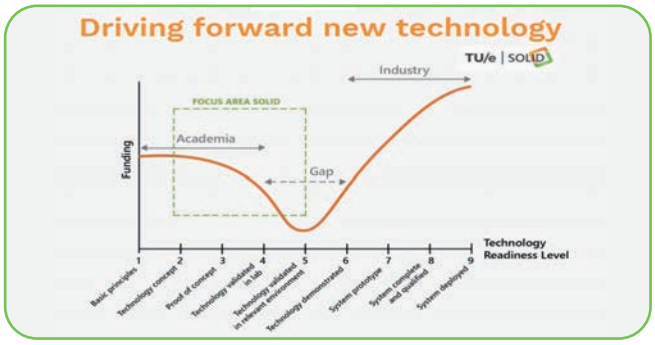
Luc Grare, Director of International Business at **Lhyfe**, presents the background of the green hydrogen production company highlighting their work, already having operational sites producing green hydrogen from wind turbines. Currently building and developing a number of 0-20 MW plants at a smaller but faster to realise scale, to become a supplier of green hydrogen across Europe by 2025. Luc details a number of projects ranging from smaller scale hydrogen production to large scale planned in the coming years.

SOLID



Nick Hol, Project Manager at **SOLID**, and Ellen Meijerink, Team Manager at **SOLID**, present their organisations work developing and researching iron-based hydrogen storage materials. They propose an ecosystem for circular energy carriers that can be used and re-used as a sustainable hydrogen carrier with a demonstrator planned at the end of 2022.

HYDROGEN & MOBILITY

RH2INE

Lilian Froitzheim, Program Coordinator **RH2ine** at Province Zuid-Holland, and **Ann-Kathrin Lipponer**, Policy Officer at **Ministry of Economic Affairs NRW** present the RH2INE project based on hydrogen usage in inland waterway transportation. The group have undertaken a kickstart study assessing the looking to

initiate the use of hydrogen in inland shipping in the short and midterm on the Rhine, the outcomes of which are being used to develop a blueprint for the next phase. The next phase is to implement the short-term strategies, including building twelve hydrogen ships and four refuelling stations.

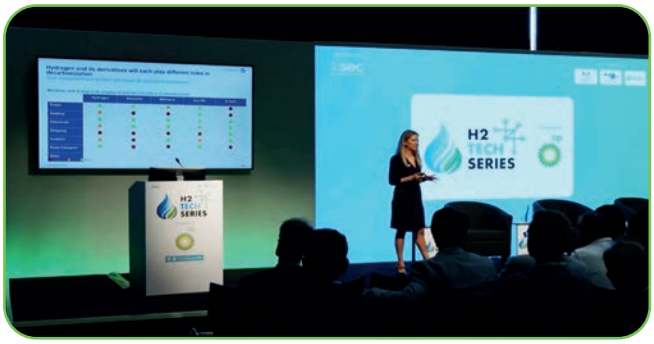
MINISTRY OF ENERGY, CHILE

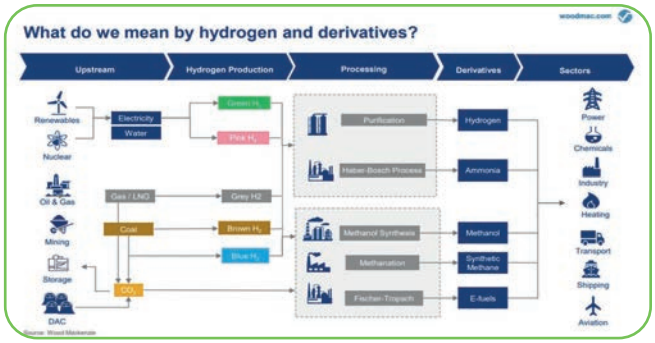
Camilo Avilés Arias, Unit Head for New Energy Carriers at **Ministry of Energy, Chile**, details the country's hydrogen strategy with targets such as the production of 200 kilotons per year of hydrogen as well as 25 GW of electrolysis capacity under operation or construction by 2030. He considers the shipping sector as a key opportunity for Chile, with the focus on the production of green ammonia as a hydrogen carrier to input into markets in Europe and Asia. Chile are looking to foster the decarbonisation of at least six green shipping corridors.

H2 TECH SERIES DAY ONE

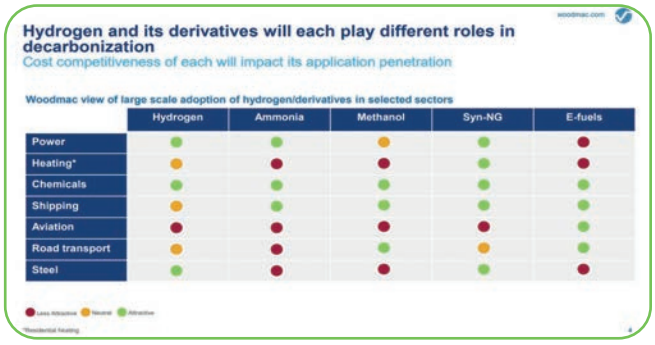
HYDROGEN AND DERIVATIVES – OPPORTUNITIES FOR SELLERS AND BUYERS

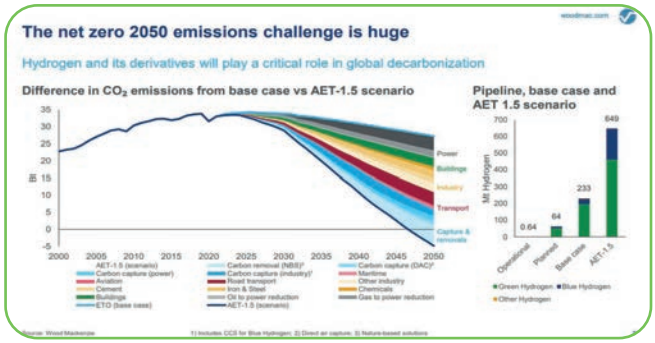
WOOD MACKENZIE

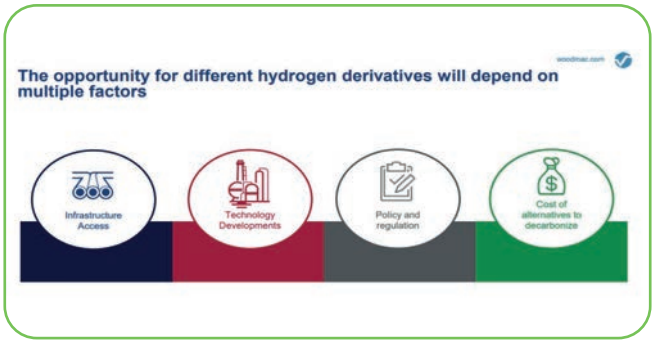




Flor De La Cruz, Sr. Hydrogen Research Analyst at **Wood Mackenzie**, presents hydrogen's role into the future net zero 2050 emissions challenge, with a discussion into the opportunities presented in the expected future hydrogen economy including the production scale required. Flor focuses on hydrogen's derivatives such as ammonia, methanol, and liquid hydrogen, highlighting some of the outcomes from Wood Mackenzie's report looking into transportation of hydrogen around the globe. ■







H2 Tech Series Day Two

H2 TECH SERIES DAY TWO

bp REIMAGINING ENERGY SHOWCASE – REPEATED TALK

Host partner bp begins day two of the World Hydrogen Summit with an introduction to the global energy transition and the challenge that is the climate change puzzle. They describe the challenge that high carbon businesses face today and some of the routes in which the process of "greening" these businesses can be supported by policy and regulations such as carbon pricing, investment, and innovation. bp's own ambition is to become a net zero company by 2050 or sooner by increasing investment in low carbon, developing offshore wind, growing their renewables pipeline, hydrogen, and carbon capture businesses. Looking to hydrogen specifically bp's ambition is to secure a 10% share of the low carbon hydrogen market in key geographies by 2030. Already bp are working with partners in building multiple major hydrogen developments around the world.

FROM PRODUCTION TO END-USE: THE IMPLEMENTATION OF INTEGRATED HYDROGEN PROJECTS

WOMEN IN GREEN HYDROGEN

Introducing the first morning session is **Gokce Mete**, Head of Secretariat - Leadership Group for Industry at **Stockholm Environment Institute** as well as a Co-founder for **Women in Green Hydrogen**, with an initial introduction to Women in Green Hydrogen. The network consists of 2500 women around the world with public expert databases, mentorship programmes and events partnerships.

To kick off the panel session, Gokce asks each member to introduce themselves, and their role in the hydrogen business as well as a provide short talk around their projects. In attendance is;

- **Lijs Groenendaal**, Business Opportunity Manager at **Shell**, working on the Holland Hydrogen 1 project. The project intends to utilise renewable wind power via a grid connection to the Port of Rotterdam where they will build a 200 MW electrolyser which will supply hydrogen to the Shell Energy and Chemicals Park to help decarbonise fuel projects. The hydrogen will also be used to help fuel heavy duty transportation in the local area to ensure that the complete value chain is captured in the project.
- **Jill Thesen**, **Federation of German Industries** (BDI), is working on the German Australian feasibility study on the import of renewable hydrogen. She discusses the roles of partnership and collaboration with the perspective from Germany, who are faced with the challenge of a high renewable energy demand in the form of hydrogen however have a limited potential for domestic production.

H2 TECH SERIES DAY TWO

- **Mirela Atanasiu**, Head of Operations and Communications in the **Clean Hydrogen Joint Undertaking** which supports research and innovations which look to facilitate the transition to a greener society in line with EU policy. Some of the larger outputs of this work include the three hydrogen valleys located in the Netherlands, Mallorca, and Scotland.

The panel moves on to discuss the benefits of partnerships and consortiums, when operating in the hydrogen economy, whether it is business to business or business to research partnerships, as well as investigating what makes large companies shift and invest into the energy transition. The discussion moves on to the barriers to uptake of hydrogen specifically, highlighting the need for scale up technologies and the correct infrastructure for offtake of hydrogen. Finally, the conversation leads to the benefits of working in diverse teams.

AUSTRALIA TECHNOLOGIES & INNOVATIONS IN HYDROGEN

Fiona Simon, CEO of the **Australian Hydrogen Council**, introduces the panellist of this session, with an invitation to each member to introduce what technologies they are involved in, what problems they are looking to solve and what comes next;

- Starting with **Tom Campey**, Chief Commercial Officer at **Hysata**, who discusses Hystata's aim to bring down the costs of green hydrogen, in particular the costs of the electrolyser. With their new electrolyser design, they achieve cell energy efficiencies of 95%, with considerations for large scale manufacture in the design to enable the future of scaling up quickly.
- **Luc Kox**, Commercial Manager at **Hazer Group**, is looking into the commercialisation of methane pyrolysis, a process that cracks methane into hydrogen and solid carbon as graphite with no carbon dioxide emitted. They are very close to commissioning their first large scale plant producing 100 tonnes per annum from a biogas feedstock.
- **Martin Carolan**, Chief Executive Officer at **Global Energy Ventures Ltd**, described his companies view on hydrogen as a compressed gas for ships with the idea of understanding how competitive compressed storage transportation can be across large distances and bigger scales.
- **Matthew Hingerty**, Deputy CEO and Head of Business Development at **Star Scientific** Limited, introduces their Hydrogen Energy Release Optimiser or HERO material, a catalyst that when exposed to hydrogen and oxygen can produce temperatures of up to 800 degrees celsius.

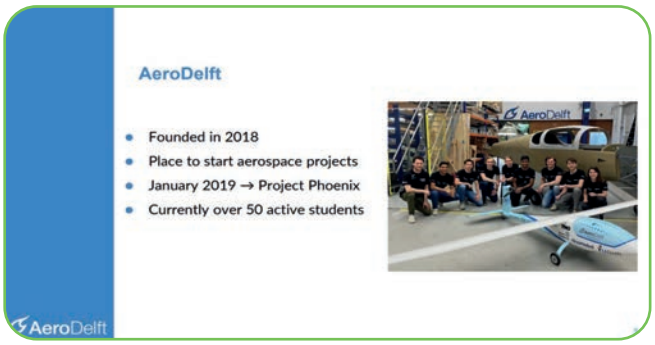
The discussions continue into how the market expectations have changed and accelerated in the past year, with issues highlighted with the regulatory frameworks being behind and slowing down potential innovation work from going ahead. The panel then moves on to discuss what they would like to see from the future hydrogen market, with points around increase in customer demand, policy changes that will enthuse the market and support for the upstream of solar and wind energy.

H2 TECH SERIES DAY TWO

TU DELFT H2 DREAM TEAMS

This talk is given by the Delft University of Technology hydrogen-powered student teams, AeroDelft, Eco-Runner, Forze and HydroMotion. Each team gives a brief rundown of their objectives and their projects to date, with key visions for the future and ambition to produce new innovations in each sector.

- **Rahiq Ullah**, Team Manager at **AeroDelft**, begins the talk with a presentation on Project Phoenix, with the target to prove and promote liquid hydrogen as an alternative to conventional fuels in aviation.



- **Coen Tonnaer**, Team Manager at **Forze Hydrogen Racing**, highlights their teams goal of promoting hydrogen technology to the general public by showing its potential in racing whilst continuing to educate students.

- **Sophie Van 't Hoff**, Team Manager at **HydroMotion**, discusses their teams challenge of designing, building, testing, and racing a flying hydrogen powered boat in one year, with the target of accelerating the implementation of sustainable energy technologies.

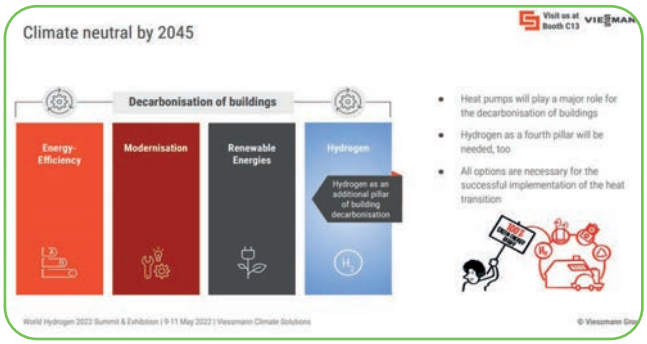
- **Axel Stroeve**, Team Manager at **Eco-Runner Team Delft**, finishes the talk with a description of their teams focus on efficiency, their mission to produce the most efficient hydrogen powered city car.

HYDROGEN & RENEWABLES

Alexander Dauensteiner, Product line owner, fuel cells at **Viessmann Climate Solutions SE**, introduces the first presentation of this session – Hydrogen in Buildings. The challenge he introduces is around the speed of decarbonisation of the housing market, he highlights the key benefits of heat pumps being fitted for new builds and for renovations however the speed of delivery along with other challenges to uptake will hinder the progress significantly towards net zero. One of the key helpers to alleviating this issue is hydrogen, Alexander highlights the

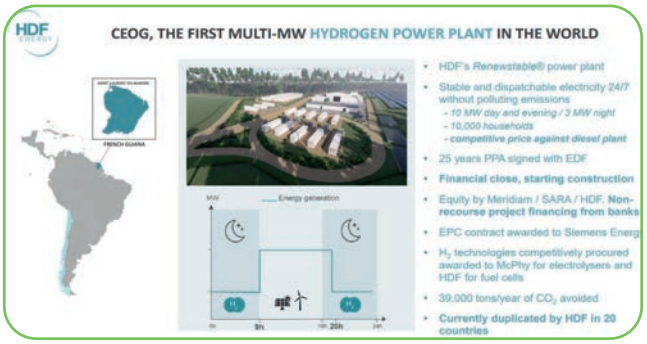
H2 TECH SERIES DAY TWO

need for hydrogen in the harder to convert buildings. He introduces Viessmann's roadmap for producing a 100% H2 ready product portfolio.



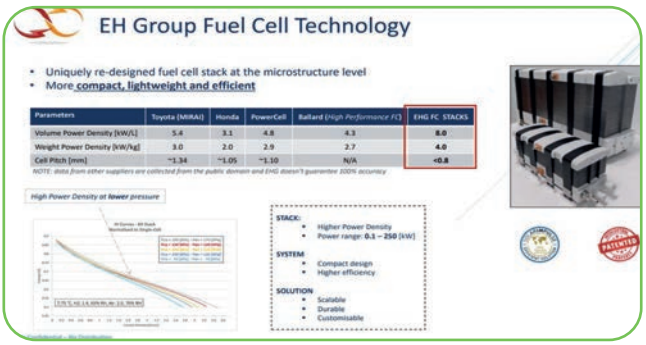
Haraldur Hallgrímsson, Director of Business Development at Landsvirkjun, **National Power Company of Iceland**, discusses some of the steps Landsvirkjun are taking to reach a sustainable world powered by renewable energy. The first project introduced is green hydrogen for road transport, looking to help decarbonise the fishing industries by bringing online 30-70 hydrogen trucks to move the fish from ports to the airport. The second project details green methanol for shipping produced using captured carbon from industry to power two cargo ships on international routes between Europe and Iceland. Haraldur concludes that domestic and international partnerships across the value-chain are one of the main keys to enabling the potential for these projects.

Nicolas Groues, Sales Manager for the large electrolyser for industrial use at **McPhy**, presents CEOG a world first project as well as discussing the roadmap around scaling up electrolysis to a 16 MW scale. Replacing a diesel plant, the intention is pair with a 55 MW solar plant with an electrolyser, fuel cell and storage capacity. The project will deliver a base load of 10 MW green electricity in the day and 3 MW at night with excess solar producing hydrogen and converting back during times of low solar generation. Nicolas also details further on McPhy's production line expansions, with targets to reach a capacity of 300 MW by 2022.



FUEL CELLS & BATTERIES

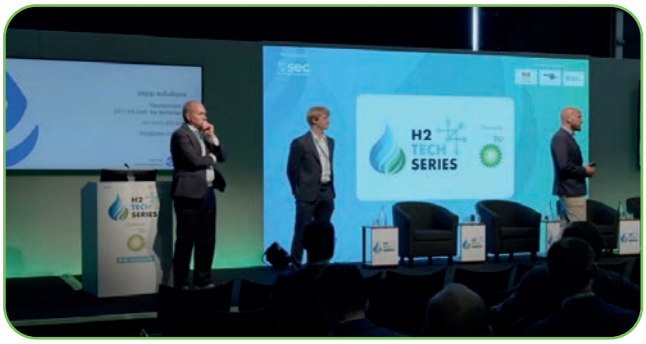
Mardit Matian, Founder and Director at **EH Group Engineering AG**, introduces their engineered low-pressure fuel cell stack technology that utilises a capillary design and focuses on a more efficient system. Working with the European Space Agency, they have completed aggressive testing of the fuel cells including high and low temperature testing, vibration testing as well as g-force testing up to 15gs. In addition to the fuel cell technology, the company is looking to scale up its production capacity to produce 70 to 80 thousand stacks per year, which is around 9 to 10 GW of production, this is enabled by a parallel production process.



H2 TECH SERIES DAY TWO

CHANGING THE GAME: IN CONVERSATION WITH LEADING HYDROGEN STARTUPS

PLATFORM ZERO



Mare Straetmans, Founder of **Platform Zero**, begins the session with an introduction to Platform Zero, a nexus of business and innovation, starting with an energy and climate campus in Rotterdam but looking to also have campuses in Brazil and Portugal. Their mission is to enable talent to initiate and accelerate innovation, venture building and impact initiatives within the maritime and ports sector together with corporates, universities, and entrepreneurs to create a better planet.

VOYEX

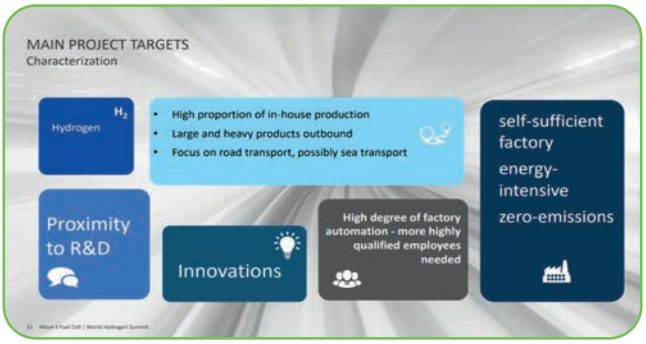
Wiard Leenders, founder at **Voyex**, provides a pitch around their new start-up which focuses on liquid organic hydrogen carrier technologies, focused at the heavy duty sector. Using a "hydrogen oil" as a vector to carry hydrogen, which is a reusable carrier that releases hydrogen with heat and can then be returned to a facility to be recharged with hydrogen. It is predicted that 60 kg hydrogen can be stored in 1 cubic meter of the oil.

ZEPP SOLUTIONS

Jan Bot, co-founder at **Zepp Solutions**, introduces their company a spin out from TU Delft's Forze hydrogen racing team which offers hydrogen fuel cells systems fit into bespoke applications which are already in use in the field. Some examples of their systems in use include, the Terberg YT203-H2 port yard trucks, the Rotterdam Watertaxi and the Ab Initio vessel.

SPOTLIGHT SESSION: INDUSTRIALIZATION OF HYDROGEN TECHNOLOGY – SCALING UP A HEAVY DUTY FUEL CELL PRODUCTION

DREES & SOMMER AND FREUDENBERG FUEL CELL E-POWER SYSTEMS GMBH



Martin Keim, Head of Process Industry at **Drees & Sommer**, and **Tobias Umseher**, Director Industrialization at **Freudenberg Fuel Cell e-Power Systems GmbH**, provide a joint presentation around the scaling up of heavy-duty fuel cell production. Initially Tobias introduces Freudenberg as a company and discusses their targets in the hydrogen fuel cell space, specifically highlighting their considerations in design for the best total cost of ownership for heavy-duty. To reach these low costs the company focuses on vertical integration of the production line, working from the raw material to the entire system build as well as highly modular designs.

Martin Keim provides more insight into the joint activities between the two companies, including their integral project development approach consisting of scaling and benchmarking analysis, location searching and technical

H2 TECH SERIES DAY TWO

due diligence. He details the main project targets and the visions developed from both teams around their production lines. Further discussions introduce their methods of evaluating the sites and potential opportunities for the production line locations as well as how they defined their parameters.

THE OUTLOOK FOR HYDROGEN

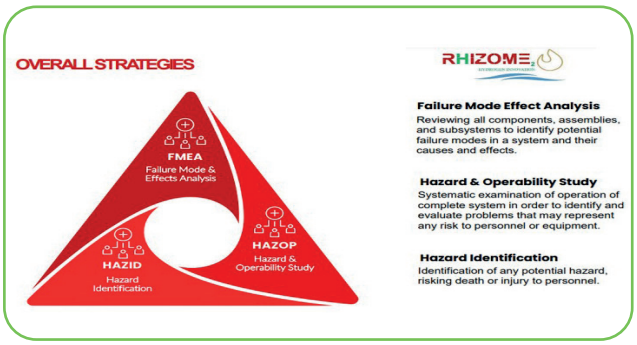
BLOOMBERG NEF

Meredith Annex, Head of Heating & Hydrogen at **Bloomberg NEF**, a market research provider covering the entire energy transition, details their understanding of hydrogen and future markets from their February market outlook. With focus on the policy side, Meredith introduces their seven signposts of hydrogen development looking at a range of factors across hydrogen strategies, standards and decarbonisation incentives within industry and transport. She then moves on to provide a closer look into the hydrogen commitments across the world as well as forecast of the electrolyser shipments and system capex predictions.

SPOTLIGHT SESSION: HYDROGEN REFUELLING CHALLENGES

RHIZOME ENERGY LIMITED

Raj Sharma, Director at **Rhizome Energy Limited**, introduces the considerations taken when addressing end-to-end reliability of hydrogen refuelling stations. The key requirements that need to be met are availability, reliability, and maintainability, and these are addressed from the design stage all the way through to the installation, commissioning, and maintenance support stage. As part of this design work, failure mode and effect analysis is performed, as well as hazard and operability studies and hazard identification studies to ensure that the systems are fully understood and that mitigation strategies can be put in place to minimise any potential downtimes.



SPOTLIGHT SESSION: HOW GREEN HYDROGEN STAYS A SOLUTION (INSTEAD OF A NEW PROBLEM)

ROYAL HASKONING DHV

Piyush Katakwar, Global Sector Lead in Hydrogen, along with **Martine Leman** Director of ESG and Climate Consultancy at **Royal Haskoning DHV**, introduce their talk on integrating environmental and

H2 TECH SERIES DAY TWO

social considerations into the business case for the hydrogen economy. Some of the risks highlighted across the value chain include, resource management, energy security, local communities and emissions and safety. With further detail provided discussing risks around the selection of water feedstocks, energy poverty challenges and land usage.

SPOTLIGHT SESSION: INDUSTRIAL PROCESS HEAT WITHOUT COMBUSTION

STAR SCIENTIFIC LIMITED

Matthew Hingerty, Deputy CEO and Head of Business Development at **Star Scientific Limited**, presents their HERO catalyst, or Hydrogen Energy Release Optimiser, an innovative catalyst that when combined with hydrogen and oxygen can produce an enormous amount of heat the only product of which is high purity water. Matthew shows a video demonstration of the catalyst highlighting the speed of heat production as well as the very high temperatures it can achieve up to 750°C. Considering early adopters of the technology, industrial heating and process heating appear to be great fits for this catalyst, with conversations happening with the dairy industry, pulp and paper and even a spa.

HYDROGEN IN HARD TO ABATE SECTORS: DECARBONISATION

COWI

Jakob Dybdal, Market Director at **COWI**, presents a discussion around the question "How to unlock both the sustainable and financial potential of hydrogen?", with a more specific look at certification of hydrogen. Via the use of certification, we can add value to hydrogen projects by complying with regulatory frameworks giving a "license to operate" as well as an opportunity for sustainability markups. Jakob describes the RED II certificates for governing the sustainability criteria for e-fuels and the regulatory drivers for those certificate values, as well as the drive from the investment side for certified products to invest into.

HITACHI ZOSEN INOVA

Robert Boehm, Product & Marketing Manager at **Hitachi Zosen INOVA**, highlights the role that hydrogen and Synthetic Natural Gas (SNG) have in enabling a

H2 TECH SERIES DAY TWO

successful energy transition with a spotlight on major projects in Switzerland. Robert details some products that Hitachi provide including their Alkaline electrolyser in a containerised solution, a biological methanation plant for bio methane and a catalytic methanation plant. Currently they are in the planning and construction phase for an energy from waste powered hydrogen electrolyser plant utilising their alkaline electrolyser system this includes compressors, storage, and trailer filling stations.

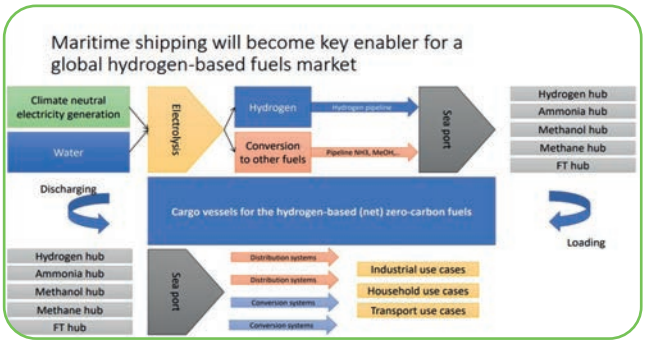
HYDROGEN & FUEL CELL INDUSTRY ALLIANCE, CHINA

Minfang Han, Executive Vice President of **China Zhongguancun Park**, Hydrogen & Fuel Cell Industry Alliance, presents via a pre-recorded message. Initially providing background around China's Dual Carbon ambitions, she discusses how the development of the hydrogen energy industry will be a key measure in meeting these ambitions as well as highlighting further key policy such as the "Medium and Long-Term plan for the development of the Hydrogen Energy Industry".

FUELLING THE FOURTH PROPULSION REVOLUTION

INTERNATIONAL CHAMBER OF SHIPPING

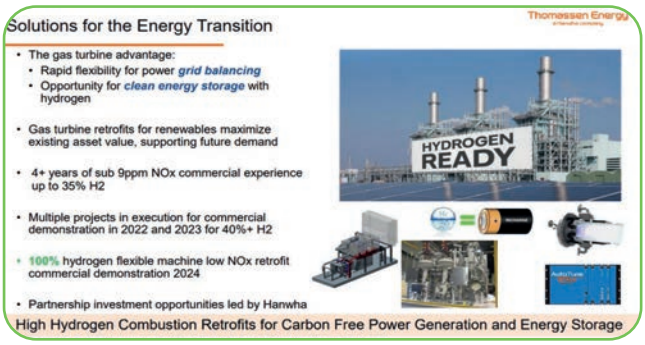
Prof. Dr. Stefan Ulreich, previews a report from the **International Chamber of Shipping** titled – "Fuelling the Fourth Propulsion Revolution", which highlights



the catalytic role of shipping in the development of net zero carbon fuels. One of the questions which the report addresses is how the demand for hydrogen and hydrogen-based fuels will change and how that demand will be transported worldwide from production centres to demand centres. To answer this question the bilateral agreements around hydrogen were analysed to underline the global scale of the market and the need for the utilisation of shipping routes to meet these agreements. Concluding the session Stefan summarises some of the reports conclusions such as the key role the maritime sector will play as well as the need for research and development to deliver key technologies for shipping and other relevant parts of the value chain.

HYDROGEN INDUSTRIAL APPLICATIONS

THOMASSEN ENERGY



Peter Stuttaford, CEO at **Thomassen Energy**, presents his company's work in hydrogen retrofits for existing gas turbine powerplants. Initially highlighting the benefits of

H2 TECH SERIES DAY TWO

gas turbines as energy converters, such as their flexibility in fuelling as well as fast load coverage. He discusses the challenges that arise when combusting hydrogen in this way, and also details current commercial operations that are already running. With a target to cover from 0% to 100% hydrogen operation with natural gas, Thomassen are leading a consortium for hydrogen retrofits with universities and industry to produce a solution able to scale from 1MW to 300MW.

GE RENEWABLE ENERGY

Khalid Said, Sales Director Industry Europe at **GE**, provides a run down of how GE is contributing towards the green hydrogen revolution with a presentation for the first time around the AmpHytrite demonstrator in Rotterdam. Beginning with a explanation of GE's coverage of the hydrogen value chain, Khalid moves into an explanation of GE's integrated electron solution. The AmpHytrite project is a demonstrator project to perform an onshore simulation of a scalable plug and play offshore centralised and off grid hydrogen production plant.

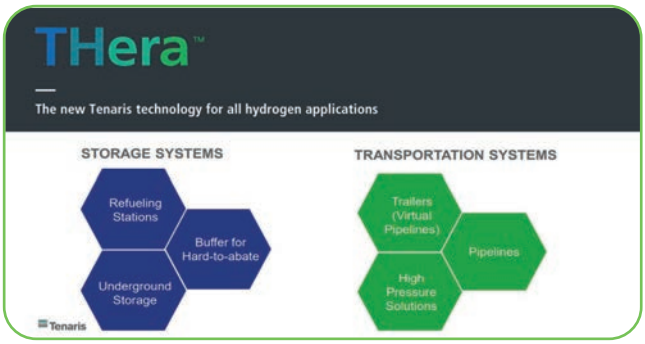
HYDROGEN HEALTH AND SAFETY TECHNOLOGIES

HYDROGEN TECHNOLOGIES EU

Beginning the presentation with a short video from **Jim Wilson**, Director at **Hydrogen Technologies EU**, introducing their product, a fit for purpose small size hydrogen and oxygen generator for use in biological environments. **Mario van den Bree**, Head of Research and Development at **Hydrogen Technologies EU**, continues the presentation discussing the need for pure hydrogen and oxygen in the baseline energy production process of living organisms, highlighting benefits such as more growth and the need for less fertilizer.

THera™ : THE NEW TENARIS TECHNOLOGY FOR ALL HYDROGEN APPLICATIONS

TENARIS

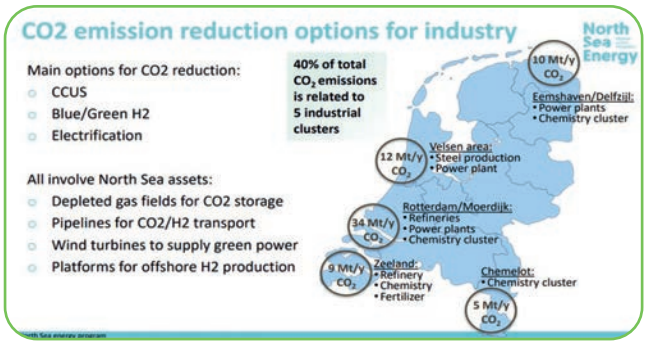


Stefano Capponi, Business Development at **Tenaris**, introduces Tenaris as a global leader in pipes and related services for the worlds energy industry, the topic of this presentation is release of a new product family THera™. This product family consists of both storage and transportation systems including refuelling stations, pipelines and underground storage facilities with over 50 hydrogen storage projects operating today worldwide. Working with the port of Los Angeles, Tenaris are working to develop hydrogen solutions for the transportation of goods within the port.

H2 TECH SERIES DAY TWO

LOW-CARBON HYDROGEN FOR HARD TO ABATE INDUSTRIES

TNO



Rene Peters, Director of Renewable Gas, **TNO**, begins the panel with a talk around why TNO believe the Netherlands is in a unique position to help decarbonise and abate the difficult industries. He discusses the positions of the industrial sectors as well as the opportunities in the North Sea to bring renewable energy to the industrial clusters, highlighting that there are five clusters that are related 40% of the total emissions in the Netherlands. Rene describes future predictions of the North Sea energy transition from conventional oil and gas production to electrification, to carbon capture storage and finally hydrogen conversion, with a detailed look at hydrogen demand predictions in the Netherland for 2050 where all scenarios expect high volume demand.

H-VISION PROJECT

A short film explaining the background, intention and aims of the H-vision project which looks to process waste refinery gases into hydrogen, utilising carbon capture and storage to produce a low carbon hydrogen which is then used as a fuel in the refinery processes significantly reducing carbon emissions of the process.

Alice Krekt, Program Director for the **Deltalinqs Climate Program** and chair of this panel begins the session focused on the details of the H-Vision project including the economics, finances and regulatory aspects. The panel is formed of five members;

- **Rene Peters**, Director of Renewable Gas, **TNO**
- **Marc Zwart**, Energy & Utility Technology Manager at **Shell**
- **Feikje Wittermans**, Business Development Manager, New Energies, **Vopak**
- **Wouter Verbeek**, Managing Consultant at **Berenschot**

The panel discusses each companies' involvement in both the H-Vision project as well as wider projects within the hydrogen economy, with questions around policy limitations with hydrogen, recent successes with subsidies and what other countries can learn from the Netherlands hydrogen work. Concluding the talk, each panellist discusses what the gamechangers in these projects and the related hydrogen economy will be, including;

- the need for blue hydrogen projects where necessary but also continuing to move on with green hydrogen without any delay
- the dangers of overregulation preventing private investments into hydrogen
- the benefits of collaborating across industries

WITH THANKS TO OUR SUPPORTERS

We look forward to welcoming you again next year on 9-11 May at #WorldHydrogen2023 - your trusted platform where hydrogen deals get done.

Speak to our team today to **Book Your Stand** as over 50% has already been sold!

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