



# WORLD HYDROGEN 2023

SUMMIT & EXHIBITION



# 2023

## EXECUTIVE SUMMARY

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# SUMMIT DAY ONE





## OPENING KEYNOTE ADDRESSES

### The World Hydrogen 2023 Summit started with two keynote addresses.

Zuid-Holland’s Jeannette Baljeu and the City of Rotterdam’s Robert Simons opened by stressing the role that governments, including local and regional authorities, can play in helping to kickstart a hydrogen economy. While they cannot build production plants or electrolysers, they are responsible for aspects such as permitting and education, Simons said. Local governments will seek to support small and medium-sized enterprises in particular, as they are crucial for driving the energy transition, he said.

The Port of Rotterdam’s Allard Castelein then outlined The Port’s vision to become a site of hydrogen production and also an import hub for hydrogen and derivatives to supply European offtakers. The Port is on course to install up to 2.5GW of electrolysis capacity by 2030, while it had only envisaged 1GW at first, he said. Government incentives have been the key driver for the upward revisions in expectations, Castelein said. On the import side, The Port wants to source hydrogen from a range of locations for energy security, and had therefore signed some 20 agreements to develop global supply chains. A virtual signing ceremony for an agreement with the Brazilian Port of Pecém, in which the Port of Rotterdam is a shareholder, took place later that same day. To handle imports, Rotterdam is building a pipeline network and has already taken delivery of the first parts, Castelein said, adding that the port authority has also received proposals from eight storage operators to cater for imports of hydrogen. Rotterdam is open to providing facilities for whatever types of hydrogen carrier the private sector might demand – whether that be liquid hydrogen, ammonia, methanol or liquid organic hydrogen carriers (LOHCs). Castelein concluded by saying that the maritime sector, including ports, should aim for carbon neutrality by 2050.

#### H.E. Jeannette Baljeu

Regional Minister, [Province of Zuid-Holland](#)

#### Robert Simons

Vice-Mayor Port, Economy, Hospitality and Governance, [City of Rotterdam](#)

#### Allard Castelein

Chief Executive Officer, [Port of Rotterdam Authority](#) and [SEC Hydrogen Advisory Board Member](#)



**We are aiming for a zero emission shipping industry by 2050.”**

#### Allard Castelein

Chief Executive Officer, [Port of Rotterdam Authority](#) & [SEC Hydrogen Advisory Board Member](#)



## FIRESIDE CHAT: US DEPARTMENT OF ENERGY: AN INSIGHT INTO US HYDROGEN PLANS

The U.S. Department of Energy’s David Crane gave an overview of the country’s hydrogen ambitions, policy and strategy. The exact regulations for hydrogen production tax credits under the Inflation Reduction Act — which could provide up to \$3/kg, depending on lifecycle greenhouse gas emissions — are to be finalised in the second half of this year, Crane said, adding that the government also intends to select its preferred hydrogen hubs by then. The White House plans to distribute around \$7bn across 6-10 selected hubs that involve different hydrogen production pathways — including from renewables, natural gas with carbon capture and nuclear power — spread across the country. It has not disclosed how many final applications it received, having previously encouraged 33 proposed hubs to make full applications. These encouraged projects were selected from 79 concept papers from projects costing at a combined \$215bn, he added. Besides encouraging production through the tax credits, the U.S. still needs to focus heavily on the demand side, and also needs to work on the “connective tissue” of transport infrastructure and storage, Crane said. In terms of building a global traded hydrogen market, development of the LNG industry can serve as a “guidepost”, according to Crane, although the hydrogen sector would have to develop much more rapidly, given global decarbonisation goals.

### Daria Nochevnik

Director for Policy and Partnerships,  
Hydrogen Council

### David Crane

Director of the Office of Clean Energy  
Demonstrations, U.S. Department of  
Energy



**We have to do something  
about demand.”**

### David Crane

Director of the Office of Clean Energy  
Demonstrations, U.S. Department of Energy





## SPOTLIGHT: AIR PRODUCTS: “MOVING H<sub>2</sub>UMANITY FORWARD WITH HYDROGEN”

Ivo Bols

President Europe and Africa, [Air Products](#)

Air Products’ Ivo Bols underlined the challenge facing the energy sector globally, noting that the world needs to add 18-19pc more renewable energy capacity every year to meet its goals. Global supply chains are needed, as a route of “self-reliance” and would increase the global cost of the energy transition by \$6 trillion, he said. Bols called for faster decarbonised hydrogen production to enable the global energy transition. “We need to course correct,” he said. Bols urged permitting bodies to speed up their work in support of renewable energy installations and distribution infrastructure. Public funding is needed to bring down the cost of hydrogen and policymakers should take a neutral approach to all production pathways, Bols said.

Governments should use regulation sparingly and try to encourage open and competitive markets where possible to drive innovation, he said, singling out import terminals and ammonia cracking facilities specifically. Argus is currently tracking 15 ammonia cracking facilities announced globally, with the majority planned for Northwest Europe. But all large-scale plants are still at early development stages. For its part, Air Products plans to invest \$15bn by 2027 in clean hydrogen projects around the world, Bols said. The Saudi Arabian Neom project, in which the U.S. firm is a partner, will produce 600 t/d of renewable hydrogen from 2026, while Air Products also plans to build the world’s largest carbon capture and sequestration facility to enable production of hydrogen from natural gas in Louisiana.



Now, look at us, its 11,000 representatives of 120 countries, talking about the hype, talking about momentum, talking about building the interest and the realisation of the crucial role hydrogen has to play in the energy transition. It is now really at the top of government’s agendas across the world.”

Ivo Bols

President Europe and Africa, [Air Products](#)



# SESSION 1: LEADING GLOBAL HYDROGEN PRODUCTION PROJECTS & POLICIES

Smartenergy’s Christian Pho Duc opened the first panel discussion with a presentation outlining major policy announcements for the hydrogen sector, including in the EU. Subsidies are important, but it will also be crucial to identify projects within Europe that could already operate fully without subsidies by 2030, Pho Duc said. The panellists subsequently outlined the progress made by their companies in the hydrogen space, but generally agreed that Europe could develop the sector faster by tweaking its policies and expanding support. HyCC’s Marcel Galjee pointed to the enormous scale-up that is required in the coming years.

While the largest operational electrolyser in the Netherlands has a capacity of 1MW and the largest in Europe has 20MW, around 100GW will be needed within the EU by 2030 and another 100GW outside to meet the bloc’s renewable hydrogen targets. “We’re talking a lot about ambitions, and even raising the ambitions, but I think we should spend more time on getting the investment decisions today,” he said. Technology will need to improve further, so a learning process is crucial, Galjee added. Ørsted’s Olivia Breese agreed, saying that “if we are collectively as an industry to move forward from the paper gigawatts [...] we all have to make those difficult decisions where everything is not in place”. She pointed to Ørsted having taken a final investment decision on the 55,000 t/yr FlagshipOne e-methanol project in Sweden last year, even though “the jigsaw pieces were not all in place” by then. The need to move ahead with investment is not restricted to production, but also applies equally for the demand side, Breese added. While project developers will have to take risks, policy support will also have to improve in Europe.

### Najla Al Jamali

Chief Executive Alternative Energy, OQ Group and SEC Hydrogen Advisory Board Member (Moderator)

### Christian Pho Duc

Chief Technology Officer, Smartenergy Group and SEC Hydrogen Advisory Board Member

### Axel Wietfeld

CEO, Uniper Hydrogen GmbH

### Werner Ponikwar

CEO, thyssenkrupp nucera

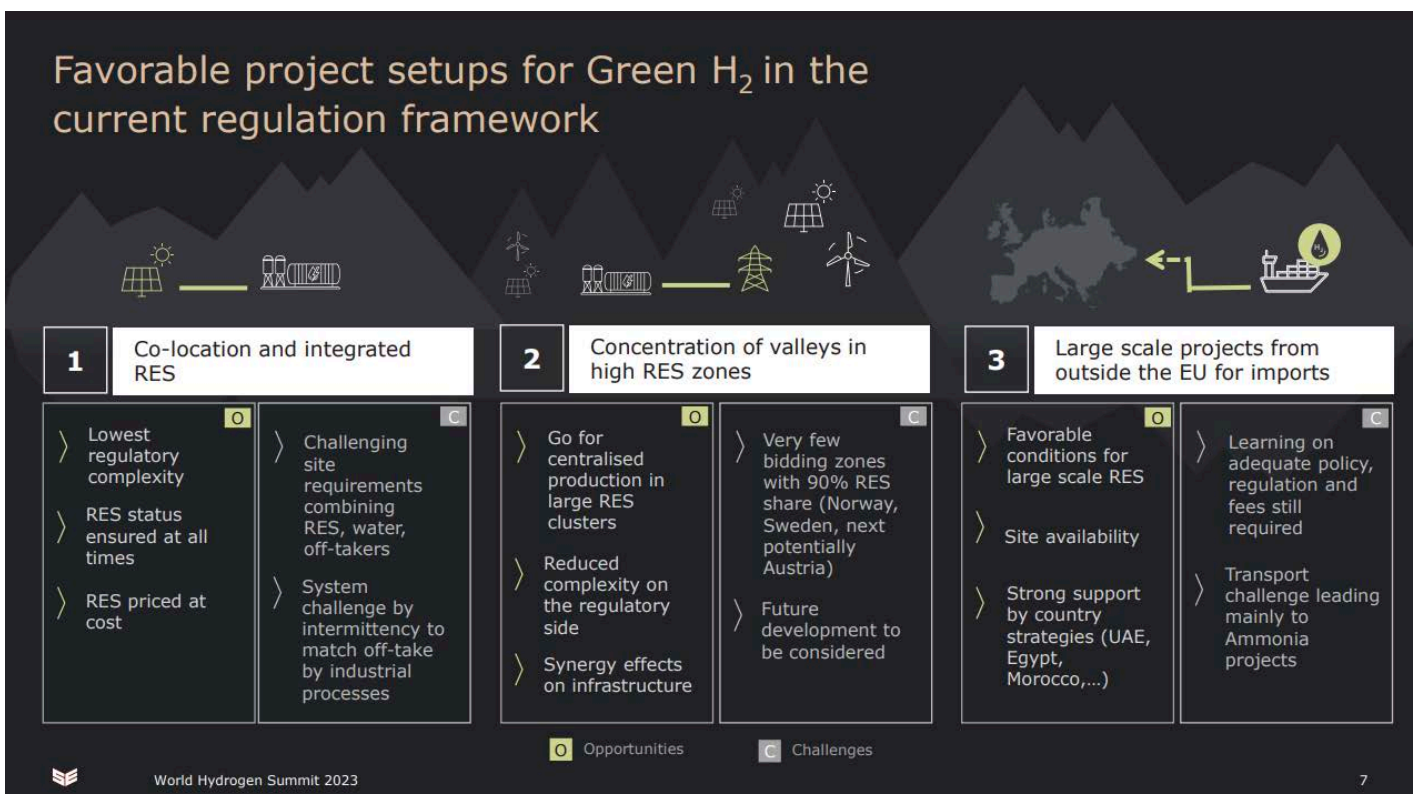
### Marcel Galjee

Managing Director, HyCC

### Olivia Breese

Senior Vice President, Head of Power to X, Ørsted

## Favorable project setups for Green H<sub>2</sub> in the current regulation framework



1	Co-location and integrated RES	2	Concentration of valleys in high RES zones	3	Large scale projects from outside the EU for imports
<ul style="list-style-type: none"> <li>Lowest regulatory complexity</li> <li>RES status ensured at all times</li> <li>RES priced at cost</li> </ul>	<ul style="list-style-type: none"> <li>Challenging site requirements combining RES, water, off-takers</li> <li>System challenge by intermittency to match off-take by industrial processes</li> </ul>	<ul style="list-style-type: none"> <li>Go for centralised production in large RES clusters</li> <li>Reduced complexity on the regulatory side</li> <li>Synergy effects on infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Very few bidding zones with 90% RES share (Norway, Sweden, next potentially Austria)</li> <li>Future development to be considered</li> </ul>	<ul style="list-style-type: none"> <li>Favorable conditions for large scale RES</li> <li>Site availability</li> <li>Strong support by country strategies (UAE, Egypt, Morocco,...)</li> </ul>	<ul style="list-style-type: none"> <li>Learning on adequate policy, regulation and fees still required</li> <li>Transport challenge leading mainly to Ammonia projects</li> </ul>

O Opportunities     C Challenges

World Hydrogen Summit 2023 7



Panellists agreed that the U.S. production tax credits and hydrogen hub programme are better suited to move the sector ahead at pace than the measures drawn up by the EU. “Europe is putting the same amount of money on the table as the U.S., but instead of having it in a one-stop-shop, there are various different pockets of money and you patchwork together your funding support,” Breese said. For Europe to maintain its leadership position, it needs speed and simplicity, she said. Galjee concurred and called for more certainty on the regulatory side.

The EU has closed in on rules for renewable hydrogen use, including regulations that would require member state to ensure that 42pc of all hydrogen used in industry by 2030 is renewable. But how countries will implement this is unclear, as is which penalties would apply for non-compliance, Galjee said. Until these questions are answered, firms cannot factor these rules into their business cases, he added. Werner Ponikwar of thyssenkrupp nucera agreed that the industry needs to pick up speed if Europe is to come close to its 2030 targets and that policy incentives will have a key role to play in this. Realising large projects from first thought to initial deliveries can take 8-10 years under current circumstances, while 2030 is just seven years away, he said. But Uniper’s Axel Wietfeld said a lot can be achieved when there is a willingness to complete projects at speed.

The firm last year was able to set up a floating storage and regasification unit for LNG in northern Germany in less than a year, partly because there was strong political backing for the project.



Europe is putting the same amount of money on the table as the U.S., but instead of having it in a one-stop-shop, there are various different pockets of money and you patchwork together your funding support.”

**Olivia Breese**

Senior Vice President, Head of Power to X,  
Ørsted



## SPOTLIGHT: ADVANTAGE CANADA IN HYDROGEN

**Laurel Broten**  
CEO, *Invest in Canada*

Invest in Canada's Laurel Broten invited hydrogen project developers to use her organisation as a point of contact to connect them with Canadian companies and policymakers. Broten reminded delegates of Canada's recently-announced financial support package, which will provide investment tax credits of up to 40pc for the cleanest hydrogen projects, while other provisions support associated low-carbon ammonia production and clean technology manufacturing. Canada intends to start exporting hydrogen to Europe as soon as 2025, following agreements with Germany, the Netherlands, and the wider EU, Broten said.

She listed a handful of projects that are already under development along Canada's east coast in the provinces of Quebec, Nova Scotia, and Newfoundland and Labrador. Besides renewable hydrogen production, the country could also leverage its natural gas reserves for blue hydrogen output, Broten said. Argus calculations show that it would cost around \$6.40/kg to produce hydrogen in Canada from offshore wind, including capital expenditure. But with a 40pc tax credit on the investment costs for electrolyzers and eligible balance-of-plant equipment, the production cost would fall to about \$5.50/kg.



The Government of Canada is introducing an investment tax credit for clean hydrogen, the projects that produce the cleanest hydrogen will receive the highest levels of support, which will be as much as a 40% credit.”

**Laurel Broten**  
CEO, *Invest in Canada*





## SESSION 2: RENEWABLE HYDROGEN PRODUCTION AND ELECTROLYSER DEVELOPMENTS

Technology company Robert Bosch GmbH's Vice-President for Sales and Business Development for Electrolysis Matthias Ziebell launched the session, saying that Bosch sees Europe, the U.S. and the Middle East and North Africa as key regions for renewable hydrogen demand growth. Bosch expects the levelised cost of hydrogen to fall by 50-65pc by 2030 compared with 2021 as renewable power generation becomes cheaper. This will "for sure" make renewable hydrogen "attractive" and has driven Bosch's decision to spend "billions of euros" in the industry over this decade, Ziebell said.

Bosch is developing various technological equipment for the sector, including proton exchange membrane (PEM) electrolyser stacks and solid-oxide fuel cells. Battolyser, meanwhile, is working on new technology "that can produce hydrogen and store electricity" and that can therefore act as a potential flexibility provider, according to Mattijs Slee. New technologies will be important for renewable hydrogen to comply with draft EU rules — such as the 'temporal correlation' requirement that will apply from the end of this decade — and to reduce dependence on critical raw materials, Slee said. The lack of rare earth materials is "a real problem" that the industry has been failing to confront he said.

### Tim Hard

SVP Energy Transition, [Argus Media](#)  
(Moderator)

### Matthias Ziebell

VP, Sales & Business Development  
Electrolysis Technology & Services,  
[Robert Bosch GmbH's](#)

### Massimo Scopelliti

Product and Marketing Manager,  
[Nidec Industrial Solutions](#)

### Mattijs Slee

CEO, [Battolyser Systems](#)

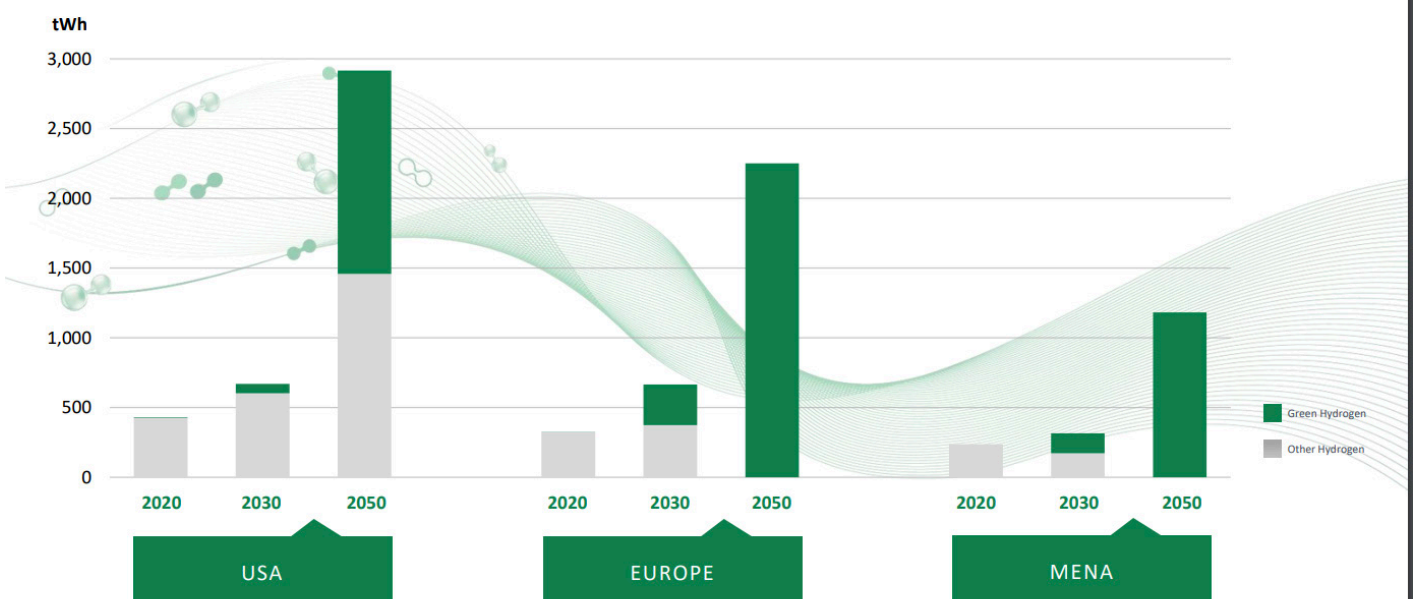
### Dr. Nima Pegemanyfar

Head of Hydrogen Business Europe,  
[Siemens Energy](#)

### Annant Shah

Director of Strategy and Route to Market,  
[SSE Renewables](#)

### Hyper scaling demand for green hydrogen



Source: Department of Energy (US), H<sub>2</sub> strategy (EU), McKinsey (MENA)

Siemens Energy’s Dr. Nima Pegemanyfar then shed some light on the company’s electrolyser manufacturing capacity. The firm could currently produce roughly 300 MW/yr at its Erlangen factory in southern Germany, but will move to gigawatt scale when opening its new site close to Berlin, which is being developed with industrial gas firm Air Liquide and is expected to start operations later this year. This will allow the firm to scale up from 1 GW/yr by the end of the year to 3 GW/yr by 2025, thereby helping to deliver on orders that the company has received, he said. Siemens Energy recently bagged a 1.8GW electrolyser order from HIF Global – the second-largest electrolyser order for any firm to date and the largest for PEM technology, according to Argus data. Pegemanyfar said high demand for electrolyser components poses a potential challenge. Lead times for components such as transformers have increased substantially because of strong demand and the wait can run into “years” for products made in Europe, he said. But there is no reason for concern that electrolyser manufacturing capacity would not ramp up quickly enough, the panellists said. Innovating together with partners can move the industry forward, and other sectors – such as smartphones and electric vehicles – show what can be achieved in a short time span, Bosch’s Ziebell said.



We need to think through the real scale of the energy transition.”

**Mattijs Slee**  
CEO, Battolyser Systems





## SPOTLIGHT: GRASPING THE OPPORTUNITY

### Fiona Simon

CEO, Australian Hydrogen Council and SEC Hydrogen Advisory Board Member

Fiona Simon of the Australian Hydrogen Council shared her thoughts with delegates on what is necessary for the industry to move ahead decisively. She said global policy support for renewable hydrogen is growing, but that questions over offtake and the cost of production still dominate discussions. For Australia specifically, the key question is how to realise its “hydrogen superpower ambitions”, and she said this will involve tackling challenges such as the build-out of an “eye-wateringly large amount of renewable electricity generation” capacity.

Simon was “thrilled” about the Australian government’s announcement the previous day that it would earmark A\$2bn for the ‘Hydrogen Headstart’ programme to provide operating support to 2-3 large-scale flagship renewable projects. “It’s not the Inflation Reduction Act, but it’s better than nothing,” she said. The association is hoping for more funds to be made available in subsequent federal budgets. Neither governments nor the private sector can bear all the risks related to the build-up of a hydrogen economy, so the “partnership here is so vital”, Simon said.



This is the time to set reasonable expectations, to get the frameworks in place for the long term.”

### Fiona Simon

CEO, Australian Hydrogen Council and SEC Hydrogen Advisory Board Member



## SESSION 3: LOW-CARBON HYDROGEN PRODUCTION AND CCUS

bp’s Felipe Arbelaez opened the session, saying the sector’s “collective efforts” should initially be targeted at industrial use of renewable and low-carbon hydrogen. bp is planning to decarbonise its own refinery operations and other hard-to-abate sectors in locations including Valencia in Spain. Industrial projects are easier to carry out than those targeting other applications, such as heating homes, not least because they involve fewer stakeholders, Arbelaez said. He also pointed to remaining difficulties with transporting hydrogen, especially by ship. “With hydrogen right now, the transportation costs can actually outweigh the cost of production,” he said, adding that “hydrogen will go from local to regional to global”. bp’s efforts are therefore initially focused on contained geographical locations, with large-scale exports to international markets, such as those from Western Australia’s Asian Renewable Energy Hub (AREH) – which bp leads as developer – only the final stage, Arbelaez said.

Starting the panel discussion with a look at natural gas-derived hydrogen, Linde’s David Burns said that carbon capture is a technology already “available at scale” today. Sequestration is still “a developing field”, he said, but the “technology is out there as well”. Linde is working with various partners around the world on projects to advance the process, Burns said, adding that especially in the U.S. there is also a lot of helpful policy support for low-carbon hydrogen, such as through the Inflation Reduction Act. But a lack of regulatory frameworks still presents a hurdle in most regions, according to Bechtel’s John Gunn. In most jurisdictions, regulatory frameworks are not fully in place – and even where they are, agencies do not have the capacity to fully progress all applications, such as for environmental permits, Gunn said.

But most panellists were upbeat on the Inflation Reduction Act’s support for low-carbon hydrogen, while Arbelaez also pointed to the “very positive” approach from the UK government, such as with regard to clustering low-carbon hydrogen producers together with infrastructure and storage operators and thereby offering greater certainty around storing captured CO<sub>2</sub>. Meanwhile, the panellists were doubtful that the EU will be able to meet its ambitious renewable hydrogen targets for 2030 – 10mn t/yr of domestic production and another 10mn t/yr of imports. “I just don’t see us being able to do that,” Burns said, adding that “the numbers are daunting” regarding build-out of electrolyser capacity. Air Liquide’s Dominique Rouge agreed, saying that “when we do the maths, we see that there will be a huge challenge to meet this target on green hydrogen, especially producing in Europe”. Hydrogen from natural gas with carbon capture and storage or utilisation will therefore have an important role to play in decarbonisation efforts, according to the panellists. “We need to be more concerned about the carbon intensity of the hydrogen, not just focused on how it’s produced,” Burns said.

### Yelda Guven

Vice President Policy, EAME, ExxonMobil |  
Low Carbon Solutions (Moderator)

### Felipe Arbelaez

Senior Vice President Hydrogen & CCS, bp

### David Burns

Vice-President Clean Energy, Linde and  
SEC Hydrogen Advisory Board Member

### Dominique Rouge

Vice President, Sales & Technology,  
Air Liquide Engineering & Construction

### John Gunn

Global Manager of Operations, Energy  
Transition, Bechtel

### Matias Saettone

General Manager, Hydrogen Products,  
Chevron New Energies, Chevron



We need to be more concerned about the carbon intensity of the hydrogen, not just focused on how it’s produced.”

### David Burns

Vice-President Clean Energy, Linde and  
SEC Hydrogen Advisory Board Member





## SESSION 4: HYDROGEN INFRASTRUCTURE: STORAGE, TRANSPORTATION AND DISTRIBUTION

The fourth session focused on questions related to development and scale-up of hydrogen storage and transportation, as well as safety. Provaris' Garry Triglavcanin explained the company's approach to shipping hydrogen in compressed form. The firm is focusing on short routes in Europe, such as between Norway and Germany. While compressed hydrogen has a lower energy density than ammonia or liquefied hydrogen, the compression process is "simple, low-cost and energy-efficient", Triglavcanin said. Provaris is targeting vessels that could carry between 430t and 2,000t of hydrogen.

For LIFTE H2's Matthew Blieske, the importance of storage and other infrastructure is too often underestimated. He said that while there is a lot of focus on generation, and electrolysis, even for "relatively small projects of 50-60MW, the cost of storage and bunkering and the export thereof can exceed the cost of generation". In California, it costs \$4-6/kg today to "move your hydrogen around", which means that "even if the hydrogen were free, it's too expensive". This is because today's systems are still too small, whether it is pipeline infrastructure, trailers or bunkering facilities, Blieske said. Changing this will take time and have to be done step by step, he added. Triglavcanin agreed that storage will be crucial.

The amount of storage that could be needed in future is "staggering", he said. Faurecia Hydrogen Solutions expects both liquid and gaseous storage of hydrogen to have an important role to play going forward, with the exact requirements varying by region, Murat Aydemir said. Faurecia is supplying storage tanks to manufacturers of hydrogen vehicles, such as Hyvia, a joint venture between carmaker Renault and hydrogen firm Plug Power. Gexcon's Lars-Marthin Knoph highlighted some of the most important safety considerations around transporting and storing hydrogen and stressed the importance of a well-trained workforce to avoid any accidents.

### Keith Casey

CEO, Pin Oak Group, LLC (Moderator)

### Garry Triglavcanin

Chief Development Officer, Provaris Energy

### Matthew Blieske

CEO, LIFTE H2

### Lars-Marthin Knoph

Hydrogen Safety Specialist – Senior Engineer, Gexcon

### Murat Aydemir

Managing Director, Faurecia Hydrogen Solutions Germany



The cost of storage and bunkering and the export thereof can exceed the cost of generation."

Matthew Blieske  
CEO, LIFTE H2



# SPOTLIGHT: DELOITTE: BUSINESS MODEL SOLUTIONS TO ADVANCE THE CLEAN HYDROGEN

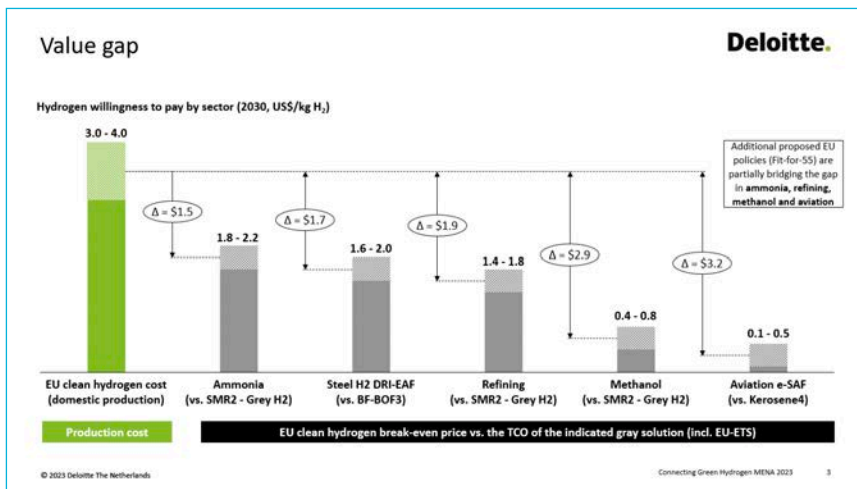
Deloitte’s Eric Vennix and Tarek Helmi pointed to the still-large gap between the cost of renewable hydrogen production and what customers are willing to pay for it. Regulations and policy incentives, such as the Inflation Reduction Act’s production tax credits, will be needed to overcome that gap, they said. They also pointed to the possibility of “natural demand” occurring in sectors where the “green premium” is less pronounced. One example is the automotive industry, with Helmi saying the cost of manufacturing a car would only increase by €200-300 when using green steel, compared with conventional steelmaking methods.

### Eric Vennix

Partner Consulting, Managing Partner Energy & Resources, [Deloitte](#)

### Tarek Helmi

Partner, Future of Energy & Global Hydrogen leader, [Deloitte](#)



We believe that what is essential is that you see value chain integration.”

### Eric Vennix

Partner Consulting, Managing Partner Energy & Resources, [Deloitte](#)





# SPOTLIGHT: UNIQUE OPPORTUNITIES FOR HYDROGEN WITHIN PTL IN THE UAE: THE BENEFITS OF ABUNDANT, CHEAP RENEWABLE RESOURCES

## Nairansamy Dorasamy

Executive Director of Bio and Chemical Energy, Renewable and Sustainable Energy Research Center, [Technology Innovation Institute](#)

Nairansamy Dorasamy of the Technology Innovation Institute pointed to the many climate change commitments that have emerged globally and in the Middle East in particular, including by the individual emirates, and said “now is the time to act” on those. The UAE can produce renewable power — and consequently also renewable hydrogen and derivatives — at low cost, which could help with meeting these commitments, Dorasamy said. Argus calculates prevailing renewable hydrogen production costs in the UAE at around \$5.60/kg, including capital expenditure, but this could fall in the coming years as the costs for renewable power generation and for electrolyzers are expected to decline. For the UAE, using renewable hydrogen to produce sustainable aviation fuel could be particularly critical, Dorasamy said. The aviation sector has come under “tremendous pressure to decarbonise” and this will be crucial for the UAE, given that 15pc of the country’s workforce is employed in this industry, he said. The UAE’s two main airlines, Emirates and Etihad, have ambitious decarbonisation goals and see power-to-liquid as key to realising them.



Now is the time to act.”

## Nairansamy Dorasamy

Executive Director of Bio and Chemical Energy, Renewable and Sustainable Energy Research Center, [Technology Innovation Institute](#)

## Unsubsidised Levelized Production Costs Across Alternative SAF Production Pathways

In addition to cost, the technological unreadiness of some SAF technologies also serves as a major hurdle on the supply side.

- To date, the AtJ, Gas-FT, and PTL technologies exist only at lab-scale or pilot-scale demonstration.
- Shifting to full commercialization will require continued investments in research, development, and demonstration



Source: Pavlenko et al.  
Note: jet fuel prices have been converted from 2018 euros/liter to 2021 dollars/gallon

## SESSION 5: HYDROGEN MOBILITY MARKET: ADVANCEMENTS ON LAND, SEA AND AIR

The following panel discussion focused on hydrogen mobility, which often triggers most excitement among those not directly involved with the industry, according to Hydrogen UK's Clare Jackson. H2XGlobal's Chief Technology Officer, Ian Thompson, said he had observed substantial growth in the hydrogen mobility sector over the past 18 months, "especially in the professional vehicle market". Interest in hydrogen is particularly strong in the "back-to-base" segment, where vehicles come back to a central refuelling station in between operations, Thompson said. This includes any vehicles that are in operation "pretty much 24/7", such as taxis, buses or last-mile deliveries. There is also growing interest in hydrogen use for other commercial vehicles, such as rubbish trucks, concrete mixers and specialised heavy trucks, Thompson said. But there is less of a push towards hydrogen for long-haul deliveries because the refuelling infrastructure is not yet sufficient, he added.

The lack of refuelling infrastructure is in fact the hydrogen mobility sector's "biggest challenge", according to FuelCell Energy's Eric Strayer. Major trucking corridors with co-ordinated refuelling infrastructure will have to be built to make hydrogen use in long-haul trucking more viable, he said. There are places where such infrastructure is more established, such as South Korea or California, but in most places a substantial build-out is still needed, Strayer said. Howden's Perry Houtepen agreed that hydrogen use in road transport is still limited, but said reducing costs for renewable hydrogen by scaling up and improving its transport, such as through liquefaction, could enable more widespread use.

Innovation will be important to help the scale-up of hydrogen use in the mobility sector, but H2X Global's Thompson is concerned that there is almost too much of it. "Every week there's a new technology that's coming out that's being done in a lab somewhere and it's the new latest thing," he said. He suggested that the industry should "make a decision at some point to pick a solution that's working at the moment" because "we are paralysing ourselves with innovation". For the UAE, aviation is a key area to partly decarbonise via hydrogen, said Masdar's Alexander Ritschel – echoing Dorasamy's statements during the previous session. But Ritschel stressed that the UAE will also have to focus on hydrogen use in the maritime sector, given that it has several key ports, while there are also opportunities for hydrogen use in road transport, such as between Dubai and Abu Dhabi. Concluding the discussions, the panellists largely agreed that aviation will be the mobility sector that accounts for the largest share of hydrogen use by 2030.

**Clare Jackson**  
CEO, Hydrogen UK (Moderator)

**Dr Alexander Ritschel**  
Head of Technology, Masdar, Abu Dhabi  
Future Energy Company

**Nicolas Marti**  
Business Development Manager EMEA -  
Alternative Fuel, Emerson

**Ian Thompson**  
Chief Technology Officer, H2X Global

**Perry Houtepen**  
Managing Director HCR, Howden,  
a Chart Industries Company

**Eric Strayer**  
Vice President, International and  
Partner Sales, Fuel Cell Energy



Every week there's a new technology that's coming out that's being done in a lab somewhere and it's the new latest thing."

**Ian Thompson**  
Chief Technology Officer, H2X Global





## SESSION 6: HYDROGEN APPLICATIONS IN INDUSTRY: DECARBONISING HEAVY INDUSTRY

The panellists started this session by highlighting some of their companies' key renewable hydrogen projects. Repsol's Tomas Malango said the company intends to take final investment decisions (FIDs) on three plants in Spain by November. The company plans to take FIDs on a plant with 100MW electrolyser capacity in Bilbao in northern Spain, a facility of the same size in Cartagena in the south, and a 150MW site in Barcelona in the northeast, Malango said. Repsol already operates a 2.5MW electrolyser in Bilbao that came on line last year. Like Repsol, Italy's Eni is looking to decarbonise its refinery processes in southern Italy by substituting grey hydrogen use. The firm is planning to trial different electrolyser configurations of 10-20MW for this, with a view to taking FIDs later this year, Andrea Pisano said. Emmanuel Rodriguez of ArcelorMittal said the steelmaker is not yet using any hydrogen but is looking to "completely change the steelmaking process" to be able to eventually use hydrogen to decarbonise. Within Europe, the firm is planning such transformations in Spain, France, Belgium and Germany, by moving from coal or coke to natural gas and — as an "ultimate step" — to hydrogen, Rodriguez said.

Yara Clean Ammonia's Jacky de Letter pointed to renewable hydrogen projects that the company is developing in Portugal and Australia, with 24MW and 10MW of electrolyser capacity, respectively. These plants stand out because FIDs have already been taken and first green ammonia based on output from the facilities could be available by the end of this year or in early 2024, de Letter said. The discussion then shifted to concrete decarbonisation goals for the end of the decade. Yara aims to cut its 2030 greenhouse gas emissions by 30pc from 2019 levels, de Letter said. Given that the company currently produces and consumes around 8mn t/yr of grey hydrogen globally, it will need to introduce a substantial amount of renewable or low-carbon hydrogen by the end of the decade to meet its targets. ArcelorMittal, meanwhile, aims to reduce its 2030 emissions globally by 25pc compared with 2018, with an even more ambitious target of 35pc for Europe. The global cuts will be equivalent to "tens of millions of CO<sub>2</sub>" emissions a year, according to Rodriguez.

Repsol's Malango said the firm's longer-term goal is to install 2GW of electrolyser capacity by 2030 and to replace 75pc of its grey hydrogen consumption. But while many companies pursue ambitious plans, McDermott's Hans van Zutphen stressed that development of hydrogen plants is still at an early stage. "We are still in the phase of hydrogen projects 1.0," he said, adding that "in five years from now, we'll look at what we're doing right now" and wonder "how we ever came up with that design". Project costs could fall markedly, with van Zutphen estimating that capital expenditure for renewable hydrogen projects could drop by 50-60pc by the end of the decade. But the question will be "how many can we build, rather than how dirt-cheap can we make it", given the scale-up in production required over the coming years, van Zutphen said. "I'd rather produce 20 more hydrogen plants at 5pc more capex than 10 hydrogen plants at 5pc less capex," he said. The panellists largely agreed that a lack of clarity, difficulties in finding offtakers because of high production costs and related problems with project bankability present the biggest challenges.

**Occo Roelofsen**  
Founder, *Power2X* (Moderator)

**Tomas Malango**  
Renewable Fuels and Circular Economy  
Director, *Repsol*

**Hans van Zutphen**  
Senior Project Manager, *McDermott*

**Andrea Pisano**  
Head of Hydrogen Initiatives, *Eni*

**Jacky de Letter**  
Director Business Development, *Yara Clean Ammonia*

**Emmanuel Rodriguez**  
Head of Decarbonization Partnerships,  
*Arcelor Mittal*



We are still in the phase of hydrogen projects 1.0, he said, adding that in five years from now, we'll look at what we're doing right now and wonder how we ever came up with that design."

**Hans van Zutphen**  
Senior Project Manager, *McDermott*



## SPOTLIGHT: HYDROGEN STRATEGIES AND PROGRAMMES IN THE EU AND US

Representing the U.S., Sunita Satyapal opened the session by reiterating the country’s clean hydrogen goals – 10mn t/yr by 2030, 20mn t/yr by 2040 and 50mn t/yr by 2050. She mentioned initiatives such as the production tax credits under the Inflation Reduction Act that are to make this possible. Argus calculations suggest that the production tax credits could bring the cost of renewable hydrogen production close to – but for now not below – that of grey hydrogen. But by the early 2030s, the U.S. hopes to bring the unsubsidised cost of clean hydrogen production down to \$1/kg, largely through technology improvements. Satyapal said more guidance on the tax credits is expected “soon” and pointed to other funding support mechanisms, including the hydrogen hub programme.

The European Commission’s Ruud Kempener then presented the EU perspective and pointed to the bloc’s own goals for the end of the decade – 10mn t/yr of renewable hydrogen production domestically and another 10mn t/yr to be imported. He also stressed that EU institutions in recent months had reached a number of draft agreements on hydrogen use, including the rules that would require member states to ensure that 42pc of all hydrogen used by industry in 2030 would have to be renewable hydrogen. Other agreements set quotas for renewable hydrogen and derivatives in the aviation and maritime sectors, while EU institutions also agreed on a framework for building up a network of hydrogen refuelling stations across the bloc. The measures will create “a market right away”, Kempener said. He also pointed to the importance of pipeline and terminal infrastructure, stating that there are already 180 projects registered across the EU that could facilitate cross-border hydrogen flows. Regulations for infrastructure development and use are expected to be finalised by the end of the year, Kempener said.

### Sunita Satyapal

Director, Hydrogen & Fuel Cell Technologies Office, U.S. Department of Energy

### Ruud Kempener

Cabinet Member, Cabinet of the Commissioner for Energy (Kadri Simson), European Commission



We see hydrogen as accounting for about 10% of total CO<sub>2</sub> reductions in the US.”

### Sunita Satyapal

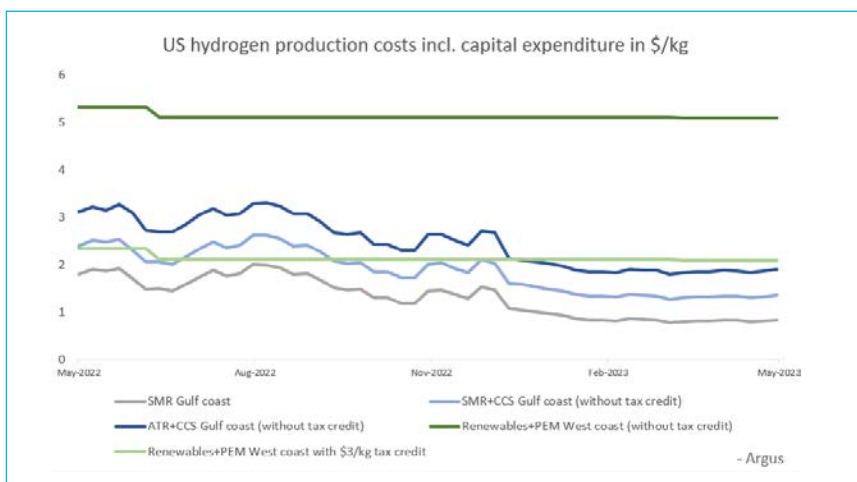
Director, Hydrogen & Fuel Cell Technologies Office, US Department of Energy



Member states have agreed on regulation in law on certain aspects of hydrogen.”

### Ruud Kempener

Cabinet Member for the Commissioner for Energy, European Commission





## SESSION 7: HYDROGEN BANKABILITY, INVESTMENTS, SUBSIDIES

Addressing the question of why final investment decisions (FIDs) for renewable hydrogen projects are still rare, Statkraft’s John Berry said the sector is in a transitional phase. Regulatory frameworks and policy incentives are taking shape, “but they are not quite rubber-stamped yet”, he said. Projects are also more complex than developers might have initially thought, for instance with regard to power supply contracts, offtake agreements and technological challenges, Berry said. KBR’s Nikunj Panchal agreed regarding the complexity, especially for projects that involve supply and offtake in different regions. Moreover, incentives have been heavily concentrated on production, while the demand side might need additional stimulation as well, Panchal said. ING’s Henry Rushton also stressed the importance of offtake agreements, suggesting that from a bank’s perspective deals over a 10-year period would arguably be required. For ARENA’s Director of Business Development and Transactions, Alex McIntosh, the difficulty lies partly in banks not being “totally comfortable with assessing risks on multiple fronts” as is required for hydrogen projects. This is why governments need to help financiers and the private sector through incentives to get the industry moving. Australia’s Hydrogen Headstart programme is an example as it seeks to provide a revenue underwriting mechanism for large-scale projects, McIntosh said, similar to the U.S. production tax credits in the Inflation Reduction Act and Germany’s H2Global scheme. The World Bank’s Demetrios Papathanasiou agreed that it has to be governments that “provide the long-term direction and the long-term certainty” to get the sector moving. Panchal suggested that shifting some of the funding that is made available to projects as a whole to “building the supply chain”, especially electrolyser manufacturing capacity, could help advance projects to FIDs. “The scale [of electrolyser manufacturing] is not there to support the number of projects that has been announced globally,” he said.

### Dr. Christine Falken-Grosser

Director, Hydrogen Coordination, [Federal Ministry of Economic Affairs and Climate Action, Germany](#) (Moderator)

### Nikunj Panchal

Global Director - Sustainability & Strategic Advisory, [Frazer-Nash Advisory/ KBR](#)

### Alex McIntosh

Director of Business Development and Transactions, [Australian Renewable Energy Agency \(ARENA\)](#)

### Henry Rushton

Director, EMEA Hydrogen Lead, [ING Bank](#)

### John Berry

Vice President Hydrogen Development and Technology, [Statkraft](#)

### Demetrios Papathanasiou

Global Director, Energy and Extractives Global Practice, [The World Bank](#)



The scale [of electrolyser manufacturing] is not there to support the number of projects that has been announced globally.”

### Demetrios Papathanasiou

Global Director, Energy and Extractives Global Practice, [The World Bank](#)



# SUMMIT DAY TWO





## OPENING KEYNOTE ADDRESS 1

### Hon. Peter Malinauskas

Premier, Government of South Australia

The second summit day was opened by South Australia’s Peter Malinauskas who touted his state’s potential for low-cost renewable hydrogen production. Malinauskas announced tangible moves towards realising the potential, including a hydrogen act to streamline permitting and pave the way for distribution of land to project developers. The act, which has since been put forward for consultation, combines all the existing regulatory frameworks into one and would enable the government to release large swathes of land to developers starting in the next four months, Malinauskas said. Under the rules, developers can bid for land through competitive processes. The state has mapped its solar and wind resources and plans to make the data available to developers, Malinauskas said. The government sees producers of renewable hydrogen and downstream products as offtakers that would allow it to commercialise its large untapped solar and wind resources. The state has surplus renewable electricity at certain times of day and it has a A\$20bn renewable project pipeline for which it needs offtakers, Malinauskas said. South Australia envisages creation of two hydrogen hubs around the Spencer Gulf – Port Bonython at the north tip and Cape Hardy on the west side of the gulf. The government plans to select a developer in July for a A\$593mn hub at Whyalla, which includes a 250MW electrolyser and a 200MW hydrogen-fuelled power station, with construction due to start later this year and hydrogen production set to get under way in 2025. The state is working to relieve water scarcity, which has thwarted previous hydrogen projects and is collaborating with a copper mining company to develop a desalination plant that would also be able to provide water for electrolysis projects, Malinauskas said.



In calendar year 2022 there were 180 days where for 24 hours of the day the state of South Australia was powered exclusively by renewable energy.”

### Hon. Peter Malinauskas

Premier, Government of South Australia



## OPENING KEYNOTE ADDRESS 2

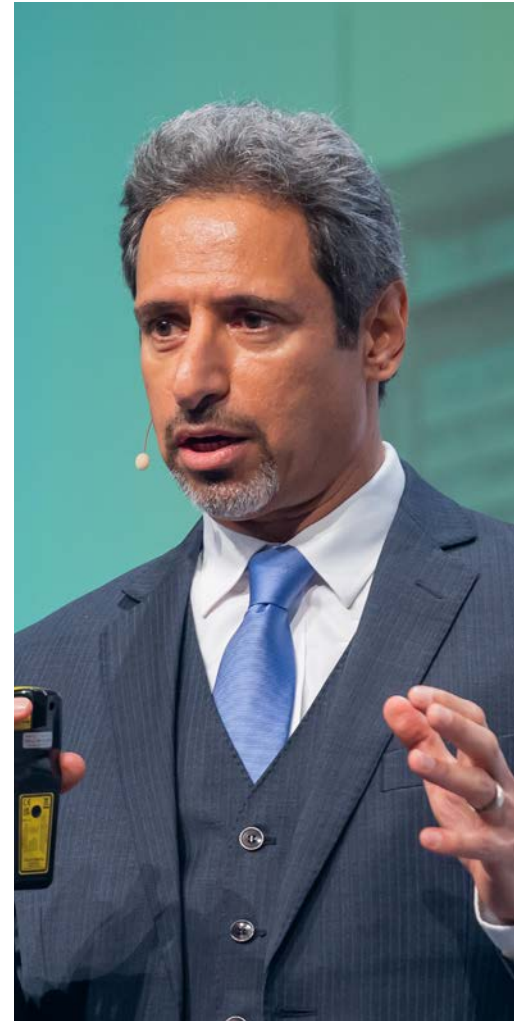
### H.E. Salim Al Aufi

Minister of Energy and Minerals, Oman

In a second keynote address, Oman’s Salim al Aufi stressed his own country’s vast potential for production of renewable hydrogen and derivatives. He announced that Oman would award the first contract for a renewable hydrogen project — following a recent auction — shortly after the summit, while a second contract could be awarded the following month.

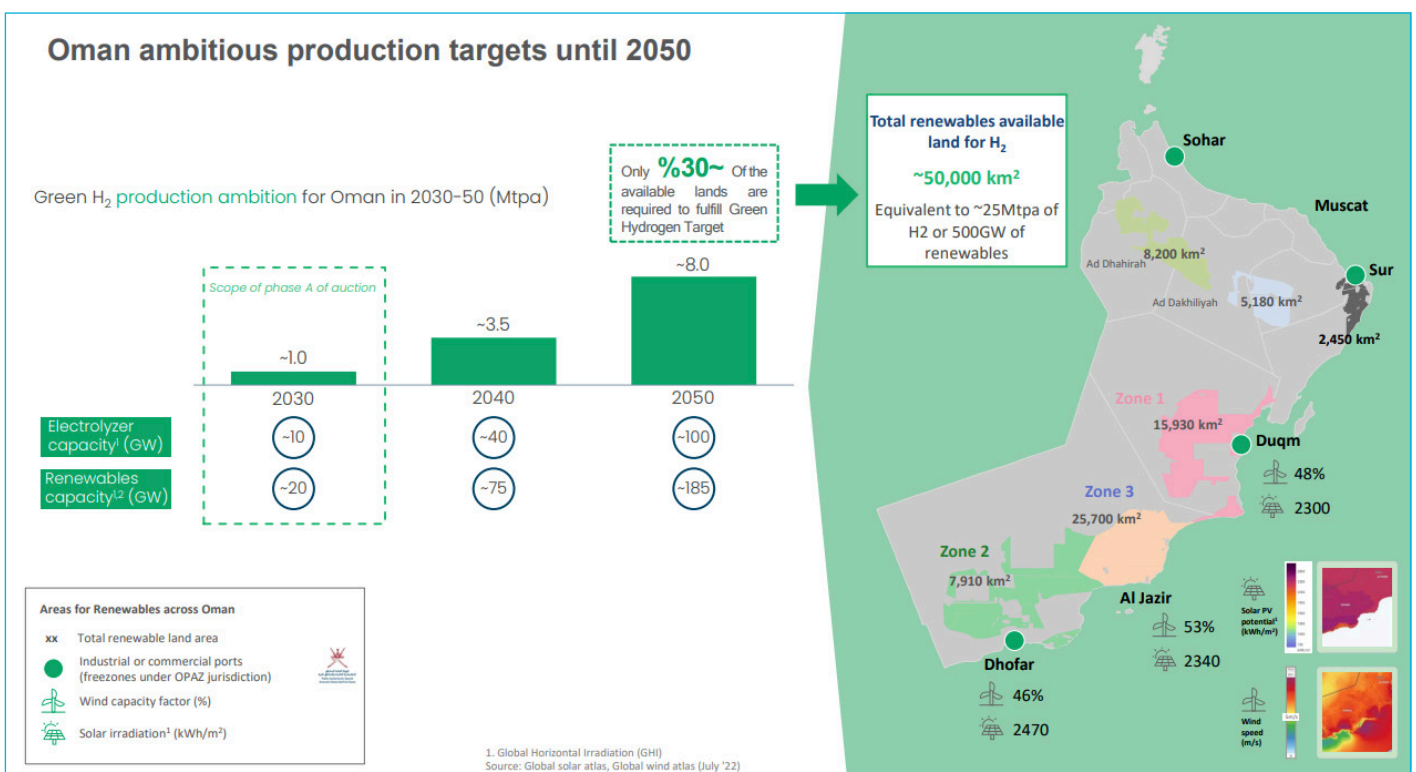
The auction for two plots of land in Duqm was launched by state-owned Hydrom late last year and triggered fierce competition, Al Aufi said. A second round of auctions will be launched “immediately” after the contracts for the first round are awarded, Al Aufi said. Hydrom signed binding terms for six agreements on renewable hydrogen projects in March, plans for which were developed before the auction process was launched. These could provide a combined 750,000 t/yr of hydrogen output, according to Al Aufi. The minister also reiterated the firm’s ambitious renewable hydrogen production targets.

The country is aiming for around 1mn t/yr by 2030 and 8mn t/yr by 2050. This would require electrolyser capacity of around 10GW and 100GW, respectively, Al Aufi said. While the 2050 target is 8mn t/yr, Oman will have the potential to produce up to 25mn t/yr by then “if all goes well”, Al Aufi said. But Al Aufi also highlighted the scale of the planned build-out and the resources needed for it. Reaching the 2050 target would require investment of around \$150bn. It would need 300mn solar panels, 44mn t of concrete, 25mn t of steel, 5.1mn t of glass, as well as vast amounts of copper, aluminium, silicon, nickel and plastic.



Oman is open for business and we are going big.”

Salim al Aufi, Minister of Energy and Minerals, Oman



## OPENING KEYNOTE ADDRESS 3

### Daryl Wilson

Executive Director, [Hydrogen Council](#)

As the third keynote speaker, industry association the Hydrogen Council’s Chief Executive, Daryl Wilson, presented the group’s Hydrogen Insights 2023 report, drawn up with consultancy McKinsey. The Hydrogen Council had by January registered over 1,000 large-scale projects announced across the clean hydrogen value chain, from production to infrastructure and end-use applications. But while projects envisaged for 2030 would require combined investment of \$320bn – up from \$240bn in May – only around 10pc had reached an FID by January. And almost half had not even entered planning stage yet, meaning that just \$170bn of the \$320bn can be viewed as “mature investments”, the Hydrogen Council notes. Strained supply chains, labour shortages, and high inflation and interest rates are slowing development, the group said. On the production side, slow permitting is also holding back development, while developers of renewable hydrogen projects are also struggling with supply of electrolysers, solar panels and wind turbines, it added. But while challenges persist, Wilson highlighted some important positives – FIDs have been taken for “major projects”, while investment in midstream infrastructure is gathering pace and “policy support seems to just keep on rising”. Developing sufficient infrastructure is particularly crucial at this point, according to Wilson. “It’s critical that we start to think not just about clusters and projects, but how hydrogen will be deployed with substantial infrastructure vision behind it,” he said. Developments are encouraging, with 95pc of all infrastructure-related investment announced globally having come in the past eight months, Wilson said – another sign that the industry is steadily maturing.

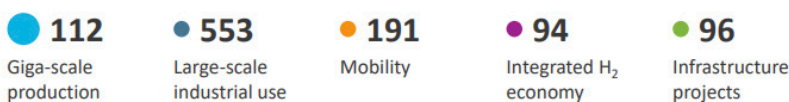
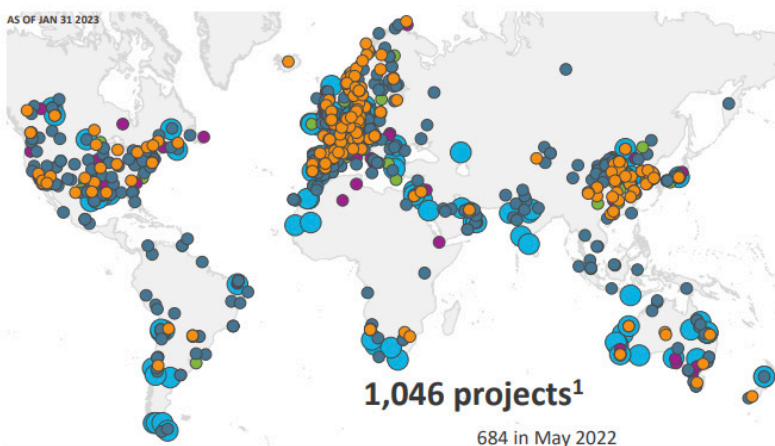


It’s critical that we start to think not just about clusters and projects, but how hydrogen will be deployed with substantial infrastructure vision behind it.”

### Daryl Wilson

Executive Director, [Hydrogen Council](#)

### Strong momentum with more than 1,040 projects announced globally

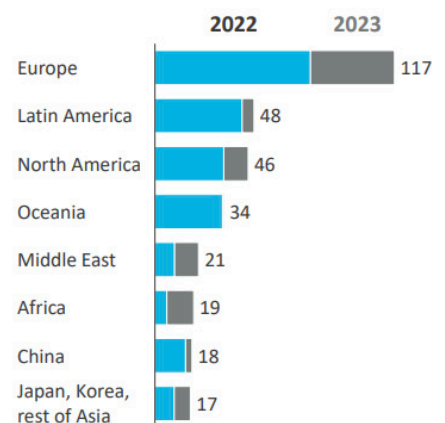


1. Focus on projects of >1 MW

Source: Project & Investment tracker, as of Jan 2023, McKinsey

### \$320 B

investments required to develop projects announced until 2030





## SESSION 8: LEADING GLOBAL HYDROGEN EXPORT PROJECTS AND POLICIES

**Maarten Wetselaar**  
CEO, *Cepsa* (keynote)

The day's first panel discussion was opened by Spanish energy firm Cepsa's Chief Executive, Maarten Wetselaar. While Wetselaar applauded recent policy progress in various regions, most notably Europe and the U.S., he cautioned that it is "not a good time to start counting trophies" and said the EU must not become complacent. He called for more regulatory clarity, such as on how recently-agreed mandates for renewable hydrogen use in industry will be implemented by member states. The EU should also mobilise more funding and streamline what is already available, Wetselaar said. "Europe should rethink its galaxy of funding sources," which he called "really, really complicated".

As part of its push to keep up with the U.S., the bloc should allow member states "to match the IRA tax incentives one for one". Wetselaar also warned that some changes to the EU state aid framework could hinder rather than help the build-out of a large-scale renewable hydrogen industry. A provision stipulating that member states must notify the European Commission regarding project support that exceeds €30mn (\$32.7mn) risks "holding things back", Wetselaar said. The provision means €30mn could act as a ceiling for member states keen to avoid the paperwork, according to Wetselaar. This could lead to lots of small-scale hydrogen plants scattered across Europe, instead of the "world-scale plants that we need to really drive down costs and create consumer confidence that the product will be cheap and available".



Europe should rethink its galaxy of funding sources."

**Maarten Wetselaar**  
CEO, *Cepsa*



Wetselaar also touted Spain’s potential to become a leader in European renewable hydrogen, citing its abundant solar and wind resources, existing hydrogen consumption and available natural gas infrastructure that could be converted to carry hydrogen. This was picked up in the subsequent discussion by compatriot Iberdrola’s Jorge Palomar, who said his company already has small renewable hydrogen projects up and running in Spain and is now working on export projects in the country and elsewhere. “Local is a reality, global is our next step,” Palomar said. Iberdrola has five projects under development for exports of green ammonia or other hydrogen derivatives, he said, adding that the firm is focusing on countries with promising renewable resources, but also where hydrogen roadmaps are established and subsidy schemes are in place.

Meanwhile, Edify Energy’s John Cole praised the potential of the Australian state of Queensland, where the firm has been developing a renewable hydrogen project “for four or five years”. Edify is looking to start with a 17.6MW electrolyser by the end of 2025, targeting domestic hydrogen use which is “predominantly diesel replacement in road and maritime transport”. In the longer run, the project could entail 3-5GW electrolyser capacity and target exports “definitely before the end of this decade”, Cole said. But for exports to happen, “there are a lot of things that have got to fall into place”, he said. ExxonMobil’s Simon Herbert spoke about the company’s Baytown blue hydrogen project in Texas, which could produce around 1mn t/yr when it comes on line in 2027-28, making it the largest in the world. The firm is seeing “a lot of customer activity” around the project, both for domestic fuel-switching and ammonia supply for exports, with the latter demonstrated in a recently announced deal with South Korea’s SK, Herbert said. Woodside’s Shaun Gregory also pointed to strong customer interest for supply from its planned facility in Perth that is to use “gas reforming and electrolysis to produce ammonia or liquid hydrogen”. The strong interest was demonstrated by a recent initial agreement with Singapore’s Keppel to supply it with 1,000 t/d of liquid hydrogen from 2030, Gregory noted.

**Dr. Dean Bialek**

Chief Officer, External Affairs & Government Relations, [CWP Global](#) (Moderator)

**Simon Herbert**

Vice President, EAME, [ExxonMobil | Low Carbon Solutions](#)

**John Cole**

Chief Executive, [Edify Energy](#)

**Juancho Eekhout**

Vice President – Business Development, [Sempra Infrastructure](#)

**Jorge Palomar Herrero**

Global Hydrogen Development Director, [Iberdrola](#)

**Shaun Gregory**

Executive Vice President of New Energy, [Woodside](#)

 Local is a reality, global is our next step.”

**Jorge Palomar Herrero**

Global Hydrogen Development Director, [Iberdrola](#)



## SPOTLIGHT: BOOSTING THE GLOBAL HYDROGEN MARKET THROUGH COLLABORATION

### Micky Adriaansens

Minister of Economic Affairs and Climate Policy, [The Netherlands](#)

The Netherlands' Micky Adriaansens stressed the need for collaboration in the hydrogen space, especially at a time when developments in the industry are gathering pace. She pointed to the Netherlands' efforts to help large emitters to decarbonise, such as in the chemicals cluster at the port of Rotterdam. The government is supporting the build-out of infrastructure to make sure that hydrogen can be transported to key demand centres, Adriaansens said. It is also looking to strengthen the electricity grid to accommodate stronger demand, including from electrolyzers, she added.

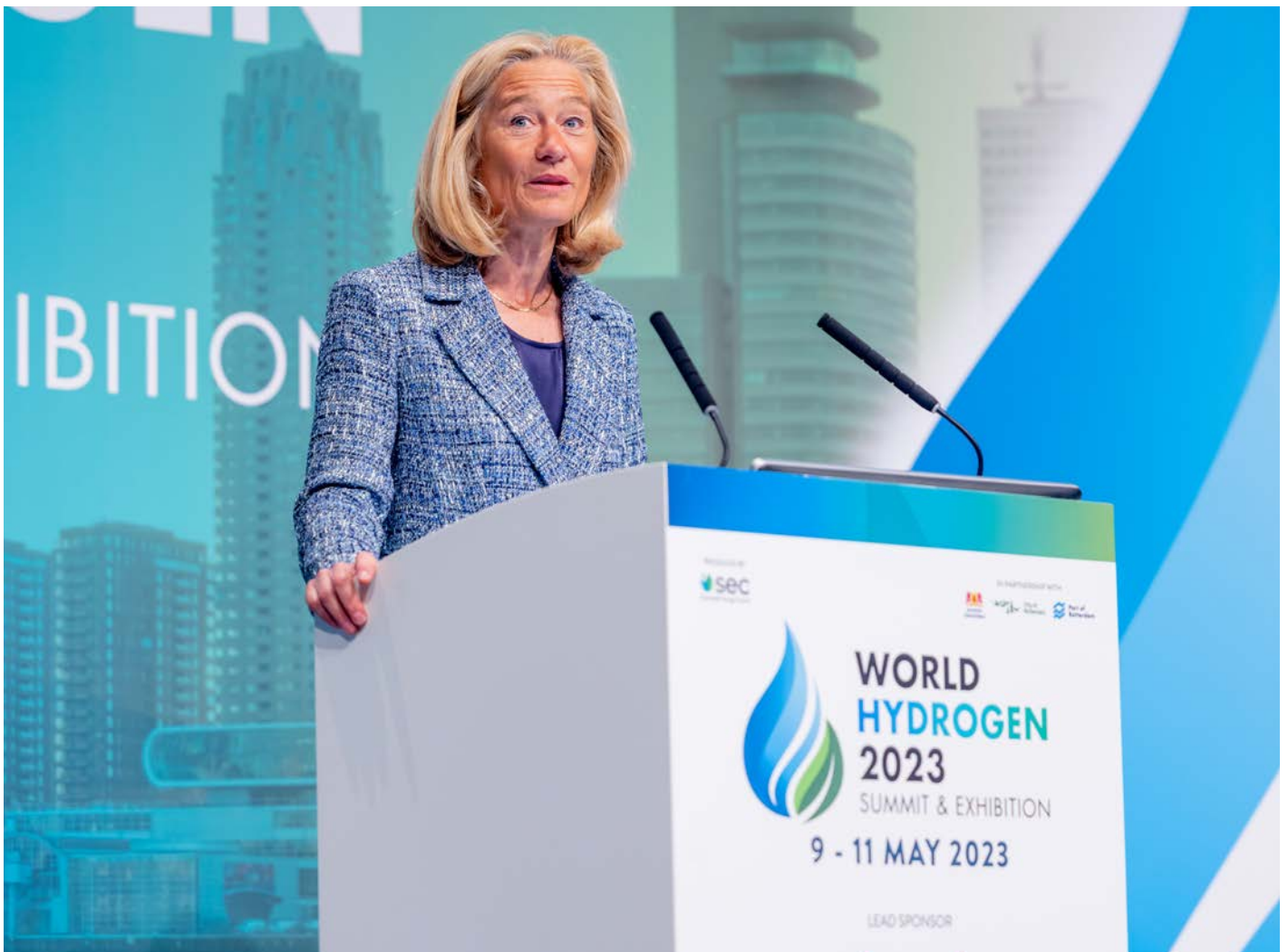
The Netherlands "will be the first country in the world to have large-scale infrastructure to import, store, transport and transfer various forms of hydrogen", Adriaansens said. At the same time, the country is also looking at domestic renewable hydrogen production, including with power from offshore wind farms. And it is open to blue hydrogen and carbon capture and storage projects, Adriaansens noted.



The Netherlands will be the first country in the world to have large-scale infrastructure to import, store, transport and transfer various forms of hydrogen.”

### Micky Adriaansens

Minister of Economic Affairs and Climate Policy,  
[The Netherlands](#)





## SESSION 9: STANDARDISATION, CERTIFICATION AND REGULATIONS

The UK's Alison Conboy started the next session by underlining the importance of certification and standards for the hydrogen sector. "We mustn't forget how foundational these low-carbon hydrogen standards are," she said, adding that they are "the real bedrock" for all the other activity. Other panellists agreed that creating certainty and transparency through standards is crucial for building up the industry and stressed that such standards should not just focus on the carbon footprint, but also on socio-economic criteria and aspects such as water use. In the eyes of GH2's Jonas Moberg, many standards are too lenient. "It is clear that four kilos of CO2 emissions for each kilo of hydrogen is not going to work," he said. He called for standards to be aligned with the goal to limit global warming to a maximum of 1.5°C.

Meanwhile, Morgan Rote of the US-based Environmental Defense Fund argued that hydrogen emissions and their "significant short-term warming potential" are too often neglected in discussions that focus on carbon dioxide and methane emissions associated with hydrogen production.

Hydrogen "leaks easily from pipes and other infrastructure", she said, adding that companies should invest in next-generation sensors to monitor leakage. Such leakages should then also be factored into lifecycle emission assessments, Rote said. For certification in the hydrogen space, the industry should learn from the biofuels and renewable power sectors, the Hydrogen Council's Daria Nochevnik said. Certification remains a contentious topic and the International Renewable Energy Agency warned earlier this year that a lack of globally-accepted standards could hamper international trade of hydrogen and derived topics.

**Matthew Hodgkinson**  
Analyst, Hydrogen, S&P Global  
Commodity Insights (Moderator)

**Alison Conboy**  
Deputy Director, Hydrogen Production,  
Department for Energy Security and Net  
Zero, UK Government

**Morgan Rote**  
Director, U.S. Climate, Environmental  
Defense Fund

**Laurent Antoni**  
Executive Director, IPHE

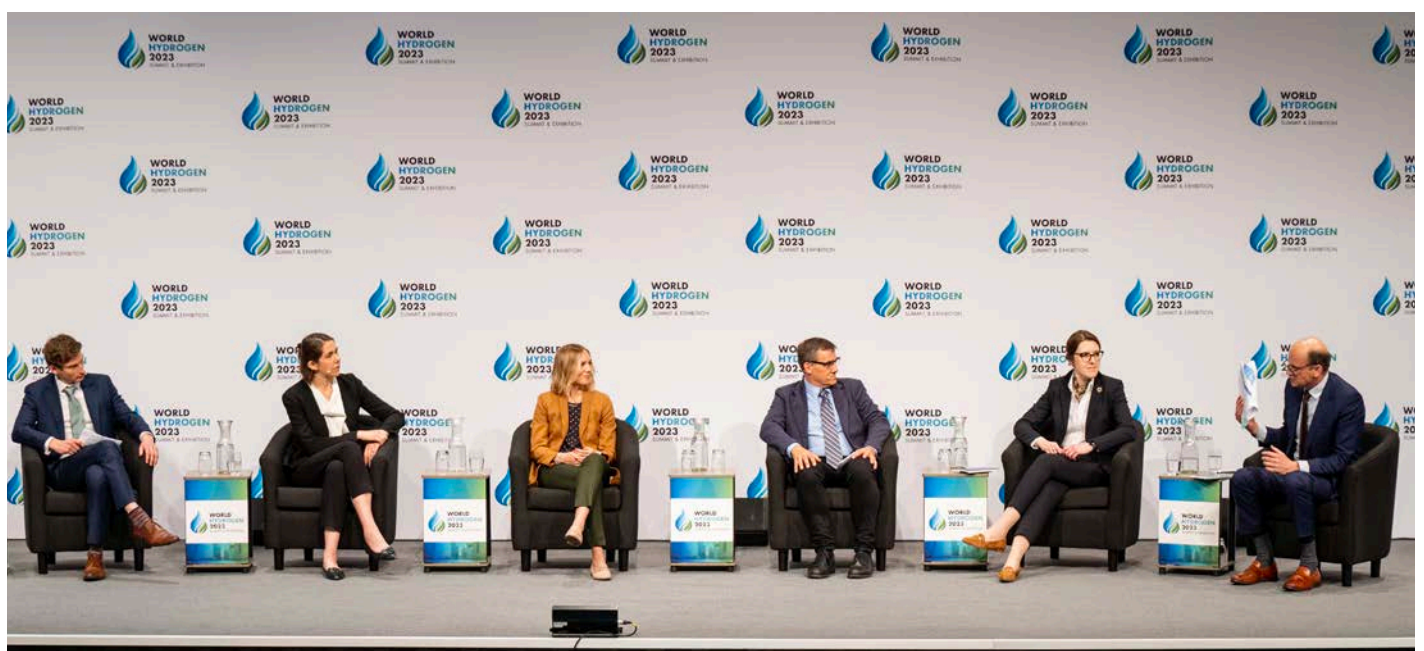
**Daria Nochevnik**  
Director for Policy and Partnerships,  
Hydrogen Council

**Jonas Moberg**  
Chief Executive Officer, GH<sub>2</sub>



We mustn't forget how foundational these low-carbon hydrogen standards are."

**Alison Conboy**  
Deputy Director for Hydrogen Production,  
UK Department for Energy Security and Net Zero



## SPOTLIGHT: EU LEADING GLOBAL HYDROGEN DEVELOPMENTS

**Frans Timmermans**

Executive Vice-President, [European Commission](#)

The European Commission's Frans Timmermans said the EU stands out globally as "the first and only major market" that has "ambitious hydrogen targets, solid funding schemes as well as a solid policy framework for hydrogen production, consumption and infrastructure development". He pointed to the EU's plans to mandate that 42pc of all hydrogen used by industry be renewable by 2030 and to rules for the aviation and maritime sector — although these agreements were yet to be adopted by EU institutions by mid-May.

While there is much talk around the incentives under the US' Inflation Reduction Act, the EU has "already approved more than €20bn to develop a European ecosystem", Timmermans said. This includes €10bn under the Resilience and Recovery Fund and €10.7bn under the Important Projects of Common European Interest (IPCEI) scheme. Compared with the US, the EU is focusing more on "long-term stability", Timmermans noted. Going forward, the auctions of the European hydrogen bank, for which a first €800mn pilot is to be launched later this year, could help the European hydrogen sector move "from niche to scale", he said.



The EU has already approved more than €20bn to develop a European ecosystem."

**Frans Timmermans**

Executive Vice-President, [European Commission](#)





## SPOTLIGHT: SAUDI-ARABIA'S GLOBAL AMBITIONS IN CLEAN HYDROGEN

**His Royal Highness Prince Abdulaziz bin Salman Al-Saud**  
Minister of Energy, Government of the Kingdom of Saudi Arabia

Following Timmermans' speech, the Netherlands, represented by Micky Adriaansens, and Saudi Arabia, represented by energy minister Prince Abdulaziz bin Salman, signed a memorandum of understanding on energy. Speaking after the signature, Prince Abdulaziz said Saudi Arabia's ambition in the hydrogen space is "limitless". Saudi Arabia wants to work with the EU "to figure out a way to categorise hydrogen as being clean", he noted. Prince Abdulaziz stressed the strong interest in hydrogen, especially from Northwest Europe, saying his delegation spent a full day in Germany with "at least 105 companies" working on "what we could do in hydrogen". Germany and the Netherlands stand out as the two countries that are most serious about hydrogen, he said, adding that this makes them natural partners for Saudi Arabia. And Rotterdam could become the preferred hub for shipped supply from Saudi Arabia, he said.



The mindset we have is that we want to be the prominent, if we can, supplier of hydrogen."

**His Royal Highness Prince Abdulaziz bin Salman Al-Saud**  
Minister of Energy, Government of the Kingdom of Saudi Arabia





## SPOTLIGHT: ADNOC'S ROADMAP TO GLOBAL LEADERSHIP IN LOW-CARBON HYDROGEN

**Dr. Nikunj Gupta**

Vice President, Hydrogen Studies, ADNOC

ADNOC's Nikunj Gupta presented his company's plans in the hydrogen space. The firm is targeting 1mn t/yr of green hydrogen production by 2030, through its shareholding in Masdar, but is also pursuing blue ammonia output. It is building a blue ammonia facility in Abu Dhabi, which it expects to be the world's first. ADNOC already produces some 300,000t/yr of hydrogen today and hopes to leverage its existing experience in the transition to cleaner output, Gupta said. But production costs still present a major challenge. Hydrogen produced from natural gas with carbon capture and storage costs around 2-4 times as much as the natural gas that it substitutes, Gupta said. And renewable hydrogen is even 4-8 times more expensive than natural gas, he added. The costs and lack of bankable demand present a major challenge for scaling up the industry, according to Gupta. Technological progress, such as for liquefaction processes, ammonia cracking and liquid organic hydrogen carriers, will be needed to slash costs across the supply chain, he said. ADNOC itself is aiming to drive forward innovation for carbon capture and storage in particular. The firm is pursuing the common approach of storing CO2 in an aquifer but is also exploring the possibility of subsurface storage of carbon as a mineral, Gupta said.



In the end it could be a mixed bag of transport solutions.”

**Dr. Nikunj Gupta**

Vice President, Hydrogen Studies, ADNOC



## SESSION 10: GLOBAL PORTS CREATING HYDROGEN HUBS AND DEMAND CENTRES

Mirroring some of Prince Abdulaziz’ comments during the previous session, bp’s James Patterson said the port of Rotterdam provides all that is needed to become a key hydrogen hub — local demand from industrial clusters, existing pipeline infrastructure and scope to transport supply to other key demand regions, such as Germany’s Ruhr. Besides Rotterdam, bp is also focusing on Wilhelmshaven in northern Germany.

While this location provides less local demand, existing pipeline infrastructure can move hydrogen to industrial clusters, Patterson said. The Port of Rotterdam is now “moving from PowerPoints to execution,” according to the Port of Rotterdam’s Nico van Dooren. Shell has taken a final investment decision on its Hydrogen Holland 1 renewable hydrogen plant, fertiliser firm OCI has decided to significantly increase its ammonia import capacity and pipes have arrived for the infrastructure build-out, van Dooren said. “We will be ready for all the derivatives and all the markets that they serve,” he added.

While Rotterdam will be focused on enabling imports for northwest Europe, the U.S.’ Port of Corpus Christi wants to become a key location for exports of hydrogen and derivatives to the EU, Asia and other regions, the Port of Corpus Christi Authority’s Sean Strawbridge said. There is a lot of talk about Houston and its potential, but much of the low-carbon hydrogen produced there will be needed to cut emissions in the region, given that Houston and industry in the Houston Ship Channel have a large carbon footprint, Strawbridge noted. Corpus Christi’s footprint is much smaller, so it could have more spare supply for exports, he said, adding that the port participated in the application for a hydrogen hub that is still in the running in the Department of Energy’s selection procedure.

Arup’s Sally Prickett said demand for e-methanol and ammonia as bunkering fuels will also contribute to ports becoming key hubs for hydrogen and its derivatives. In addition, ports will have a “huge role to play” in making large-scale hydrogen projects happen, as they will help to bring wind turbines, solar panels and other equipment to remote locations, Prickett said. The panellists largely agreed that streamlined and clear regulations — related to permitting, for instance — will be required if ports are to play a key role in a future hydrogen economy.

### Peter Hartl

Associate Partner, [Horváth & Partner](#)  
(Moderator)

### Nico van Dooren

Head of Business Development, [Port of Rotterdam Authority](#)

### James Patterson

VP Hydrogen North West Europe, [bp](#)

### Sean Strawbridge

CEO, [Port of Corpus Christi Authority](#)

### Lucien Robroek

CEO, [Nuvera Fuel Cells](#)

### Sally Prickett

Director, Hydrogen Advisory, [Arup](#)



We will be ready for all the derivatives and all the markets that they serve.”

### Nico van Dooren

Head of Business Development, [Port of Rotterdam Authority](#)



## SPOTLIGHT: AN INSIGHT INTO UK HYDROGEN STRATEGY

### Lord Callanan

Minister for Energy Efficiency and Green Finance, Department for Energy Security & Net Zero, [UK Government](#)

Lord Callanan outlined the cornerstones of UK hydrogen strategy. The UK is aiming for 10GW of low-carbon hydrogen production capacity by 2030, with at least half of this to be renewable. This could “unlock over £11bn of private investment”, according to Lord Callanan. The UK wants to support projects across the entire hydrogen value chain and is developing support mechanisms for this, he said. It recently launched consultations on process to select green and blue projects for support, after choosing first proposals in an initial round earlier this year. Lord Callanan reiterated that the government aims to draw up support models for transport and storage infrastructure until 2025. Unlike other countries in Northwest Europe, the UK sees itself as a potential exporter of low-carbon hydrogen and derived products, and Lord Callanan said “there is exciting potential in this area.”



By 2050 the UK’s hydrogen economy could support up to 100 thousand jobs.”

### Lord Callanan

Minister for Energy Efficiency and Green Finance, Department for Energy Security & Net Zero, [UK Government](#)





## SESSION 11: AN OUTLOOK FOR HYDROGEN'S FUTURE

Air Products' Caroline Stancell opened the session, saying Air Products has \$15bn committed to blue and green hydrogen products under development. Talking about initial use cases for renewable and low-carbon hydrogen, Shell's Paul Bogers agreed with many other panellists, pointing to the need to decarbonise existing consumption. The 91mn t/yr of predominantly grey hydrogen used globally today produces some 860mn t/yr of CO<sub>2</sub>, roughly equivalent to the whole of the German economy, making it an obvious starting point, Bogers said.

But Shell is also "quite bullish on heavy-duty mobility", he said. And sectors such as steel are undergoing "a much faster transition than we expected". SFC Energy's Podesser added that replacing stationary equipment such as diesel generators will also be a crucial area in reducing emissions, while boosting resilience in sectors like telecommunications. In terms of how a large-scale hydrogen ecosystem will develop, Bogers sees potential parallels with the emergence of the LNG market. This developed by "working back from the customer", with Japanese utilities as the starting point as they showed willingness to bring supply into their country and to agree long-term contracts that allowed for the value chain to be built out, Bogers said.

Technip Energies' Eyries pointed out that the set-up and design of hydrogen production plants will depend heavily on location, not least because this will determine the split between capital and operating expenditure. While the cost of electricity could account for 65-70pc of the levelised cost of hydrogen production in Europe, it could be as low as 25-35pc in more remote locations where abundant wind and solar capacity means that production power is cheaper, he said.

As in previous panels, the panellists concluded by stressing that the policy and regulatory framework needs to provide sufficient certainty to take investment decisions. Stancell urged policymakers not to "overregulate too soon". "The impetus to try to regulate everything before it starts will stop innovation... slow down progress" and "make everything much more difficult to develop", she said. Safety is another key area, Bogers said. "I think there is no other sector that has still got the hallmarks of a 1937 incident hanging over it," he said, referring to the Hindenburg airship disaster. "If someone gets this badly wrong, it could set back the whole industry for everyone participating."

### Geoff Tuff

US Hydrogen Lead, [Deloitte](#) (Moderator)

### Caroline Stancell

General Manager, Hydrogen for Mobility - Europe & Africa, [Air Products](#)

### Paul Bogers

Vice President - Hydrogen, [Shell](#), and [SEC Hydrogen Advisory Board Member](#)

### Dr. Peter Podesser

CEO, [SFC Energy AG](#)

### Wouter van der Bijl

Executive Director, Business Development, [Fluor](#)

### Damien Eyries

Vice-President Green Hydrogen Solutions, [Technip Energies](#)



The impetus to try to regulate everything before it starts will stop innovation."

### Caroline Stancell

General Manager, Hydrogen for Mobility - Europe & Africa, [Air Products](#)



## SESSION 12: HYDROGEN CARRIERS: AMMONIA, METHANOL, LIQUID HYDROGEN, LOHC

Yara’s Eystein Leren and KBR’s Henrik Larsen pointed to the existing ammonia infrastructure that could facilitate the use of ammonia as a hydrogen carrier, in addition to its direct applications. There are 120 ports capable of receiving ammonia now, Larsen said. “This is a starting point,” Leren said, although both agreed that infrastructure would need to be scaled up. Some 20mn t/yr of ammonia is currently shipped across oceans and “it’s probably going to be five times more if you just look 10 or 15 years ahead”, at least assuming that ammonia is used extensively as a hydrogen carrier, Larsen noted. Larsen said there will probably be space for all transport vectors, including liquid organic hydrogen carriers (LOHCs) and liquefied hydrogen. For Fraunhofer ISE’s Christopher Hebling, it will be a question of what a shipper has available. “If you don’t have a carbon source, then of course you go with ammonia” because “you only need water and air and sun and wind”, he said. But “if you do have a sustainable carbon source, the picture is somehow different”, because derived products such as jet fuels and e-methanol will provide a big market.

For anyone looking to sell hydrogen as a final product, dimethyl ether (DME) could become a favourite carrier, Hebling said. DME has the highest “technical capacity of hydrogen” at 26.8pc – compared with 17.8pc for ammonia and 18.8pc for methanol. The CO2 component in the DME can be captured when the product is dehydrogenated, allowing for it to be reused in a circular manner, Hebling said. Koole Terminal’s Mekkes picked up the question of infrastructure build-out, stressing the need for new terminals for ammonia and other carriers – which can be made more difficult by limited land availability – and for growing vessel fleets. The required capacity increase is “beyond imagination” and needs to be tackled with a large scale in mind, he said. “There is quite a lot of talk about getting ammonia as a fuel or a feedstock into Germany in the shape of a train or a barge”, but “that’s a route we don’t want to pursue”, he said. “It’s just not physically possible, so we need significant amounts of pipeline infrastructure”.

### Alicia Eastman

President, [InterContinental Energy](#), and  
SEC Hydrogen Advisory Board Member  
(Moderator)

### Henrik Larsen

Vice President, Clean Ammonia &  
Hydrogen, [KBR](#)

### Piyush Katakwar

Global Hydrogen Lead, [Royal  
HaskoningDHV](#)

### Tamme Mekkes

Business Development Director,  
[Koole Terminals](#)

### Eystein Leren

Market Development Director, [Yara Clean  
Ammonia](#)

### Prof. Dr. Christopher Hebling

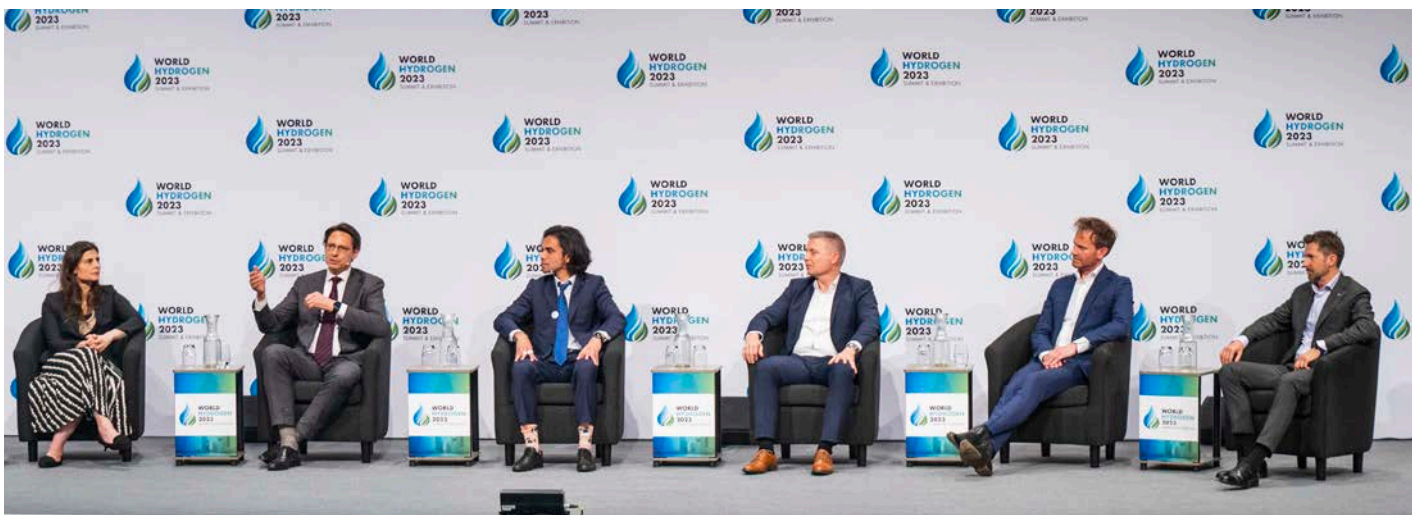
Director Division Hydrogen Technologies,  
[Fraunhofer ISE](#)



If you don’t have a carbon source, then of course you go with ammonia because you only need water and air and sun and wind, he said. But if you do have a sustainable carbon source, the picture is somehow different.”

### Christopher Hebling

Director Division Hydrogen Technologies, [Fraunhofer ISE](#)



# SPOTLIGHT IMPORTS INTO EUROPE THROUGH THE PORT OF ROTTERDAM

## Randolf Weterings

Programme Manager Electrification and Hydrogen, [Port of Rotterdam](#)

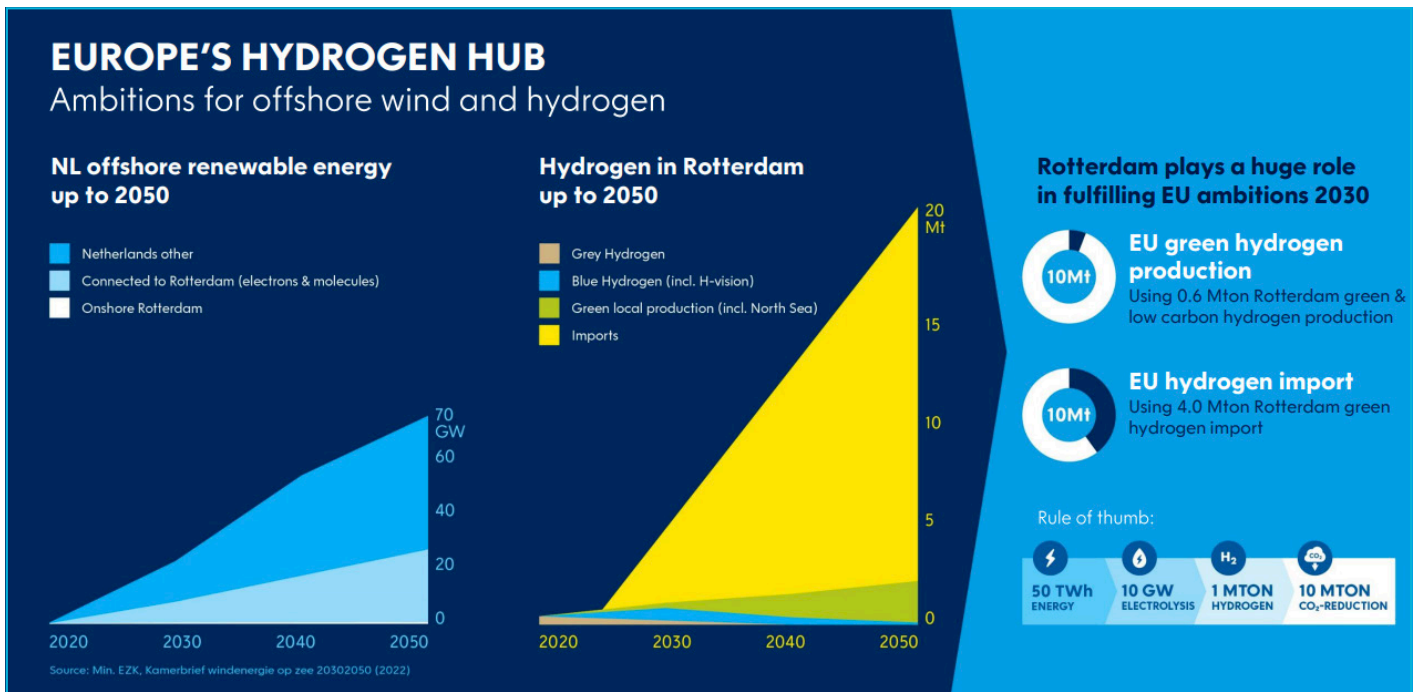
Randolf Weterings outlined The Port of Rotterdam’s ambitions in the hydrogen space and the energy transition as a whole. The port hopes to contribute 4mn t/yr of renewable hydrogen imports to the EU’s targeted 10mn t/yr of receipts by 2030, and to provide 600,000 t/yr of production within the port, against the bloc’s 10mn t/yr output target. This production target could require around 2.5GW electrolyser capacity being installed in the port, Weterings said. Nine import terminals for hydrogen have been announced in the port area, with six focusing on ammonia, two on liquid organic hydrogen carriers and one on liquid hydrogen, he said, adding that more projects are expected to follow later this year.



We estimated that we need roughly 20 million tonnes of hydrogen by 2050.”

## Randolf Weterings

Programme Manager Electrification and Hydrogen, [Port of Rotterdam](#)





## SESSION 13: GLOBAL HYDROGEN TRADE CORRIDORS: CONNECTING ESTABLISHED AND NEW SUPPLIERS TO GLOBAL OFF TAKERS

### CORRIDOR 1: Australia to Europe

**Speakers:**  
**Nicola McFarlane**

Director of Hydrogen and New Energies Division, Department of Jobs, Tourism, Science and Innovation, [Government of Western Australia](#)

**Dr. Falk Rouven Bömeke**

Head of Division VB1: General issues of bilateral climate and energy cooperation; cooperation in North America, East Asia, Oceania and Turkey, [Federal Ministry of Economic Affairs and Climate Action, Germany](#)

### CORRIDOR 2: Green hydrogen supply chain corridor from Pecém to Rotterdam

**Speakers:**  
**Hugo Figueirêdo**  
CEO, [Pecém Complex](#)

**Jonas Rechreche**  
Business Analyst, [Proton Ventures](#)

### CORRIDOR 3: South Korea to the World

**Speakers:**  
**Jaedo Moon**  
Chairman, [H2KOREA](#), Chair, [Global Hydrogen Industrial Association Alliance \(GHIAA\)](#)

**Dongkyu Kim**  
Director at Investment Promotion Department, [Ulsan Free Economic Zone Authority](#)



The first discussion on potential supply corridors focused on future Australian exports of renewable hydrogen and its derivatives, such as ammonia, to Germany. German government representative Falk Rouven Bömeke expects Germany to require substantial amounts of imports by 2030 to help decarbonise industry and said energy partnerships with countries, including Australia, will be crucial. Other government officials recently indicated that Germany might need to cover 50-70pc of its demand through imports. Meanwhile, Australia’s Nicola McFarlane has seen a major shift over the past 6-12 months in “the drive for commercialisation with the policy mechanisms”, most recently through her own country’s Hydrogen Headstart programme. Bömeke agreed and highlighted Germany’s H2Global scheme, which seeks to bridge the gap between production costs and what offtakers are willing to pay. Visits made by delegations from the two countries have borne witness to German offtakers’ interest on one hand and tangible progress on Australian production projects on the other, the speakers agreed. Based on Argus calculations, renewable ammonia could be produced in Australia at just over \$1,000/t, including capital expenditure, while the cost would exceed \$1,500/t in Germany.

The second talk looked at the potential for renewable hydrogen supply from the northeast Brazilian Port of Pecém in the state of Ceará to Rotterdam. In northeast Brazil, 91pc of electricity already comes from renewable sources, Pecém’s Hugo Figueiredo said. This means that even hydrogen production with power from the grid would count as renewable under the European Commission’s draft definition, without the need for further measures, such as a power purchase agreements, Figueiredo noted. This could facilitate exports to the EU, he said. Jonas Rechreche of Proton Ventures, which is planning to set up a hydrogen and ammonia production site at Pecém with partners, agreed this makes the location attractive for project developers. Studies have shown that Ceara could be one of the most competitive locations for renewable hydrogen production, with potential for the levelised cost of hydrogen to be as low as \$0.55/kg by 2050, according to Figueiredo. Pecém also offers benefits to developers such as a free trade export zone with tax reliefs. While the initial focus will be on exports to Europe, hydrogen could also be used to decarbonise industry in the hinterland. The planned corridor between Ceará and Rotterdam involves Brazilian and European companies, including Casa dos Ventos, Comerc Energia, GES and Trammo, Rechreche said. Feasibility studies for production projects have been completed and the consortium is now looking for offtakers that are “willing to consider a premium” for a product that complies with EU rules and for “investors and banks willing to invest”, he said. Commercial ammonia output of 400,000 t/yr could be under way in 2026. Finalising European regulations will be key to realising the plans, Figueiredo said.



We have really seen that shift in the last 6-12 months of the drive for commercialisation with the policy mechanisms.”

**Nicola McFarlane**

Director of Hydrogen and New Energies Division, Department of Jobs, Tourism, Science and Innovation, [Government of Western Australia](#)



I would see in 2030 so much demand in Germany and Europe that we can’t cover that demand by ourselves.”

**Falk Rouven Bömeke**

Head of Division VB1: General issues of bilateral climate and energy cooperation, [German Ministry of Economy and Climate Protection](#)



One of the cheapest costs of green hydrogen in the world.”

**Hugo Figueirêdo**

CEO, [Pecém Complex](#)



We have more than 90% of electricity that is renewable.”

**Jonas Rechreche**

Business Analyst, [Proton Ventures](#)

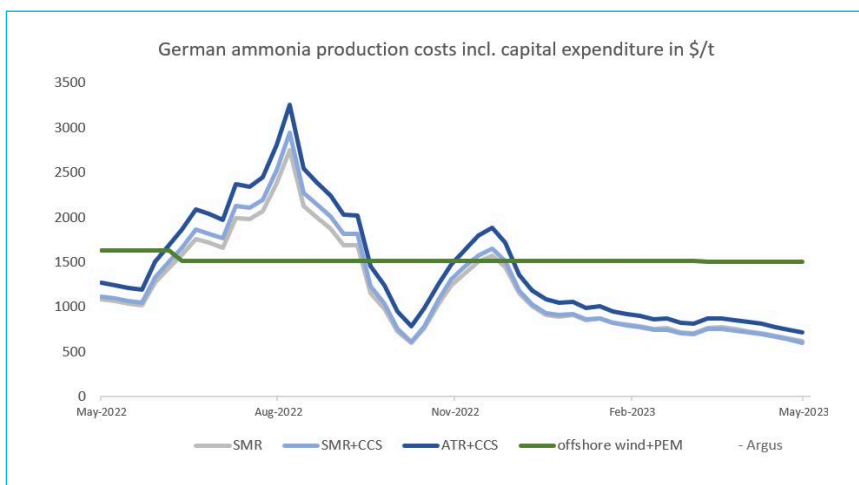
The third part of the session focused on South Korea. H2Korea’s Jaedo Moon pointed to the important role that South Korea sees for hydrogen in its efforts to decarbonise and highlighted the progress that the country has made. More than 30,000 fuel-cell electric vehicles are now in operation in South Korea, up from just over 5,000 in 2019. The number of hydrogen refuelling units has increased to 227 from 34. South Korea’s strategy encompasses domestic production of green and blue hydrogen, involvement in projects overseas and securing liquid hydrogen and ammonia vessels for transport of hydrogen from overseas, Moon said.



Over 30,000 passenger fuel cell cars are on the road.”

**Jaedo Moon**

Chairman, H2KOREA and Chair, Global Hydrogen Industrial Association Alliance (GHIAA)



The central government designated the hydrogen green mobility regulation-free special zone in Ulsan.”

**Dongkyu Kim**

Director at Investment Promotion Department, Ulsan Free Economic Zone Authority

Moon also pointed to plans for clean hydrogen certification, a bidding market for hydrogen-based power generation and financial incentives for production. The incentives could take the shape of feed-in premiums or contracts-for-difference and will be decided by the end of 2023, Moon said. Moon’s presentation was followed by one from Dongkyu Kim, who outlined Ulsan’s hydrogen plans. The city currently produces 840,000 t/yr of grey hydrogen, but is aiming for 84,000 t/yr of green hydrogen by 2030, Kim said. It also wants to extend the pipeline network, to increase the number of refuelling stations and establish infrastructure for liquid hydrogen production and distribution. Efforts are supported by Ulsan’s designation as a “hydrogen green mobility regulation-free special zone”, which is supposed to streamline regulations around research and development, Kim said. The local government also provides tax relief and cash grants for firms looking to invest, he said.







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