



#WorldHydrogen2022

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WORLD HYDROGEN 2022 SUMMIT & EXHIBITION

Summit Executive Summary

22



RYSTAD ENERGY

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Addresses
Hydrogen's Future
Energy Policy, The Netherlands
Economy: The Sarawakian Way
Pari Tun Openg, Premier of Sarawak, Malaysia
Hydrogen Economy
CEO, Australian Hydrogen Council (AHC)

WORLD HYDROGEN 2022
SUMMIT & EXHIBITION
9 - 11 MAY 2022

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Opening
H.E. Rob letter
Accelerating
The Right Honourable
Representing the Australian



WORLD HYDROGEN 2022

SUMMIT & EXHIBITION

Summit Day One

SUMMIT DAY ONE

SUMMIT WELCOME ADDRESS



The World Hydrogen 2022 Summit begins with welcome addresses from the organisers, who set the tone for the next days ahead. **Catalina Zuliani**, Product Director, **Sustainable Energy Council** welcomes participants and thanks all the stakeholders present for their commitment to developing this key industry to deliver on our decarbonization goals.

The Summit Master of Ceremonies, **Simone van Trier**, takes the stage alongside **H.E. Drs. J.N. (Jeannette) Baljeu**, Regional Minister, **Province of Zuid-Holland** and **Ahmed Aboutaleb**, Mayor of Rotterdam.



Together they discuss the role that the Government is playing to contribute to the hydrogen economy by cooperating closely with the business community, through investment, infrastructure, research, permits, and importantly through learning what is necessary from businesses so they can prepare to deliver this via legislation. Mayor Aboutaleb highlights the importance of the Port of Rotterdam as it has the infrastructure for the distribution of hydrogen in the future.

ALLARD CASTELEIN, PRESIDENT & CEO, PORT OF ROTTERDAM AUTHORITY



Allard Castelein, President & CEO at the **Port of Rotterdam Authority** and SEC Hydrogen Advisory Board Member takes the stage next, making a key announcement that the Port of Rotterdam, alongside 70 partner companies, governments and agencies envisage they can deliver at least 4.6 million tonnes of hydrogen annually by 2030. That is equivalent to 25% of the new REPowerEU goals of 20 million tonnes by 2030. This is considerably more than expected and kicks off the hydrogen economy to a flying start which will ensure the diversification and decarbonization of European energy in the years to come. ■

“

We have to really accelerate and start looking at all sources that we can actually generate, and that's why I am so pleased to see you all here because we can deliver some four million tonnes of imports by 2030.

”

Allard Castelein, President & CEO
Port of Rotterdam Authority

SUMMIT DAY ONE

OPENING KEYNOTE ADDRESSES

Each speaker presented the plans and steps that their country has taken to develop the hydrogen economy. While common points of regulations and support from the government are mentioned for all countries, there are certain differences:

H.E. ROB JETTEN, MINISTER FOR CLIMATE AND ENERGY POLICY, THE NETHERLANDS



1. The Netherlands Vision for Hydrogen's Future

H.E. Rob Jetten, Minister for Climate and Energy Policy, The Netherlands placed a strong focus and emphasis on infrastructure for hydrogen that could make it a hub for Europe in terms of distributing hydrogen. Hydrogen generation from offshore wind is mentioned to be a pathway for making hydrogen in the country. However, this will be expensive, and the Netherlands will look like a net importer for a number of years and therefore large-scale storage will need to be looked at.

“ We need to accelerate the energy transition, because the energy transition is the pathway towards transformation of the global energy sector ”

H.E. Rob Jetten
Minister for Climate and Energy Policy
The Netherlands

THE RIGHT HONOURABLE DATUK PATINGGI ABANG HAJI ZOHARI TUN OPENG



2. Accelerating the Global Hydrogen Economy

The Right Honourable Datuk Patinggi Abang Haji Zohari Tun Openg, Premier of Sarawak, Malaysia also has the ambition to be a hub in the Southeast Asia region, strongly focusing on using hydrogen for transportation. The region will look to use hydroelectric for hydrogen generation. Internationally, Japan and South Korea will be its partners. Malaysia does have a strong history in the hydrocarbon economy which can help it to be a key player.

3. Australia: Building a Global Hydrogen Economy

Representing the Australian Delegation: Dr Fiona Simon, CEO, Australian Hydrogen Council (AHC). The Australian Government is providing 1 billion USD support, with a strong focus on export to Asia and use of hydrogen where battery and electrification is not possible. Rystad Energy hydrogen research shows Australia is ranked 10th in terms of public financial commitment. ■

DR FIONA SIMON, CEO, AUSTRALIAN HYDROGEN COUNCIL (AHC)



SUMMIT DAY ONE: SESSION ONE

HYDROGEN TECHNICAL LATEST ADVANCEMENTS, INNOVATIONS, SOLUTIONS & PROJECT DEVELOPMENTS

Chaired by **Rob Arthur**, Director of Partnerships, **Sustainable Energy Council**, the panel brings together;

Felipe Arbelaez, Senior Vice President Hydrogen & CCS, **bp**,

Christian Pho Duc, Chief Technology Officer & Managing Director H2 Projects, **Smartenergy**, SEC Hydrogen Advisory Board Member

Paul Bogers, Vice President - Hydrogen, **Shell**, SEC Hydrogen Advisory Board Member

Dr. Marcus Guzmann, Vice President, Hydrogen Business Development, **ADNOC**

Dr. Axel Wietfeld, CEO, **Uniper Hydrogen**

to discuss hydrogen innovation and development.



Felipe Arbelaez estimates hydrogen will account for 8% of the world's energy needs in 2050 and will be worth 290 billion. bp aims to have 10% market share of hydrogen in core sectors. bp has had multiple planned projects for hydrogen (Netherlands, UK, etc..) but also wants regulations and support for CCS. **Felipe Arbelaez** believes that the end sector, CO2 impact and efficiency of the value chain will determine the choice of hydrogen carriers.

Christian Pho Duc of Smartenergy wants a change towards mindset for higher acceptance of renewable energy and hydrogen. **Christian Pho Duc** presents an overview of some innovations seen in the sector such as ZeroAvia, Sunfire, Solid oxide electrolyzer using waste heat of industry, Hypoint cryogenic tank for liquid hydrogen and Tenova's application of DRI.

Paul Bogers describes hydrogen as the Swiss army knife of the energy system. Shell is targeting low carbon hydrogen use in its refineries for heavy goods transport, but is also talking to steel makers and data centre owners. The key is to focus on R&D to reduce costs and enable these applications. **Paul Bogers** sees challenges in the supply chain for everything not just electrolyzers or renewables. Infrastructure will need to be developed at the same time as producing projects.

ADNOC is also committing to hydrogen but **Dr. Marcus Guzmann** believes blue hydrogen is important also to scale up and use as a stepping stone. ADNOC is leveraging existing partnerships from the oil and gas trade and collaborating with Japanese players such as Itochu, Idemitsu, Inpex and South Korean companies like SK gas, GS energy and KNOC for low carbon ammonia and hydrogen.

Interestingly, Rystad research shows many hydrogen exports going to Japan is blue. Again, a global standard for green hydrogen is deemed essential. This is shared also by **Dr. Axel Wietfeld** who highlights the fact that there needs to be harmonization in requirements and standards. In the gas network, there can be very different safety and regulations requirements between neighbouring countries, making it hard to synchronise and develop infrastructure. Uniper is working on multiple green hydrogen projects together with a few blue hydrogen projects. They are also working on hydrogen storage. A few technical challenges such as how electrolyzers need to deal with intermittency of renewables is pointed out. An acceleration on grant processing is also noted. ■



SUMMIT DAY ONE: SESSION TWO

ELECTROLYZERS, HYDROGEN TECHNOLOGIES, PRODUCTION & COST DEVELOPMENT ANTICIPATION

Chaired by **Rob Arthur**, Director of Partnerships, **Sustainable Energy Council**, the panel brings together;

Virtual Address: **Dr. Sunita Satyapal**, Director, Hydrogen and Fuel Cell Technologies Office, Office of Energy Efficiency and Renewable Energy, **U.S. Department of Energy**

Andrew Horvath, Global Group Chairman, **Star Scientific Limited**, SEC Hydrogen Advisory Board Member

Ohira Eiji, Director General, Fuel Cell and Hydrogen Office Advanced Battery and Hydrogen Technology Dept., **NEDO (The New Energy and Industrial Technology Development Organization)**

Mattijs Slee, CEO, **Battolyser Systems**

of urgency and ambition around facilitating the development of a hydrogen economy, backing it up with firm goals for cost reduction and investments to suit. The session also included detailed technology briefs from two cutting edge businesses looking to take part in the hydrogen revolution; Battolyser Systems and Star Scientific. Battolyser Systems aims to reduce the cost of hydrogen to \$1.5/kg by 2026 using a proprietary combination of batteries and electrolyzers to optimise operational expenditure, whereas Star Scientific is targeting heat intensive industries such as food and beverage sectors with their new and promising solution which can use hydrogen and their secret catalyzer to reach temperatures of more than 700 degrees Celsius.




Regarding commercial type of electrolyzers, it is worth noting from Rystad’s database that alkaline is taking the lead for larger scale projects while PEM is more for small scale. It is also worth watching pressurized alkaline technologies that also has some PEM performance advantages without too much cost downside. ■


Summary: Strategy and Next Steps

- Accelerate RD&D to reduce cost
- Launch demos and H2 Hubs, focusing on regional networks
 - Co-locate production through end use
- Enable benefits and a resilient, sustainable, and equitable clean energy economy
 - Emphasis: Disadvantaged communities, emissions reduction, jobs, air quality, and stakeholder engagement


Examples of Resources Based on RFI Stakeholder Feedback



To facilitate partnerships see H2 Matchmaker www.energy.gov/eere/fuelcells/h2-matchmaker

Current status 

Items	Japan's Target (in 2030)	Current status (as of Sept 2021)
Stationary Fuel Cell		
Residential Fuel Cell (EneFarm)	5.3 million	> 410,000
Mobility		
Passenger Vehicles	800,000	> 6,500
Fuel Cell Buses	1,200	> 100
Hydrogen Refueling Station		
Public Stations	900	> 160



The session included key policy and outlooks for the USA and Japan, represented by **Dr. Sunita Satyapal** of the USA DOE and **Ohira Eiji** of NEDO respectively. The soon-to-be hydrogen nations hold a shared sense



SUMMIT DAY ONE: SESSION THREE

CLEAN H2 INFRASTRUCTURE DEVELOPMENT, STORAGE AND DISTRIBUTION

Moderated by **Noe van Hulst**, Chair, **IPHE** & Hydrogen Advisor to **IEA** & **Gasunie**, SEC Hydrogen Advisory Board Member, the session brings together an expert panel which includes;

David Burns, Vice President Clean Energy Development, **Linde**, SEC Hydrogen Advisory Board Member

Nico van Dooren, Head of Business Development, **Port of Rotterdam Authority**

Osamu Ikeda, Managing Director, **Chiyoda Corporation Netherlands B.V.**

Antony Green, Hydrogen Director, Gas Transmission & Metering, **National Grid**

David Vermaas, Associate Professor, **TU Delft** to discuss infrastructures for hydrogen transport.

and LOHC might come out as main carriers for future hydrogen trade.

Chiyoda is also focusing on LOHC technologies to transport hydrogen and have trialed this between Brunei and Japan. **Osamu Ikeda** shared the company plans to fully scale up by 2030 but will need that demand to accelerate.

The pipeline network for hydrogen is the focus also in the UK for hydrogen distribution domestically and eventually connecting to Europe **Antony Green** highlighted. There is a strong focus on refurbishing rather than new-build. Positive steps have been taken by National Grid to test refurbished pipes for hydrogen use. There was some mention of compressors, which look to be a key cost component for pipeline network. ■



NEW INFRASTRUCTURE IS CRUCIAL TO SUPPLY INDUSTRIES WITH HYDROGEN

Right now, Rotterdam supplies a large part of NW Europe's industries, including North Rhine Westphalia, with fossil fuels and feedstock.

To supply these with the vast quantities of sustainable energy and feedstock needed to decarbonize, new infrastructure like the Delta Corridor has to be developed.

LEGEND: **Hydrogen** (H₂), **CO₂** (in red), **Delta Corridor** (H₂), **Delta Corridor** (CO₂), **Delta Corridor** (H₂ & CO₂), **Delta Corridor** (H₂ & CO₂ & other products)

3 | 10 June 2022 | Port of Rotterdam

Linde is one of the world's largest industrial gas players, with extensive experience in hydrogen infrastructure, including hydrogen pipeline as well as liquefaction facilities. The technology is there and is waiting to be scaled up, **David Burns** believes long term contracts and support from demand side will help accelerate this.

Global Hydrogen Supply Chain Demonstration

Chiyoda, Mitsubishi Corporation, Mitsui & Co., Nippon Yusen Kabushiki Kaisha established the new entity named AHEAD**, and successfully completed the world's first global H₂ supply chain demonstration project in 2020.

Description	
Scale	210 tons/year at facility scale (Maximum)
Duration	2020
Hydrogen Supply	Brunei Darussalam (Hydrogen production)
Hydrogen Demand	Kawasaki City, Japan (Fuel for gas turbine power plant)
Transportation	250 tank containers (Container ship/truck)
Business Scheme	Established by AHEAD Funded project by NEDO**

5,000 km

2

The Port of Rotterdam has also put in steps to develop its pipeline infrastructures for domestic use as well as to connect to Germany through the Delta corridor. Being a port with plans for importing hydrogen, **Nico van Dooren** says the port believes its infrastructures will need to be ready for all type of carriers including ammonia and LOHC.

Enabling the energy transition by leveraging existing assets Infrastructure

Unrivaled H₂ network: global reach, strong local presence

From production

- Operation of 150+ steam methane autothermal reformers and PSAs
- Solutions for on-site production
- 40+ electrolyzers installed in joint Venture with E.ON Power

Through processing

- Largest H₂ liquefaction capacity in the world with over 170 tons/day
- Recovery and purification
- Carbon capture and CO₂ processing
- Vast experience in H₂ compression

To storage and distribution

- Largest fleet of liquid and gaseous H₂ tankers
- 1000 km H₂ pipeline
- World's first high-purity H₂ commercial cavern, 10+ years
- World leader in cryogenics, 20,000+ cryogenic tanks supplied**

** More than 20,000 emergency tanks for liquefied gases supplied since 1982

From Rystad Energy's perspective, being able to handle all carriers will be quite costly for the port and ammonia

SUMMIT DAY ONE: SESSION FOUR

PANEL DISCUSSION: RENEWABLE POWER FOR CLEAN HYDROGEN

This session begins with a virtual keynote address from **H.E. Dan Jørgensen**, Minister of Climate, Energy and Utilities, **Government of Denmark**. Whilst sharing the important ambitions Denmark has for the future, he also divulges that Denmark’s targets are to reduce their emissions by 70% in 2030 compared to 1990. The Danish Government is investing heavily in upscaling technologies and Denmark is now establishing the world’s first Energy Islands. Around the turn of the next decade the plan is to make enough electricity for the consumption of 12 million European homes. With continued collaboration and partnerships, the aim is to connect all North Sea partners to a common offshore grid. **H.E. Dan Jørgensen** also shared that currently there are already 100 hydrogen taxis driving around Copenhagen, next year the 1st Green Container Ship from Maersk will sail through the Baltic Sea and in 2025 the 1st Green flight will set off on a Danish route.

H.E. DAN JØRGENSEN, MINISTER OF CLIMATE, ENERGY AND UTILITIES, DENMARK



Arno Bonte, Vice Mayor for Sustainability, Clean Air and Energy Transition, **City of Rotterdam** highlighted that for 4 consecutive years they are already moving towards a 50% reduction and even more in 2030, to become a climate neutral city before 2050, and shared that this success was largely down to the Rotterdam Climate Agreement.

Moderated by **Dr. Thomas Hillig**, Managing

Director, **THEnergy**, the panel session continues and includes;

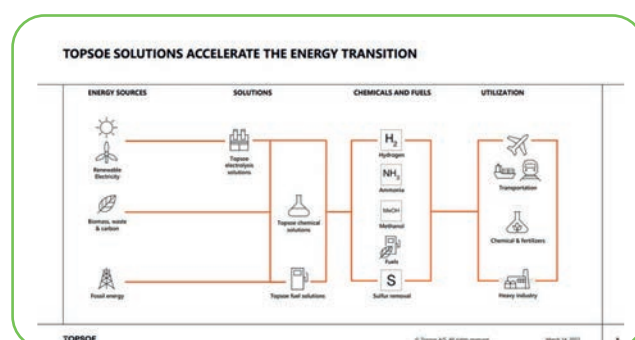
Julie Cerqueira, Principal Deputy Assistant Secretary, Office of International Affairs, **US Department of Energy**

Christian Wix, Head of Product Development, PtX, **Topsoe**

Alicia Eastman, Co Founder and President, **InterContinental Energy**, SEC Hydrogen Advisory Board Member

This session looks into the renewable energy required for green hydrogen scale up. **Julie Cerqueira** USA DOE, presented their plans and cases for increased renewable development and investment for hydrogen making. However, more needs to be addressed in the supply chain capability to meet this renewable energy demand. Technology-wise, **Christian Wix** mentioned there is no real challenge in dealing with variable renewable energy but the importance in terms of utilization hour is to provide enough volume so the end use sector can run their process 100% of the time to reduce cost. **Alicia Eastman** from Intercontinental Energy believes their approach for massive gigawatt facility can help ensure a high utilization rate which creates a plant layout to create hubs surrounding these large scale facilities.

To meet Rystad’s current expected pipeline of green hydrogen by 2030, it will require almost 200 GW, and even more than this if RePowerEU goals are to be met. Renewable growth for green hydrogen will be one of the key challenges. ■



SUMMIT DAY ONE: SESSION FIVE

BLUE HYDROGEN & CCUS PATHWAYS: SHORT TERM STRATEGY OR PART OF THE TRANSITION?

Moderated by **Guloren Turan**, General Manager for Advocacy, **Global CCS Institute**, and joined by panelists;

Dr Zeid Al-Ghareeb, General Manager of Hydrogen and Carbon Circular Economy, **Ministry of Energy of The Kingdom of Saudi Arabia**

Matthew Williamson, VP Blue Hydrogen, **bp**

Ulrich Schmitz, Vice President Marketing, **Atlas Copco Gas and Process**

José Miramontes, Vice President Sales, **Honeywell UOP**

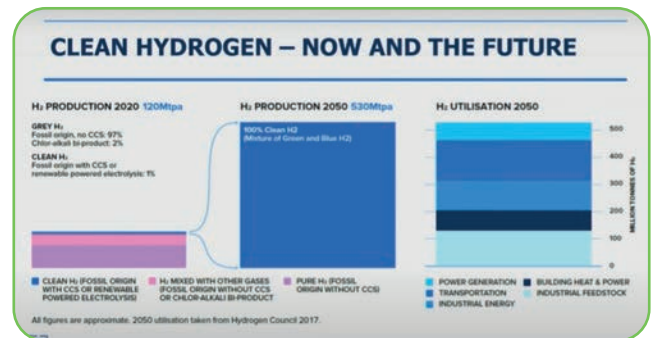
Erik Oswald, VP, Advocacy and Policy Development, **ExxonMobil Low Carbon Solutions**

Most panelists agree that there is a need for blue



hydrogen as it provides lower cost and the volume needed for applications. As **José Miramontes** of Honeywell puts it, blue hydrogen is a viable, ready, low cost and commercially proven technology which can enable infrastructure investments for hydrogen; and there does exist sufficient carbon storage capacity around the world, alongside ample end use off-take sectors for the captured carbon. **Dr Zeid Al-Ghareeb** noted that blue hydrogen can become a solution that supports the energy transition and especially clean mobility, singling out the commitment of **The Kingdom of Saudi Arabia** to develop hydrogen mobility, it is also pointed out that it is critical for stakeholders to collaborate in addressing key challenges. **Matthew Williamson** demonstrated Teesside to prove the possibility of blue hydrogen as a “low carbon, low cost” opportunity for meeting hydrogen demand. **Ulrich Schmitz** commented that the upcoming years will require technology developments, moving towards technologies that are able to deal with lower temperatures

on the shipping side of hydrogen for example, as well as higher temperatures going for higher process efficiencies. **Erik Oswald** explained CCS and low emission fuels also sits in the crosshairs of Exxon Mobile in their forthcoming strategy, which includes low carbon, regardless of colour; they are participating in demo studies for blue hydrogen, but are firm believers of both green and blue, and support the use of all colours to propel the transition, both for road transport and other sectors. ■



bp on Teesside

- CO₂ Transport & storage**: 20 mtpa
- H₂ Teesside**: 1GW blue hydrogen
- Net Zero Teesside power**: Gas-fired power with CO₂ capture, 800MW
- HyGreen Teesside**: 60MW green hydrogen, Transport

Solutions for Protecting Global Climate and Human Health

Increased amount of CO₂ & xCO₂, H₂, Renewable and Energy Storage related projects

Technologies are required to support New, Emerging and Sustainable Energy Sources

- Off-gas gas screw compressors for fuel gas supply
- Compressor / expander for thermal energy storage
- Compressor / expander to xCO₂ (Ox) / energy recovery
- Cryogenic compressor for LH₂ BOB
- Compressors and expanders for hydrogen liquefaction

BLUE AND GREEN H₂

Today

Blue H₂ technology is ready now

- Offers the lowest cost of production
- Commercially proven unit operations
- Enables H₂ infrastructure investment
- Requires CO₂ end use or sequestration

Future

Green H₂ becomes more competitive

- Future segmentation depends on how quickly and significantly electrolyzer costs drop
- Honeywell's Catalyst Coated Membrane development driving down costs and increasing efficiency significantly

Development of infrastructure

- Renewable electricity and electrolyzer capacity (to green)
- CO₂ sequestration for blue
- Transport from regions with cheap renewable electricity across sequestration

Sufficient CO₂ storage capacity exists around the World

SUMMIT DAY ONE: SPOTLIGHT SESSION

HYDROGEN, AMMONIA & HYDROGEN CARRIER

This session is moderated by **Alicia Eastman**, Co Founder and President, **InterContinental Energy**, SEC Hydrogen Advisory Board Member, who is joined by;

David Bow, Executive Vice President, **Plug Power**

Dr. Paolo A. Farina, Senior Energy Market Analyst (Gas), **Energy Exemplar**

Dr. Tom Houghton, Consulting Director, **E4tech**, an **ERM Group Company**

Andrea Galt, Head of New Energy – Europe, **Woodside Energy**

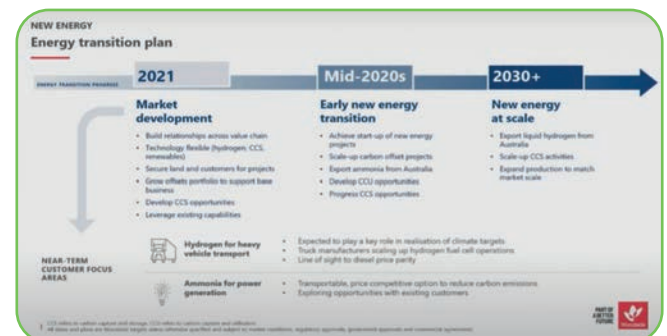
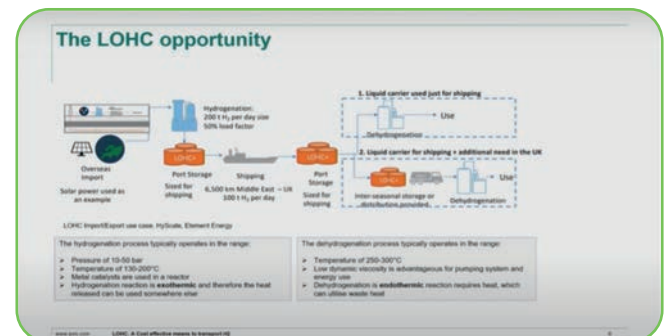
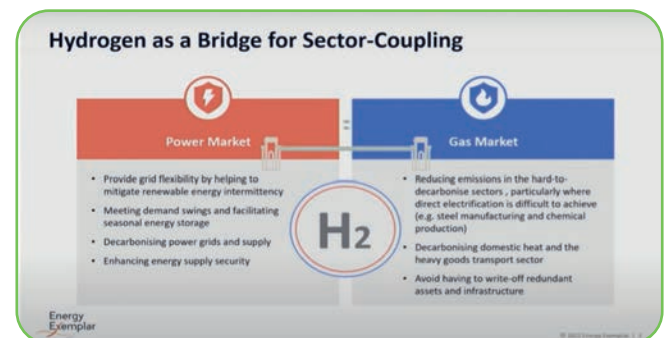


The session brought together the panelists to discuss general hydrogen carriers. **David Bow**, Plug Power shared they are looking to be a vertically integrated company that will provide technology and build facilities and application across the hydrogen value chain. The company wants to be fast and therefore will look more for existing and off-the-shelf proven solutions. The biggest pipeline of the company is green ammonia, followed by steel and e-methanol.

Dr. Paolo A. Farina shared his thoughts and highlighted that he doesn't believe that you can look at hydrogen on its own merit, that we need to model and understand power and gas in combination to truly understand hydrogen's role in the energy transition.

Dr. Tom Houghton from ERM highlighted they frequently carry out technology research and consultancy from the aspect of environmental impact and health and safety risks. ERM scores LOHC quite high as a carrier to bring hydrogen into Europe.

Andrea Galt of Woodside puts hydrogen as key for its energy transition, seeing the main opportunities for hydrogen in ammonia, steel and transportation where batteries do not perform well, such as trucks and utility vehicles like forklifts. Many of Woodside's projects will reach FID after 2023 with focus on both domestic use and export via ammonia.



From Rystad Energy perspective, ammonia and steel production stands out as clear key demand segments for clean hydrogen in the short term, but they will use hydrogen in two different forms: ammonia and pure hydrogen. Therefore, ammonia and LOHC as carriers to transport hydrogen are looking to have a big market thanks to less requirement on infrastructures. ■

SUMMIT DAY ONE: SESSION SIX

PANEL DISCUSSION: HYDROGEN NEW FRONTIERS: AFRICA'S COMMERCIAL OPPORTUNITIES

This session is moderated **Dr. Innocent Uwujaren**, Co-founder, **Cheranna Energy**, Chairman, **Africa Hydrogen Partnership (AHP)**, and joined by Panelists;

James Mnyupe, Presidential Economic Advisor, **Government of The Republic of Namibia**

Manuel Kuehn, Head of New Energy Business for Middle East and Africa and Head of Sales for New Energy Business, **Siemens Energy**

Drs. Ing. Marcel Jacobs, Executive Director, **Jacob Lawren Ltd Ghana**

Jorgo Chatzimarkakis, CEO **Hydrogen Europe**, SEC Hydrogen Advisory Board Member



The session aims to showcase Africa's role in the hydrogen economy. Panelists agree that this plan of importing hydrogen from Africa to Europe is not a form of neo colonialism because it creates so much opportunity and value for Africa. For example, instead of exporting iron ore, the continent can start making green produced iron to support green steel making. Also, agriculture is a confirmed demand segment for the Middle East with ammonia making, which creates a more diverse and stronger food source. In terms of electrolyzers, Siemens is interested to scale up and has built an entire factory to improve manufacturing work.

Rystad's data shows that Africa is becoming one of the key regions in the hydrogen world with Mauritania and Egypt sitting at 4th and 5th place overall in terms of low carbon hydrogen production. There are significant more investment plans for green hydrogen in Africa compared

to the USA. However, not many projects have been announced in Sub-Saharan Africa. ■

“ With the EU Commission’s REpowerEU plan, which needs 320 GW . . . we understand that we cannot produce all this hydrogen in Europe domestically . . . we don’t have enough sun, wind, and that is why the prime partner is Africa. Africa has been detected by the EU as the major partner in starting this endeavour . . . to replace gas and other fossil energy carriers and to create resilience because it will not be one country anymore that we depend on as Europeans, it will be diversified.

Jorgo Chatzimarkakis
CEO Hydrogen Europe

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WORLD HYDROGEN 2022

SUMMIT & EXHIBITION

Summit Day Two

SUMMIT DAY TWO

OPENING KEYNOTE ADDRESSES

THE HON MICK DE BRENNI, MINISTER FOR ENERGY, RENEWABLES AND HYDROGEN



A virtual address is made by **The Hon Mick de Brenni**, Minister for Energy, Renewables and Hydrogen and Minister for Public Works and Procurement, **Queensland Government, Australia**. He announced that a Memorandum of Understanding has just been signed – a landmark agreement between Queensland and the Port of Rotterdam, which will further develop the hydrogen export supply chain, seeing Queensland soon to be exporting hydrogen to Europe’s largest Port.

He also announced that since 2015 some 50 large-scale energy projects have been classified as operational or underway across QL and these 50 projects alone will avoid over 13.8 million tonnes of CO2 emissions each year.

Queensland is expanding its workforce – with a focus on developing local skills and training. They have committed 50 million dollars to develop state of the art hydrogen training centers of excellence in QL.

In the coming months, a 10-year energy plan will be released and they have also just signed as a foundation partner to the Smart Energy Council’s Zero Carbon certification scheme. The scheme assesses the embedded carbon content of hydrogen to ensure that renewable production is maintained.

H.E. Kalistat Lund, Minister of Agriculture, Self-Sufficiency, Energy and Environment, **Government of Greenland** addresses the audience. Greenland are moving towards a fossil free future, accentuating the

H.E. KALISTAT LUND, MINISTER OF AGRICULTURE, SELF-SUFFICIENCY, ENERGY AND ENVIRONMENT



importance of hydrogen, which will also be vital for Greenland’s ambition to become a net energy exporter in the future.

Daryl Wilson, Executive Director, **Hydrogen Council** takes the stage to give a short presentation ‘Global Hydrogen Industry: State of the Union’, providing the audience with a global perspective from the industrial point of view from the **Hydrogen Council**.


History was made this year where the first load of liquid hydrogen moved nine thousand kilometers from Australia to Japan through a group of very ambitious and innovative players led by Kawasaki.

Tracking over the last number of years – now totaling more than 500 projects, direct investment of more than 500 billion dollars.


There is still a gap, with 400 million US dollars of investment required to reach our aspiration for a net zero ambition and many of the projects announced are yet to reach FID. ■

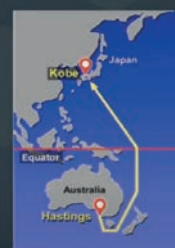
Hydrogen History is Made January 2022

Left: Kobe for Australia on December 24th, 2021



Maiden Voyage Ceremony at Port of Hastings on January 21st, 2022





1869 Oil (153y)
1959 LNG (63 yrs)
2022 Hydrogen

Hydrogen Council

SUMMIT DAY TWO: SESSION SEVEN

PANEL DISCUSSION: DECARBONISING HARD TO ABATE INDUSTRIAL SECTORS

HON. MICHAEL MATHESON, CABINET SECRETARY FOR NET ZERO, ENERGY AND TRANSPORT, SCOTLAND



The session begins with a Keynote Address by **Hon. Michael Matheson**, Cabinet Secretary for Net Zero, Energy and Transport, **Scotland**.

Recognising that hydrogen isn't a single project or a program of activities, he accentuates that it's a sector and needs to be developed as such in an integrated whole system way. Scotland can't achieve it on their own, a strong hydrogen economy can only be obtained through collective effort from industry, government and communities working together. Scotland are committed to working collaboratively with international partners to accelerate their mutual transition to achieving net zero.



The session discusses the role of hydrogen in hard to abate sectors, moderated by **Eric Vennix**, Partner, Consulting, **Deloitte Netherlands** with participation from **Edit Mucsi**, Director, Minerals and Energy, **Government of South Australia**

Tarek Helmi, Partner, Consulting, **Deloitte Netherlands**
Han Fennema, CEO and chairman of the Executive Board, **N.V. Nederlandse Gasunie**

Salah Mahdy, Global Director for the Hydrogen Market, **Howden**

Amongst the discussions most seemed to agree that there will be a premium in using low carbon hydrogen alternatives for these sectors and consumers will also be part of the equation.

To deliver low carbon and green hydrogen to these sites for the hard to abate sectors, infrastructure will be key, with existing infrastructure to play a key role in reducing costs.

Safety was also pointed out as a key factor to be considered. Besides the technical challenges, it is worth noting that these sectors are normally low-margin and will need financial incentives to move towards a greener technology. End-user signal of switching to green products will also help (green steel commitment from BMW is an example). ■

“ Like most nations we are now grappling with the complexity of how to decarbonize hard to abate sectors such as domestic, heat, heavy transport and industrial sectors.

We know that emissions that need to continue to decline significantly whilst also ensuring that Scottish industry competes on a level field and remains globally sustainable.

Hon. Michael Matheson
 Cabinet Secretary for Net Zero, Energy and Transport **Scotland**

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SUMMIT DAY TWO

KEYNOTE ADDRESS - EU LEADING GLOBAL HYDROGEN DEVELOPMENTS

FRANS TIMMERMANS, EXECUTIVE VICE-PRESIDENT, EUROPEAN COMMISSION



Frans Timmermans, Executive Vice-President, European Commission

Addressed the rock star nature of green hydrogen, Russia’s aggression against Ukraine and how hydrogen can play a role as a ‘freedom fuel’, and therefore an essential part of the future of our energy system, both in Europe and across the globe.

Timmermans also announced the coming of more regulatory incentives, roadmaps and other supportive initiatives from the EU that are being set out to support the hydrogen economy come to life. Timmermans is also firm on the role that Africa and the Mediterranean countries are going to play in leveraging their renewable resources that go above and beyond their local demand, and the excellent export opportunity it poses for these countries. ■



“

As politicians and as public authorities, we can and will help to bridge the cost difference between green hydrogen and dirtier forms of energy in the start phase. We have concrete instruments for that — carbon contracts for difference — and we will make proposals to roll them out massively so that green hydrogen gets the kick-start that it needs.

Permitting must be accelerated, and it must be accelerated drastically, in clear go-to areas that allow a speedy procedure and ensure nature protection at the same time. We have to be very, very creative. In our upcoming plans, we will make concrete proposals to achieve that.

”

Frans Timmermans
Executive Vice-President
European Commission

SUMMIT DAY TWO - SESSION EIGHT

GLOBAL HYDROGEN TRADE PANEL: BRINGING TOGETHER HYDROGEN PRODUCERS AND OFFTAKERS

Joining the moderator, **Dr. Yunji Xu**, General Manager Hydrogen Industry, **Shell** are panelists;

Boudewijn Siemons, COO, **Port of Rotterdam**

Dr. Dimitrios Dimitriou, Manager, Hydrogen Business Development, **ADNOC**

Tomas Malango, Hydrogen Director, **Repsol**

Jeff Pollack, Chief Strategy & Sustainability Officer, **Port of Corpus Christi Authority**

Bert den Ouden, Project Director, **HyXchange Project**

to discuss their plan to develop the hydrogen economy and hydrogen trade.

“ For the hydrogen economy to achieve net zero we need to work together, we need to have energy producers, energy consumers and the governments working together to create a pathway rapidly for the hydrogen economy to be established and to achieve this in the next few years.

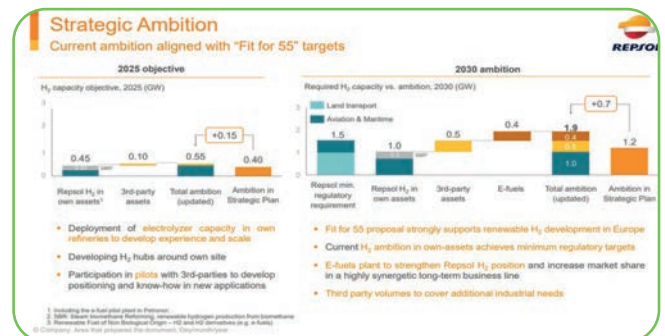
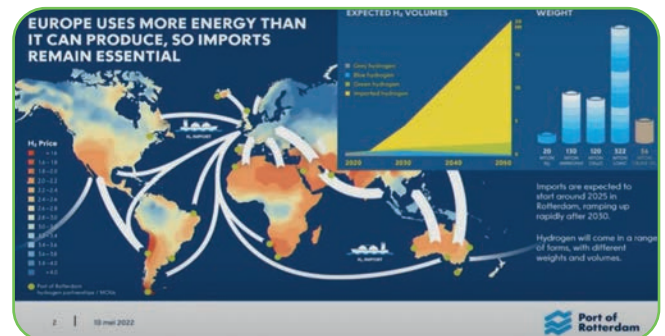
Dr. Yunji Xu

General Manager Hydrogen Industry, Shell



All the NOC and Oil majors have plans to use hydrogen to decarbonise and will use hydrogen initially to reduce emissions from their refineries, pet-chem businesses and others within industrial clusters, and as demand for refined crude products decrease in the future, moving to use hydrogen for clean fuel and methanol business. They also look to be agnostic on color of hydrogen, choosing both blue and green hydrogen while most agree that green is the final answer in the future.

This approach is also shared by the port and infrastructure groups, looking to develop their port and clusters for all color of hydrogen. **Jeff Pollack** placed an emphasis on blue hydrogen as they have good potential locations for centralized carbon storage and sequestration. However, regulations will play an important role for hydrogen trade as certificate-of-origin system will be enforced to accurately decide the ‘color’ of hydrogen. ■



- ### Port Corpus Christi's Role in CCUS
- » Send clear signal to marketplace that centralized CCUS solution IS coming
 - » Cultivate CCU opportunities (new projects/Port customers)
 - » Identify/vet/permit route alternatives for CO₂ delivery infrastructure
 - » Lease Port-owned pore space for CO₂ injection and storage
 - » Facilitate logistical/commercial connections between emitters & CCS service providers
 - » Deploy Port capital to fund key infrastructure elements
 - » Pursue/leverage federal capital
 - » Advocate for appropriate state and federal policy

SUMMIT DAY TWO - SESSION NINE

HYDROGEN MOBILITY TIMESCALES, ECONOMICS & OPPORTUNITIES: ROAD, TRAIN, AND AIR TRANSPORTATION

Grace Quan, President & CEO, **Hydrogen In Motion Inc. (H2M)**, SEC Hydrogen Advisory Board Member is chairing this session and is joined by;

Adamo Screnzi, Deputy CEO, **Hydrogen Refueling Solutions**

David Holderbach, CEO, **HYVIA**

Vasilis Gregoriou Ph.D., Chief Executive Officer, **Advent Technologies Holdings, Inc**

David Morgan, Director of Flight Operations, **easyJet**.

We Are Developing the **DIGITRONIC Fuel Cell System** To Solve The Key Problems Of EVs And Existing Fuel Cells

EV TRUCKS	OTHER FUEL CELL TRUCKS	ADVENT DIGITRONIC
Range	Utilization	Resilience
Utilization	Payload	Efficiency
Payload	Fuel Flexibility	Cost Per Mile
Resilience	Resilience	
Efficiency	Efficiency	
Cost Per Mile	Cost Per Mile	Cost Per Mile

Ideal for **Heavy-Duty Mobility**



HYVIA : A COMPLETE AND UNIQUE ECOSYSTEM

- HYVIA ecosystem will include light commercial vehicles with fuel cells, hydrogen refueling stations, supply of carbon-free hydrogen, with services for financing and maintenance of fleets.
- HYVIA will first offer a range of fuel cell-powered LCVs.
 - Master Van H2-TECH
 - Master Chassis Cab H2-TECH
 - Master City Bus H2-TECH
- Vehicles are built on a dual power architecture, equipped with a 33 kWh battery, a 30kW fuel cell and tanks containing between 3-6kg of hydrogen, depending on the version.
- HYVIA will assemble fuel cells and hydrogen refueling stations.
- HYVIA will produce green hydrogen from electrolyzers.
- HYVIA solutions will be sold throughout Europe from mid-2022.

The session focuses on the use of hydrogen in the transportation sector and discusses the use of hydrogen in trains, trucks, vans and aviation. Infrastructure is again mentioned here as one of the key challenges, from refueling stations to hubs for aviation. Advent is working on a high temperature PEM fuel cells to break away from the need to use high purity hydrogen. It is also interesting that Hyvia's solution involves battery units, indicating there is room for these two technologies to co-exist and even help each other. While trucks and commercial vehicles can push hydrogen demand already as of today, aviation's demand of hydrogen will still be quite a few years away to become a reality. ■

5. To meet hydrogen demand in transport, a solid infrastructure is needed – from energy and H2 producers to station operators

Drivers H2 in transport – Infrastructure

Value chain	Clean feedstock	H ₂ production	H ₂ transport	H ₂ retail/end-use
Description	Clean (zero emission) and cost-competitive feedstock as energy or methane	Production of clean hydrogen (blue or green) in large plants	Transport of hydrogen either via pipelines or as bulk cargo with ships or trucks	Use hydrogen e.g. as fuel for road vehicles via hydrogen refueling stations (HRS)
Example players	ETH POWER, ENGIE, INEOS, etc.	Hydrogen production plants	uni par, etc.	Hydrogen refueling stations (HRS)

FOCUS AREA

H2M: SIGNIFICANT MARKET POTENTIAL

Distribution	Hydrogen Fuel Cell Applications	Energy Storage
<ul style="list-style-type: none"> H2M can cost effectively transport and distribute H₂. Hydrogen Council estimates 55 million tons of H₂ generated a year worth US\$115B 	<ul style="list-style-type: none"> H2M tanks can be used in all fuel cell applications Automotive light duty vehicles are a US\$6B market (202M new vehicles a year) 25 % LHV use from transportation Aerospace – e.g. LH2 (drones) market is worth \$12B market 	<ul style="list-style-type: none"> H2M can store excess energy as H₂. Renewable energy market estimated at US\$77B in 2019 Renewables 250 – 300 Terawatts of excess solar and wind can be converted into H₂ = US\$3B opportunity

US\$11 trillion + market

H2M technology is the key to unlocking the hydrogen supply chain

Increase revenues:

- H2M can cut fuel cost from \$12 to \$6/Mg and further with volume production making it competitive to gasoline and battery electric vehicles
- H2M can conform tanks to market
- H2M tank swapping to optimize refueling CAPEX

Decrease costs:

- H2M reduces capital cost of storage
- Low pressure reduces operating costs associated with compressors and chillers
- H2M high density, two thirds the size of 700 bar, will reduce transportation costs

Depending on the market, H2M can open US\$40-160T in potential H2 storage sales

Creating a regional hydrogen infrastructure

Hydrogen Hub at Airports by Airbus

This concept involves collaborating with airports to develop a stepped approach to decarbonise airport facilities, ground operations and transportation using hydrogen

- 2020** Launch of preliminary studies into airport infrastructure and energy production needs
- 2023** Start of concept deployment at airports worldwide
- 2030** Ramp-up of hydrogen infrastructure deployment worldwide
- 2035** Entry into service of 2500+ hydrogen aircraft at airports

AIRBUS

SUMMIT DAY TWO - SESSION TEN

HYDROGEN & MARITIME: SOLUTIONS, INNOVATIONS & TIMESCALES

The session is moderated by **Eva Ravn Nielsen PhD**, Chief Adviser, **Ramboll** and is joined by **Lucien Robroek**, Chief Executive Officer, **Nuvera Fuel Cells, LLC** and **Alexander Saverys**, CEO, **CMB.TECH**.



After a brief video intro about CMB.TECH **Alexander Saverys** explained off-grid applications need a solution, as batteries don't always offer one, which is why they believe in hydrogen for small applications and ammonia larger ones.



Lucien Robroek presents the case for Nuvera's diversified application for fuel cells across different applications, not just for conventional road transport, but also for heavy duty vehicles for industry applications, emergency vehicles etc., emphasizing the benefit associated with the short refueling, long range and high power that is provided by fuel cells.

Also specifically targeting seaports as a key driver for the hydrogen growth, such as Rotterdam Port, where hydrogen engines will have a special place.

Ramboll is spearheading the green shipping in the Baltic Sea, where the company is partnering with key players to set up bunkering hubs and set the infrastructure in place for the smooth, sound operation of a green maritime industry powered by hydrogen. ■

Clean energy / engines: Sea Ports as driver for hydrogen growth

Port Side:

- Cranes
- Rubber-Tire-Gantries
- Reachstackers
- (Empty) Container Handlers
- Terminal Tractors
- Drayage Trucks
- Commercial Vehicles
- Buses

Port drawing: 'Art of Rotterdam'

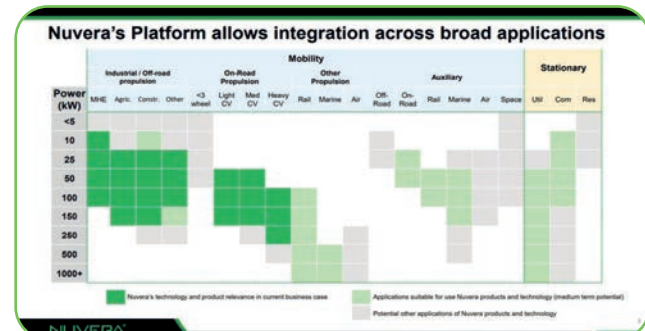
Ship Side:

- Ship-to-Shore Power
- Auxiliary Power
- Pilots
- Ferries
- Special Ports Vessels
- Short Sea Shipping
- Ocean going Vessels

Hydrogen Infrastructure:

- Transport Pipes
- Industrial Production
- Industrial Usage
- Fueling systems

Many of the critical use cases 'meet at the port'...
Public-Private collaboration to accelerate further



Bornholm Bunker Hub

Kick-starting green shipping in the Baltic Sea

- Feasibility study
- Potential for 1 GW Power-to-X plant producing hydrogen and ammonia for shipping in 2030
- A strong partnership

Strategic Port Planning and Logistics

Holistic hydrogen and derivatives expertise

Port equipment technology assessment

Terminal planning

Demand analyses

Risk analyses

Bunkering regulatory analyses

Fleet market evaluation

Like entire Ramboll, "Strategic Port Planning and Logistics" is interdisciplinary thinking green energies from the cradle to the grave!

SUMMIT DAY TWO - SESSION ELEVEN

FINANCING, REGULATIONS & POLICIES SUBSIDIZING HYDROGEN PROJECTS & DEVELOPMENTS

The panel brings together **Alex Barnes**, Senior Advisor, **S&P Global Commodity Insights** (session moderator) and panelists;

Max Gottschalk, Managing Partner, **HYCAP**

Mr Sungbok Kim, CEO, **H2Korea**

Michael Mudd, Director, Global Sustainable Finance, **Bank of America**

to discuss the situation surrounding investing into hydrogen projects. At this stage the current low carbon hydrogen projects are not yet bankable as there is little history with the projects. They also are not yet commercially viable and so there needs to be more incentives.

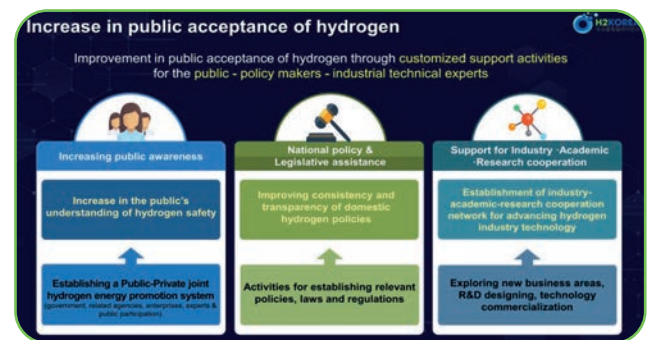
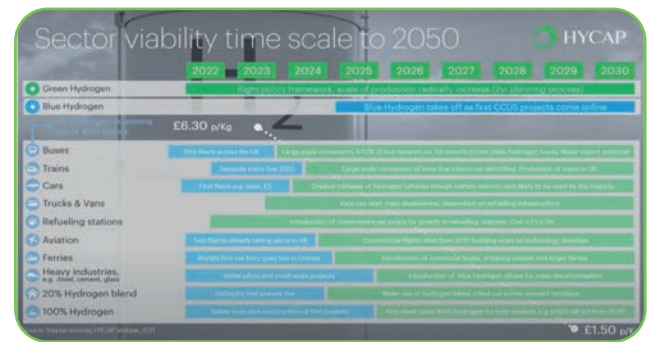
potentially be a few ways to incentivise low carbon hydrogen in America, from expanding renewable credits to green hydrogen, to tax equity partnership between project owners and sponsors. ■



Max Gottschalk from HyCap said they are focusing on transportation at the moment in the UK, leveraging schemes such as RTFO and RTFC. The fund also believe cfd application to green hydrogen can be a good step and transportation is good to create domestic demands.

Sungbok Kim from H2Korea also has hydrogen mobility as one of its focuses as well as power generation through fuel cells and ammonia co-firing. South Korea has pushed a lot for hydrogen, recently introducing clean hydrogen certification and Clean Hydrogen Portfolio Standard. With this, hydrogen in South Korea is quite ahead of Europe.

Michael Mudd of Bank of America highlights the initiative for funding of decarbonisation projects is very strong the focus is to scale up. There could



SUMMIT DAY TWO - SESSION TWELVE

REGIONAL HYDROGEN SUPPLY CHAINS INTEGRATION

The session is moderated by **Clare Jackson**, Chief Executive Officer, **Hydrogen UK** is joined on stage by;

H.E. Drs. J.N. (Jeannette) Baljeu, Regional Minister, **Province of Zuid-Holland**

Dr. Stefan Kaufmann, Innovation Commissioner for Green Hydrogen, **Federal Ministry of Education and Research, Germany**

Gabrielle Henry, Director, Industry Engagement and Development, **Victorian Department of Environment, Land, Water and Planning**

Sally Prickett, Vice President Hydrogen Market Development, **bp**



Dr. Stefan Kaufmann from Germany wants to bring offtakers and production sites together and believes regulation will play a key role, especially for elements like pipeline development. He highlights the hydrogen backbone, pipeline to central Europe, shipping through rivers and liquid hydrogen transport by trains. There is a strong need to speed things up.

Gabrielle Henry from Victoria, Australia mentions deep water ports, pipeline network for regional infrastructure, with the belief that creating demand schemes like the hydrogen highway (25 hydrogen trucks between Victoria and New South Wales) will help. Victoria will help connecting companies to create hydrogen hubs.



This session discusses regional hydrogen supply chains with the presence of government bodies from Zuid Holland, Germany, Victoria (Australia) and bp. All attendees agree that partnerships and collaboration between sectors in the regions are key. Common and robust standards, certifications and regulations will also be key.

H.E. Drs. J.N. (Jeannette) Baljeu, Regional Minister for the Province of Zuid Holland highlights the Regions ambitions to become Europe's Hydrogen Hub but points out the supply chains for shipping, trucks and other methods of transportation will need to align and work together. It is also important to understand the eco-system of the region, use of existing infrastructures and know how to connect in order to plan the infrastructure development.



bp is developing the H2-fifty in Rotterdam to create demand and want to use this as a base to enable the connection of regions. bp is also helping with the Delta corridor and doing the same in many countries, Australia, United States and the United Kingdom. ■

SUMMIT DAY TWO - SESSION THIRTEEN

GLOBAL HYDROGEN SUPPLY CHAINS CREATION & DEVELOPMENT

This session is moderated by **Philip Green**, Australian Ambassador to Germany, Switzerland and Liechtenstein, **Department of Foreign Affairs and Trade** who is joined by **Hon. Alannah MacTiernan MLC**, Minister for Regional Development; Agriculture and Food; Hydrogen Industry, **Western Australian Government** **Martijn Coopman**, Program Manager International Hydrogen Supply Chains, **Port of Rotterdam** **Ivo Bols**, President Europe & Africa, **Air Products** **Cornelis Hulst**, COO, **Pecém Industrial and Port Complex, Brazil**

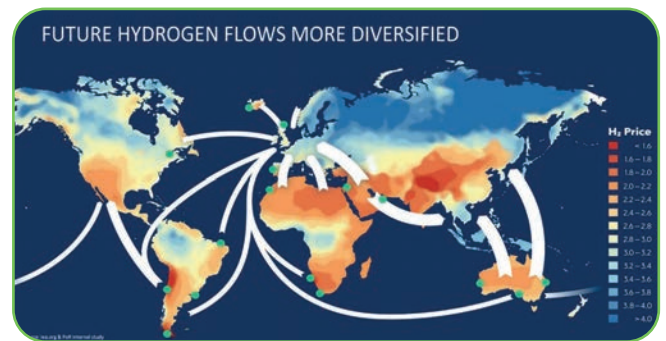
to discuss the global hydrogen supply chain to enable world trade.



Hon. Alannah MacTiernan from Western Australia is looking to attract electrolyser manufacturers to set up in the state, focusing on major projects and creating demand stimulation. 1% of electricity will be powered by renewable hydrogen and 10% of gas blending into gas grid. Knowledge is a challenge in Western Australia and the work on small electrolyser projects will help build the skills required for larger projects.

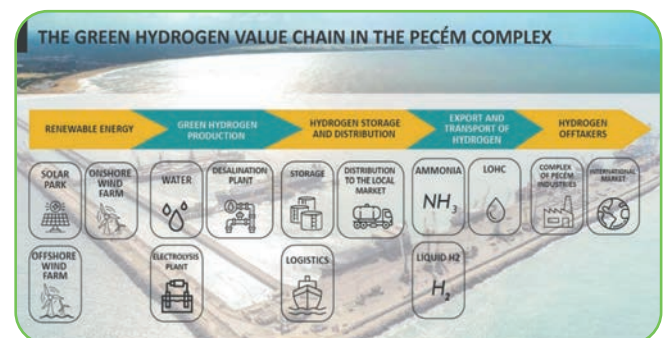
Martijn Coopman from Port of Rotterdam shares the plans to import 4 million tonnes of hydrogen by 2030 and will look to get hydrogen from as many places as possible (Chile, Uruguay, Canada, Australia) while making sure all countries benefit, for example water desalination support in Jordan and building local value chains in Namibia. Port of Rotterdam also believes that the cost gap needs to be accepted. Green ammonia

will be globally traded by 2025 but liquid hydrogen will develop later, like the LNG market where there'll need to be a long term direct contract.



Ivo Bols from Air Products is working on the Neom project as one of the first projects of scale and the blue hydrogen and refueling station in Rotterdam. These large scale projects will kickstart the global supply chain. Hydrogen certification is essential for international supply chains and equal treatment of locally produced and imported hydrogen.

Cornelis Hulst of Port of Pecem is also focusing on the operations side of the port to enable international supply chain. Key points that need work and further consideration for operations are cheap electricity, water environmental requirement for certain carriers (ammonia), flexibility of the supply chain and certifications. There is also a need for local demand to kick-start projects. All agree the key is innovation and knowledge and the main obstacle is offtake. ■



SUMMIT DAY TWO - CLOSING DISCUSSION

HOW DIFFERENT SECTORS ARE WORKING TOGETHER TO IMPLEMENT A HYDROGEN FUTURE?

The final session is moderated by **Prof Peta Ashworth OAM**, Director, **Andrew N. Liveris Academy for Innovation and Leadership**, Chair, **Sustainable Energy Futures**, Chair, Queensland Government Hydrogen Taskforce, **The University of Queensland** who is joined by panelists;

H.E. João Galamba, Secretary of State for Environment and Energy, **Portugal**

Oliver Thorel, VP Chemicals and Low Carbon Hydrogen, **Aramco**

Ben Nyland, President & CEO, **Loop Energy**

Glenn Llewellyn, Vice President, Zero-Emission Aircraft, **Airbus**

Dr. Manfred Schuckert, Head of Regulatory Strategy and Int. Hydrogen Strategy, **Daimler Truck AG**

Dr. Manfred Schuckert from Daimler Truck AG also plans an entirely different design for hydrogen trucks to replace diesel and very welcome ETS scheme to push decarbonization. ■

“ To become a producing and exporting hub and we want to present jointly with Rotterdam which will hold the importing facilities as a new interconnection in Europe. Portugal cannot be condemned to only have interconnections with Spain. ”

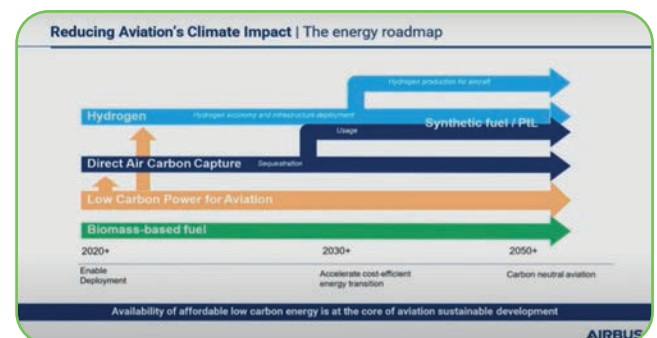
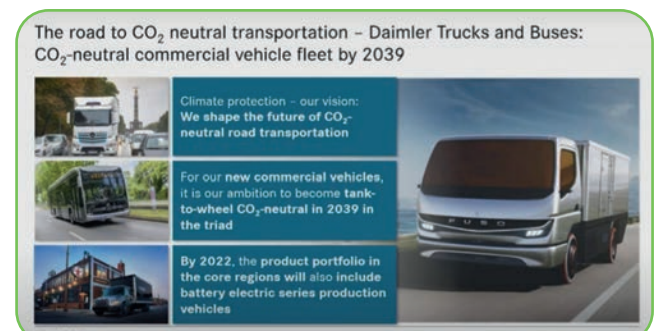
H.E. João Galamba
Secretary of State for Environment and Energy
Portugal



The discussions center around the need for hydrogen development that it needs to be a joint effort with a lot of collaboration, research and partnerships to create an ecosystem. This was highlighted by **Glenn Llewellyn** from Airbus as they are now collaborating with sectors and industries that they never really talk to, like the automotive OEMs and the space industry.

H.E. João Galamba from Portugal aims to use its renewable resources to be more involved in the European hydrogen economy rather than just be linked to Spain, pointing out that Sines could be used as a hub to trade with the Port of Rotterdam.

Oliver Thorel from Aramco also wants to use blue hydrogen to scale up the industry and wants more clarity on regulation – a common theme at the summit.

The road to CO₂ neutral transportation – Daimler Trucks and Buses: CO₂-neutral commercial vehicle fleet by 2039

- Climate protection – our vision: We shape the future of CO₂-neutral road transportation
- For our new commercial vehicles, it is our ambition to become tank-to-wheel CO₂-neutral in 2039 in the triad
- By 2022, the product portfolio in the core regions will also include battery electric series production vehicles

WITH THANKS TO OUR SUPPORTERS





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