



HYDROGEN
ADVISORS

Hydrogen in 2019

A review of some of the major developments

Prepared for you by Raphael Schoentgen



2020

— HAPPY NEW YEAR —



Raphaël SCHOENTGEN

Founder & CEO

Hydrogen Advisors
231 rue Saint Honoré
75001 Paris

+33 6 08 04 71 34
rs@hydrogenadvisors.com

1999 - Head of France Northern Region Economic Development Office

2004 - Private advisor in charge of International and European Affairs to the French Minister of Energy, Telecommunications and Industry

2009 - President of ENGIE in China , one of the world's largest utilities, active in 70 countries

2013 - Chief Technology Officer of ENGIE and Member of the Executive Committee

2015 - Elected President of Hydrogen Europe (association of European companies active in hydrogen and fuel cells) and President of FCHJU, the European fund backing the sector

2017 - Active contribution to the creation of the Hydrogen Council, a club of Fortune 100 and specialized companies advocating hydrogen as a new energy vector, and its launch in Davos

2018 - Private entrepreneur in the field of hydrogen and fuel cells, and founder of Hydrogen Advisors

HYDROGEN ADVISORS' CLIENTS & SERVICES



Banks, Funds, Family Offices

Hydrogen strategy in relation with existing activities
Scouting and investment in companies and projects
Due diligence



International bodies, governments (country / region / city level)

Hydrogen reports / roadmaps and policies / regional development
Projects development / attracting investments
Public aid



Large and mid size companies

Hydrogen strategy in relation with existing activities
Projects development
Public aid for projects and R&D



Start ups

Development strategy
Partners and investors quest
Public aid for projects and R&D

Executive Summary



Following on from 2018, 2019 was again filled with an impressive array of political commitments to the hydrogen economy. At the Clean Energy ministerial meeting (gathering of countries most engaged in fighting climate change post COP21), a dedicated hydrogen initiative was launched. The World Energy Council also launched one. Hydrogen was at the centre of discussions at the G20 in Osaka following a report from the International Energy Agency stating it will be the next LNG. Several agreements were signed between countries to collaborate on hydrogen: India with France, Korea with Israel, Germany with the Netherlands and Morocco, EU with the USA and Japan. Several countries adopted new hydrogen plans (e.g. Ireland), finalized their hydrogen strategies initiated in 2018 (e.g. Australia) or gave a financial boost to existing plans (e.g. Germany). A certification process for green hydrogen was also put in place in Europe. Finally, several economies expressed a wish to become the world leader in hydrogen: Korea, Australia, Germany, and the EU via its new EU Vice President Mr Timmermans in charge of the green deal.

All these political commitments are of course related to major developments on the ground.

In the field of industry, where hydrogen is a major entrant in several processes, a series of new green hydrogen projects were launched to decarbonize chemicals production (e.g., Yara and Engie) fuel production in refineries (e.g., Uniper and BP) or steel (e.g., Equinor, Open Grid and ThyssenKrupp), again following progress from 2018.

In the field of energy, the size of several power to hydrogen projects reached the impressive GigaWatt threshold, many of which related to offshore wind developments in Northern Europe. In parallel EU gas transport operators worked intensively on the introduction of up to 20% hydrogen in existing gas pipelines and Kogas tabled a record US\$4 bn planned investment in hydrogen. Projects to use hydrogen fuel cells in private homes (e.g. GBP110 mn in Aberdeen / UK), commercial buildings (e.g. a 20 MW fuel cell in a data centre in the USA) and industrial sites (e.g., a 200 MW fuel cell plant announced in Korea) continued to break new size records. Gas turbine operators also developed hydrogen injection solutions for existing turbines.

2019 also brought major developments in the field of mobility:

- Regarding pure H₂ production for mobility, next to offshore wind conversion to H₂ massive projects, new electrolyser players appeared (small and large systems), while interest in natural H₂ also increased.
- Regarding H₂ transportation, both LOHC technology (hydrogen mixed in an organic liquid carrier) and LH₂ (liquefied hydrogen) progressed, while pipeline projects and underground storage projects increased. The world first LH₂ ship was also put to sea in Japan just before Christmas.
- Regarding H₂ filling stations, one can notice that Saudi Arabia opened its first one, Poland & Italy showed new developments, and independent H₂ stations networks appeared in Switzerland and Scandinavia.
- Regarding cars and light duty vehicles, 2019 was the year of tier one suppliers (e.g. Faurecia and Michelin backing Symbio to become the #1 supplier of fuel cells in Europe, and Bosch buying 11% of Powercell). New cars designs also reached the market, including the Groove (Pininfarina©) for China or the Mirai 2 from Toyota. On the OEM side, the CEO of PSA announced they would market hydrogen vehicles in 2021. Finally, the Nexo set the one-tank record distance for a hydrogen car at 778 km.
- Regarding logistics, further large hydrogen forklift projects dedicated to harbours were developed while Nuvera opened a plant in China.
- Regarding hydrogen buses, much larger projects were noticed worldwide (e.g. a 600 strong fleet planned for Scandinavia), worldwide production levels increased, new applications appeared such as the first hydrogen articulated bus in operations, and long distance bus operators also show now interest.
- Regarding trucks, the market was extremely active with players like Cummins (diesel engine manufacturer) and Iveco (#4 EU truck manufacturer) entering the market, while actors like Nikola in the EU and US, Ford's JV with Weichai in China, VDL in Europe, Hyundai in Switzerland and Norway, all continue to develop. The first H₂ refrigerated trailers and H₂ garbage trucks came to the market. Finally the first H₂ mining truck is being developed.

- Regarding trains, the world's first hydrogen train, made by the French company Alstom, started operations in Germany in 2018. In 2019 several large orders were placed (e.g. in France and the UK). In parallel, several new hydrogen train projects with new suppliers surfaced in Korea, Japan, Russia, Sweden, Poland and the USA.
- Regarding marine applications, while a series of pilot projects started in 2018, H₂ solutions gained momentum across more applications in 2019. This included fuel carriers, container ships, heavy weight-lifting ships, cruising ships, ferries, yachts, sailing yachts, fishing boats, harbour pusher boats, river barges, windfarm maintenance boats, etc.
- Regarding planes, H₂ made its entry as a fuel to power flights (and not anymore only to power auxiliary equipment like in 2018) : the first 6 seats piper plane with hydrogen and a fuel cell took off, and pilot projects for a H₂ based glider and a H₂ based electric chopper were disclosed.

All these developments were backed by major industrial alliances and M&A deals that reached new heights. For instance, Iveco invested US\$250mn and Hanwha & Bosh both invested over US\$100mn each in Nikola, valuing the company at US\$3bn. Cummins took a controlling stake (81%) in Hydrogenics, valuing the Company at US\$290mn, and Linde invested in ITM Power.

On the alliance side, Hyundai partnered with Saudi Aramco and Cummins. Sinopec partnered with Air Liquide and Refire. Hydrogen Europe partnered with the EU Automobile Manufacturer's Association, the Internal Road Union, and the Waterborne Technology Platform to push H₂ solutions. Finally, the Hydrogen Council partnered with the European Investment Bank to push H₂ investment.

Finally, new R&D centres were opened worldwide (and could not all be reported in the following slides), with noticeable efforts from Toyota, who opened new centres in Australia and China.

Countries



Jan 7th – Korean Announces Roadmap to Become the World Leader in the Hydrogen Economy

Korean **HYDROGEN** Road Map



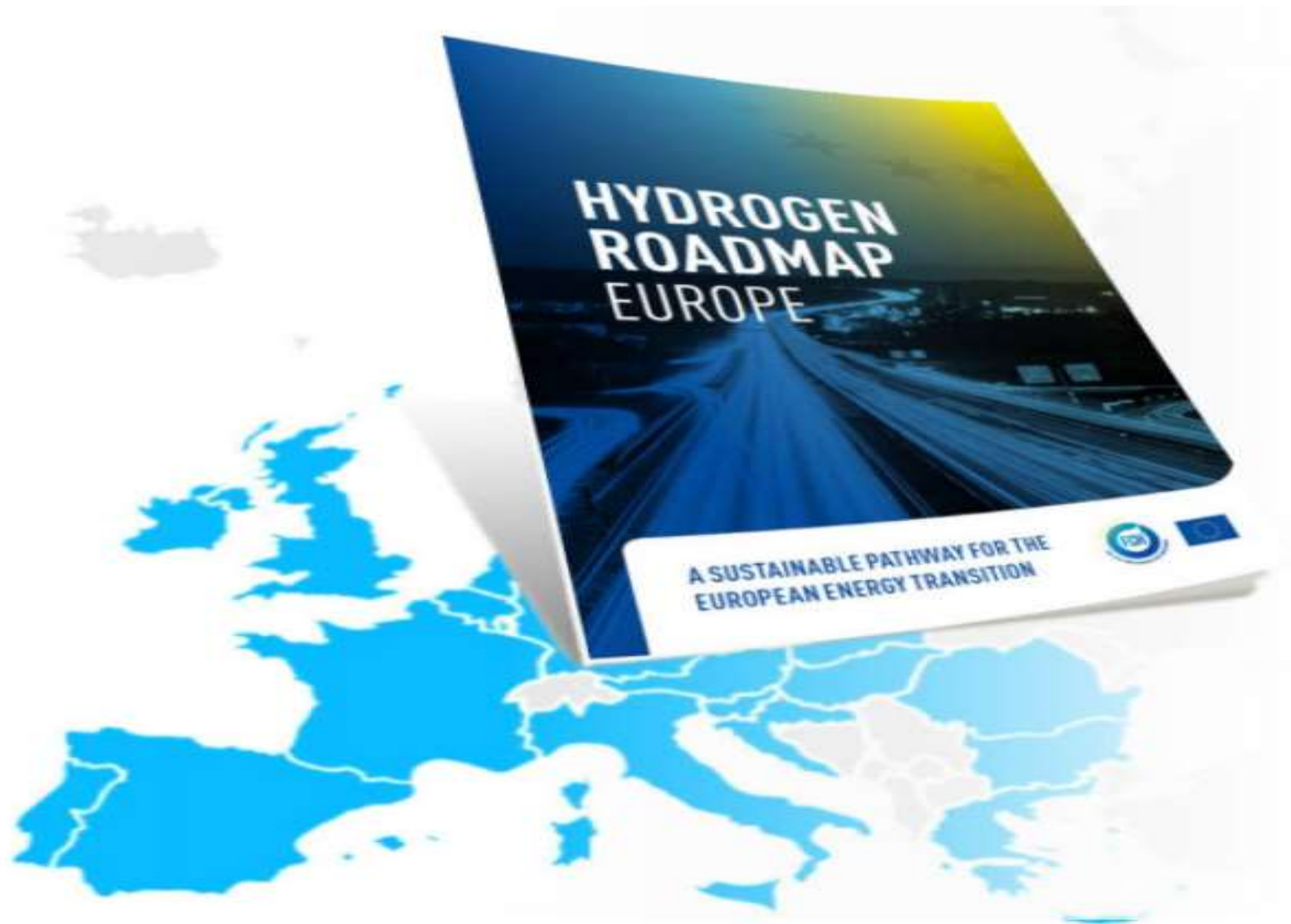
Jan 21th – Australian Labor Government will Invest USD 1.14 billion in a National Hydrogen Plan to make Australia a World leader in the hydrogen industry



Jan 21th – Air Liquide, Khalifa University and Toyota released a study on H₂ mobility in the UAE



Feb 11th – A Hydrogen Roadmap for Europe was published by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU)



Feb 11th – Launch of Certify, the Green Certificates for Hydrogen in Europe



April 2^d – Merkel: We need to switch to electric or hydrogen-powered fuel-cell cars



May 3^d – The Heads of the 5 Northern Landers in Germany signed a declaration in Hamburg stating that Northern Germany wants to be a leader in building a “Green Hydrogen Economy”



May 23^d – the Occitanie Region in France launched a green hydrogen plan of Euro 150 million



May 29th - During the 2019 Clean Energy Ministerial Meeting in Vancouver, an international joint initiative to promote the development of the hydrogen economy was launched



AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

COUNTRIES



Canada



European Commission



India



Japan



Korea



New Zealand - Observer



Norway



Saudi Arabia



United States

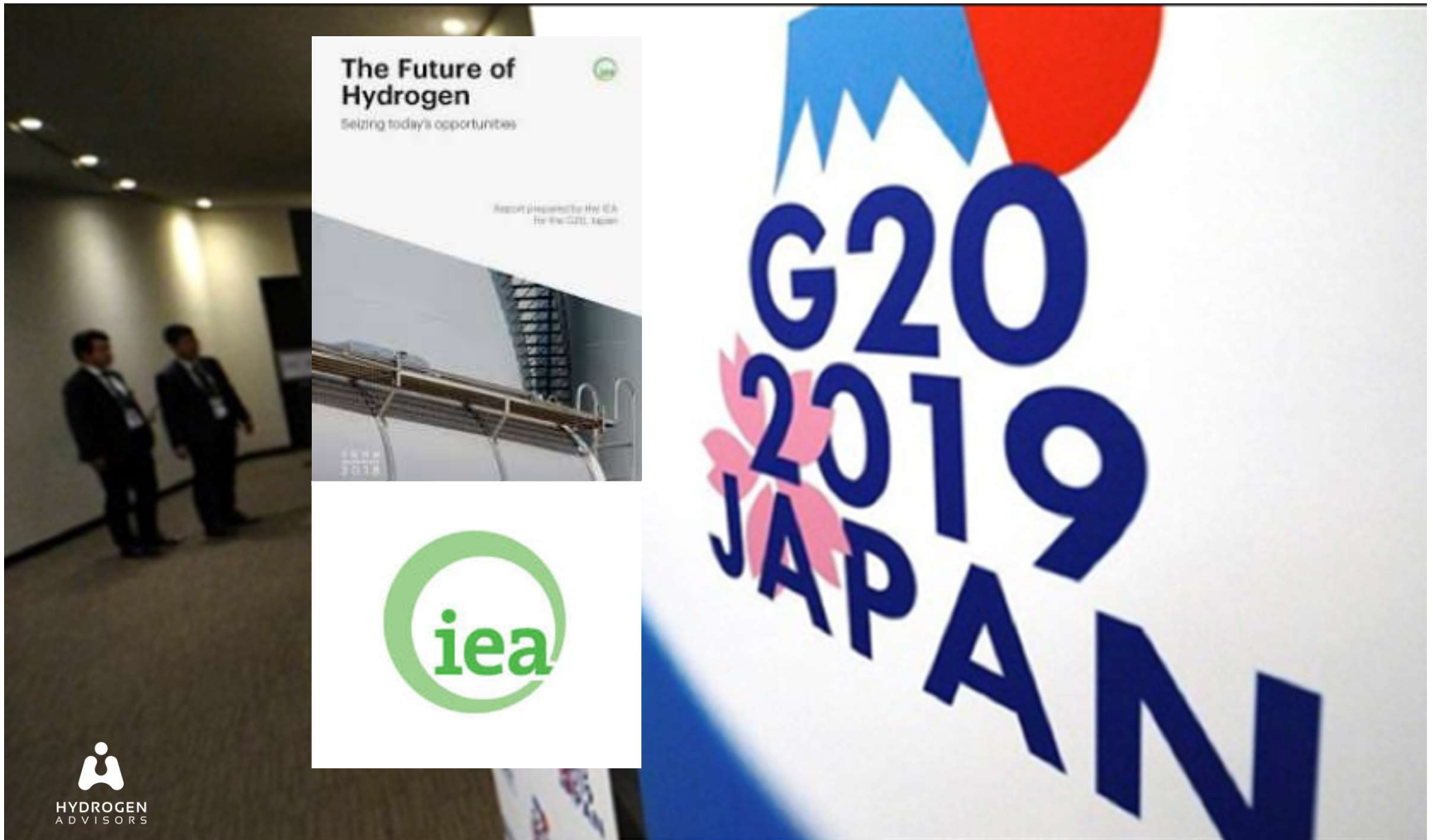


Netherlands

June 16th - Japan, EU and USA agreed to a hydrogen and fuel cell partnership



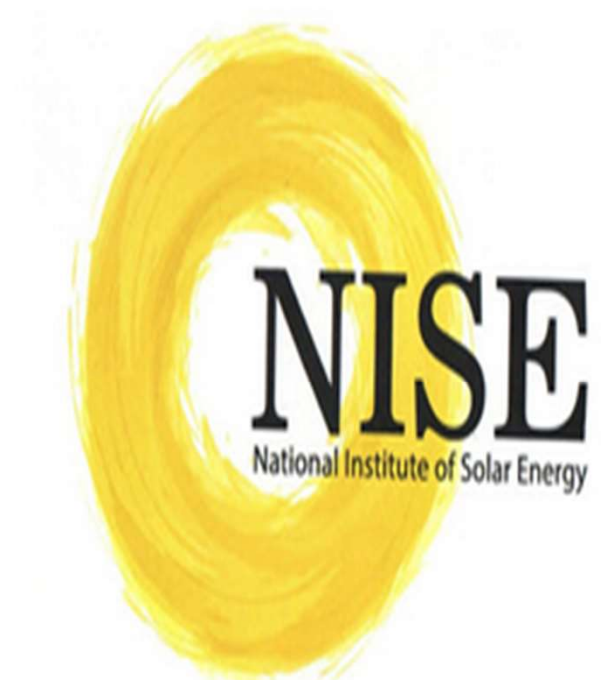
June 26th - Hydrogen took the centre stage at the Osaka G20 meeting, while the IEA produced a report stating that hydrogen could be the future LNG



July 16th – Korea and Israel signed a cooperation agreement on hydrogen



August 30th – French CEA and Indian National Institute of Solar Energy signed a collaboration agreement on hydrogen at the occasion of the French President's visit to India



October 5th – Federal Minister of Economics Peter Altmaier and Dutch counterpart Eric Wiebes agreed to Cooperate on the Hydrogen Economy during a Germany-Netherlands Summit



October 9th – Germany added Euro 300 million to existing Euro 480 million pledge for hydrogen research as the country aims to be a leader in the field of hydrogen technologies



Nationale Organisation Wasserstoff-
und Brennstoffzellentechnologie



Nationales Innovationsprogramm
Wasserstoff- und
Brennstoffzellentechnologie

October 11th – Europe presented an array of projects for Euros 40+ million investment / 60+ companies / 1000 + filling stations / 15k H₂ trucks / 100k H₂ light duty vehicles / 100 H₂ ships /

Hydrogen

for Climate Action



Nov 5th - “Our goal is clear. We want Germany to be the global number one in hydrogen technology” said Mr Altmaier at German Ministers’ Roundtable on Hydrogen



Nov 20th – The World Energy Council launched a global hydrogen charter to align global efforts for the development of a low carbon hydrogen economy



Hydrogen global



25th Nov – Ireland Hydrogen Roadmap for Transport was published



Narrative Summary:

A Hydrogen Roadmap for Irish Transport, 2020-2030

Date:
October 2019

**HYDROGEN POWERED BUSES =
ZERO EMISSIONS + CLEANER AIR**



**HYDROGEN
ADVISORS**

November 25th - Frank Timmermans, Vice President of the EU Commission said that clean hydrogen has a pivotal role in the energy transition and is an industrial sector for the EU to lead



December 2^d – the German Government planned to import hydrogen from Morocco following a report from Fraunhofer for Moroccan and German cooperation authorities



STUDY ON THE OPPORTUNITIES OF "POWER-TO-X" IN MOROCCO



November 23^d – the Australian State and federal energy ministers formally approved the National Hydrogen Strategy prepared by Chief Scientist Alan Finkel



Australian Government



**COAG
Energy Council**



December 6th – Hyundai started a feasibility study for hydrogen based mobility in India



HYDROGEN
ADVISORS

Industry



Feb 13th – ENGIE and YARA will take Hydrogen to the factory (design study for ammonia plant)



April 26th – Uniper and BP will drive the production of “green” hydrogen via a 10 MW electrolyser to inject it in refineries



May 6th – Preem and Vattenfall formed a partnership to produce hydrogen on a large scale – (20 MW electrolyser) to decarbonize a refinery in Gothenburg



VATTENFALL 



October 9th – Thyssengroup, Equinor and Open Grid Europe launched a study to promote the development of climate friendly hydrogen to decarbonize the steel industry



Energy



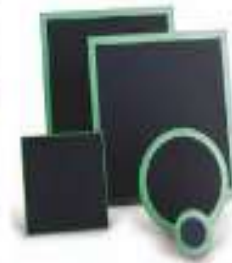
Feb 1st – H2U and Baker Hughes (GE group) announced a collaboration to deploy 100% hydrogen-fired gas turbines at Port Lincoln, South Australia



Feb 1st – Umicore will expand its production capacity for fuel cell catalysts



Feb 12th – Elcogen signed a Euro 12 million loan from the European Investment Bank to set-up a manufacturing plant for Solid Oxide Fuel Cell systems



Fuel cell technology
elcogen

March 8th – South Korea: 200 MW Hydrogen Fuel Cell Power Plant to be built in Gyeongju



April 2^d – EDF to launch a dedicated company active in the field of hydrogen - Hynamics



hynamics
GROUPE **edf**

April 28th – KOGAS to spend won 4.7 trillion (USD 4.01 billion) on hydrogen producing facilities



Under the plan, KOGAS will construct 25 hydrogen-producing facilities and pipelines totaling 700 kilometers to transport the gas.

By 2030, KOGAS expects 1.73 million tons of hydrogen to be supplied annually.

The state-run gas supplier said demand for hydrogen in the country will reach 1.94 million tons a year by 2030 and 5.26 million tons by 2040.

KOGAS said with increased output, prices of hydrogen will likely fall to 4,500 won per kilogram from the current range of 6,500 won to 7,500 won.

Also, the corporation said it will import 300,000 tons of hydrogen by 2030 and 1.2 million tons by 2040.

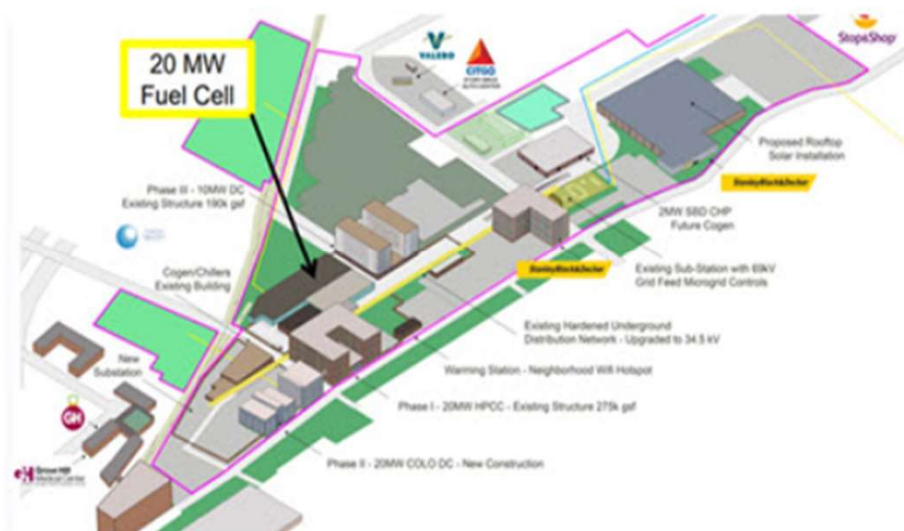
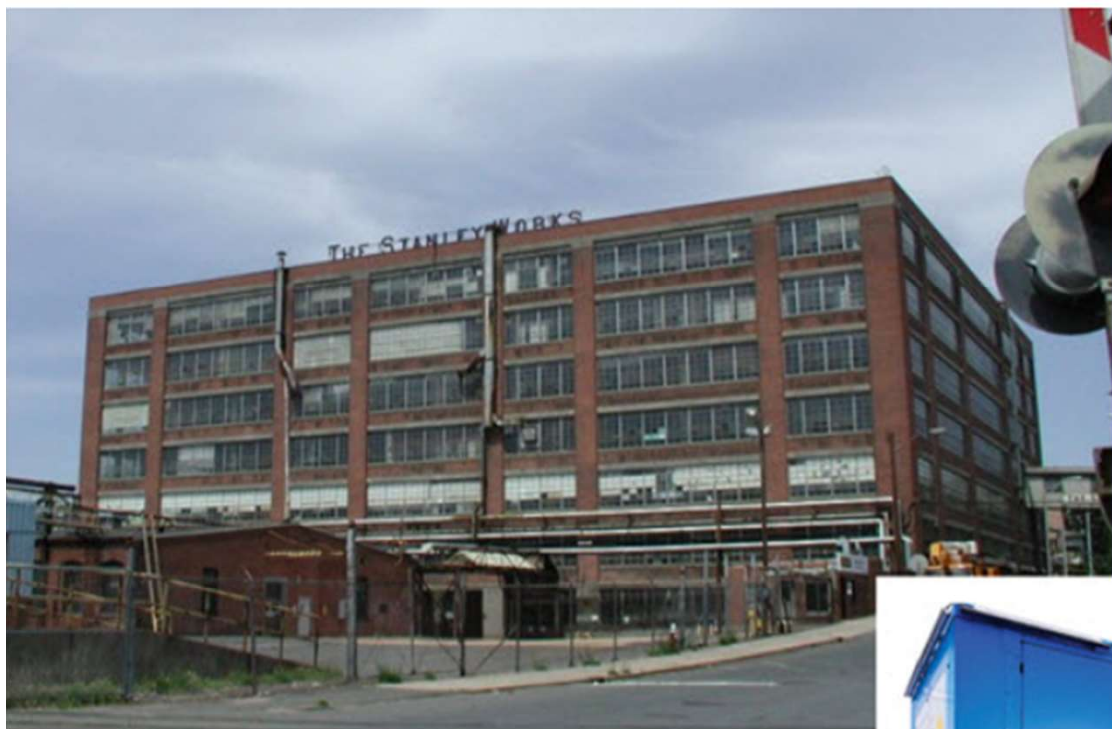
South Korea has been seeking to boost the so-called hydrogen economy as a new growth engine.

July 25th – £ 110 million to test hydrogen in 550 homes in Aberdeen

Aberdeen



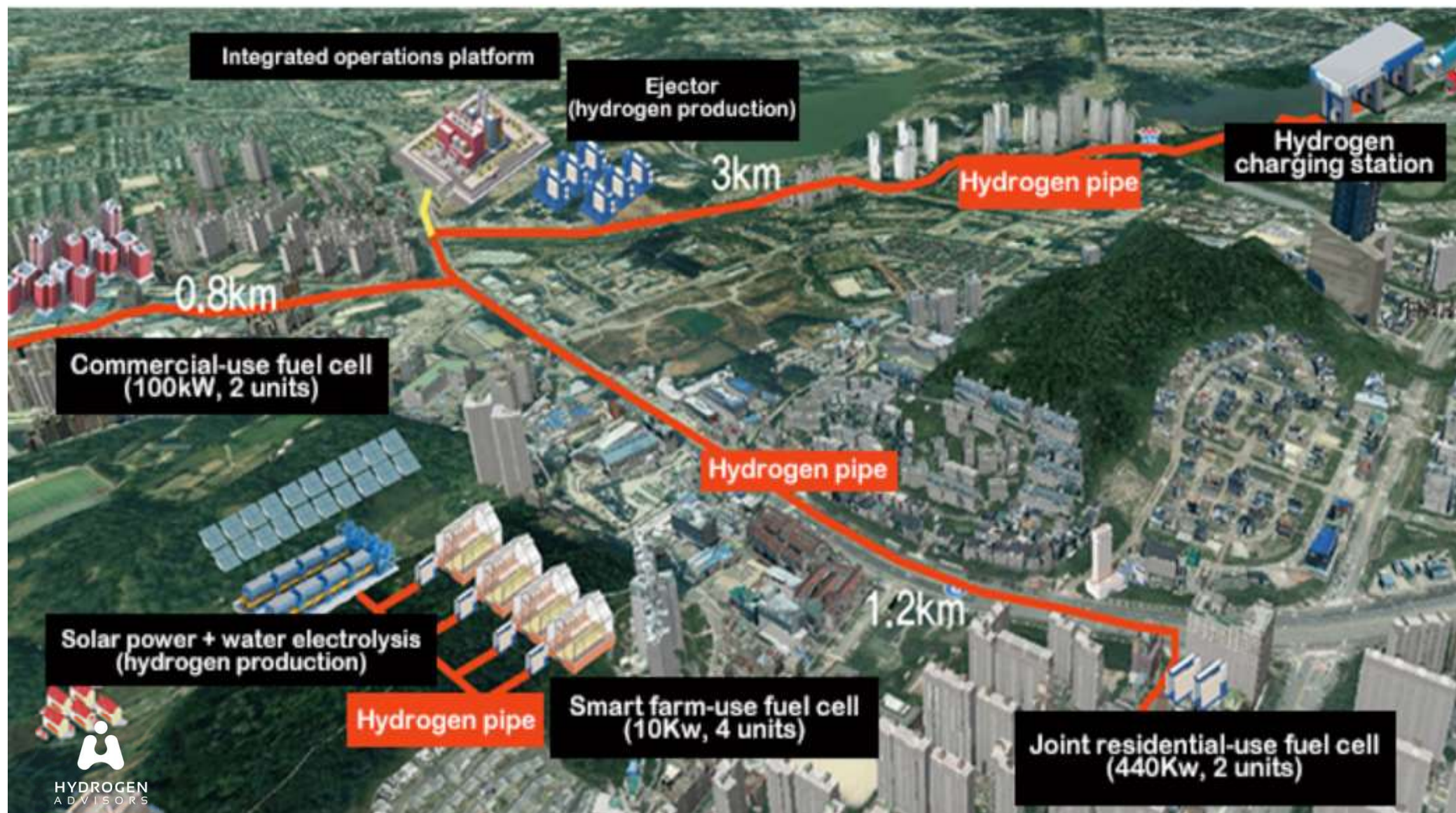
October 9th – the world's largest indoor fuel cell (20 MW) will be deployed for Stanley Black & Decker USD 1 billion new data hub in New Britain, Connecticut USA



October 11th – South Korea announced that it will create 3 Hydrogen Cities by 2022

Hydrogen city plan

*Based on 6 square kilometer area



October 24th – Ansaldo Energia and Equinor collaborate on validation of 100% hydrogen combustors for gas turbines running in power plants to generate electricity



Nov 30th – Petroma provided power to a village in Mali using hydrogen coming out naturally from the ground – a world first (like oil and gas can naturally be found in the underground)



December 5th – the German Ministry of Transport and Digital Infrastructure (BMVI) allocated Euro 5 million funding to install 505 fuel cell systems to power critical radio telecom networks



December 7th – TEVOLT supports the development of an offgrid self-sufficient municipal housing development (170 homes) powered entirely by hydrogen in the Swedish town of Vårgårda



December 10th – HDF announced building in France the world's first plant for mass production of high-powered fuel cells (over 1 MW) following technology transfer partnership with Ballard



December 20th – 7 industrial partners will develop a 2 MW demo project of green hydrogen production from offshore wind for mobility applications (up to 20 buses/day) in Denmark

Ørsted

nel

Everfuel

GREENHYDROGEN

ENERGINET/DK

DSV
PANALPINA

Brintbranchen
Hydrogen Denmark



HYDROGEN
ADVISORS

Hydrogen production



Jan 7th – Air Products to build second liquid hydrogen production facility in California



Feb 11th – Amprion and OGE push ahead with 100 MW electrolyzer hydrogen plant



Feb 18th – ERGOSUP raised Euro 11 million for the deployment of small to medium, and modular, production and storage of carbon-free hydrogen units



HYDROGEN
ADVISORS

March 14th – Ørsted will establish green hydrogen from Dutch offshore wind farms



March 26th – launch of a gigawatt alliance in the Netherlands around hydrogen



October 3^d – Tractebel Engineering develops a new hydrogen offshore platform



November 22^d – John Cockerill Jingli Hydrogen, one of the world leaders in electrolyzers, inaugurated its new production center at Suzhou (China) with an annual production of 350 MW



Hydrogen transport



Feb 15th – First LHOC project to go to scale in China (Euro 300 million investment)



April 7th – SNAM: Europe's first supply of hydrogen and natural gas blend into the transmission network to industrial users



April 13th – German Association for Gas and Water (DVGW) developed rules for climate-friendly hydrogen in the natural gas Infrastructure



April 30th – GRTgaz Partners with CATALYSE to maximize hydrogen injection into the existing gas transmission network via the coating of curved surfaces from inside the pipes



May 1st – Hypos Consortium launched in Germany to develop R&D in hydrogen underground gas storage systems



July 31th – Vopak, Mitsubishi Ventures, Covestro and AP Ventures invest in Hydrogenious LOHC hydrogen transport solution



October 11th – SNAM announced that hydrogen can fulfil 25% of Italy's energy in a 95% decarbonization scenario by 2050 and will test now 10% injection of H₂ in gas transmission grid



Nov 24th – 7 leading players in Belgium will cooperate to develop the production, transport and storage of hydrogen



December 11th – World first LH₂ carrier is put to sea in Japan by Kawasaki and will rotate first between Australia and Japan



HYDROGEN
ADVISORS

December 19th – Willhemsen, Norsea and partners received USD 3,7 million funding to develop liquid hydrogen supply chain for maritime applications in Norway



Filling stations



Jan 24th – Spain: Collaboration Agreement signed to boost hydrogen as a fuel in transportation



Feb 19th – Auvergne-Rhône-Alpes region invests Euro 8 million into hydrogen stations



**Auvergne
Rhône-Alpes**

May 6th – France: 11 hydrogen mobility projects selected for public funding



Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE
ET SOLIDAIRE



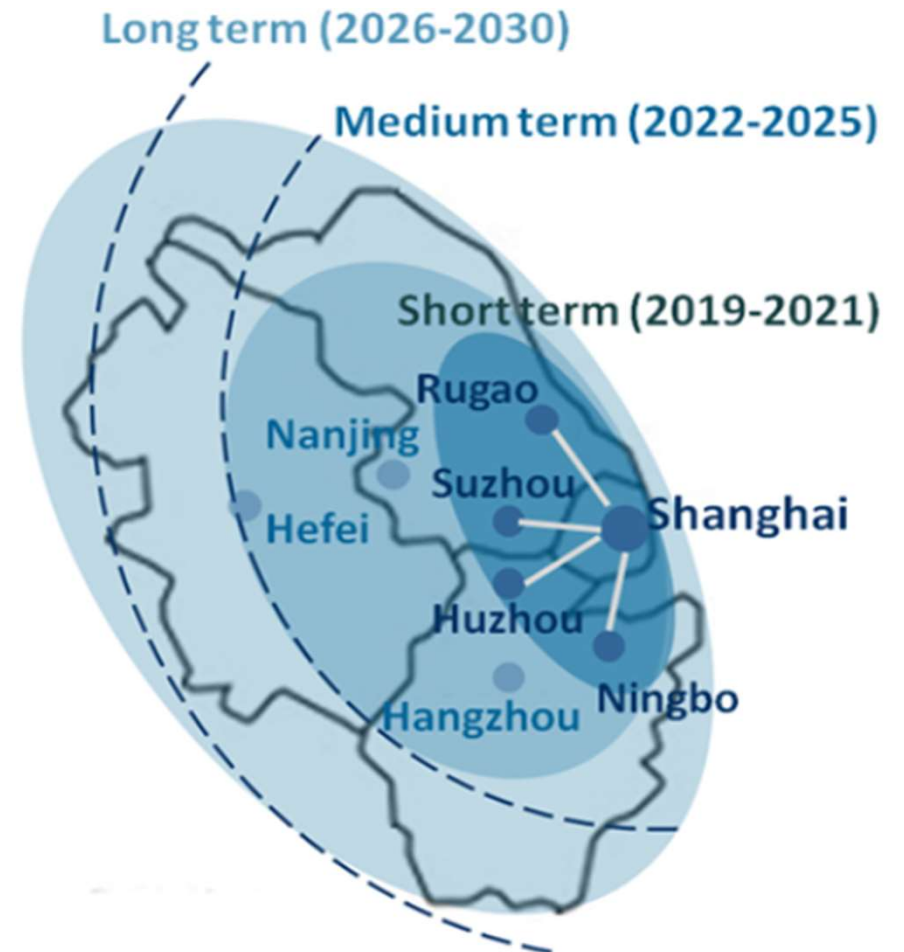
H₂

ADEME



Agence de l'Environnement
et de la Maîtrise de l'Energie

May 24th – Yangtze River Delta Region unveiled plans to develop hydrogen filling stations along its highways



**Hydrogen Corridor Development
in the Yangtze River Delta Region**

June 3^d - Toyota and Eni announced a collaboration to speed up the development of hydrogen stations and cars in Italy



June 18th - Saudi Aramco opened the first hydrogen station in Saudi Arabia in cooperation with Air Products



August 29th – Linde took 10% in Swiss Hydrogen that will produce hydrogen from hydropower to deploy an H₂ filling stations network for 1600 hydrogen trucks to be delivered by Hyundai

Linde

SWISS
HYDROGEN

ALPIQ



December 16th – Everfuel started deploying a network of stations in Scandinavia to provide green hydrogen to mobility applications using large amounts of fuel (buses / trucks / taxi fleets)



December 16th – Orlen will start construction of hydrogen filling stations in Poland in 2021



December 23th – NEL partnered with H2 Energy, Greenstat and Akershus Energi to deploy hydrogen filling stations as Hyundai trucks are planned to enter Norway starting in 2020



nel^o

GREENSTAT

H₂energy

 Akershus
Energi



Cars



Feb 26th – Air Liquide, IDEX, STEP, and Toyota created HysetCo to promote the development of hydrogen mobility with the objective of 600 Hydrogen Taxis by end of 2020



April 26th – Pininfarina and Grove set up a partnership to develop a premium H₂ car for China



Grove
Hydrogen
Automotive



pininfarina

June 13th - Total became the new partner of H2O (hydrogen in Le Mans)



Sep 14th – Carlos Tavares CEO of PSA confirmed hydrogen cars from his company will come to the market in 2021 starting with vehicles for fleet owners



October 10th – the new Toyota Mirai (Mirai 2) hydrogen car design was revealed



October 14th – Hyundai Spain new advertisement campaign with a famous athlete running in a bubble connect to the Hyundai Nexo exhaust pipe



October 24th – Great Wall announced it is ready for mass production of hydrogen fuel cell cars



HYDROGEN
ADVISORS

Nov 29th – Bertrand Piccard from Solar Impulse broke the world record of distance for an electric car with 778 km on one fill using Hyundai Nexo hydrogen fuel cell car



December 29th – Symbio, a JV between Michelin and Faurecia, announced the establishment of the largest European fuel cell plant in Europe in Lyon



Logistics



Jan 2^d– Port of Valencia first port in EU to integrate hydrogen in its operations



Nov 29th – Terberg new generation of yard tractors will integrate hydrogen fuel cells



December 18th – Nuvera breaks ground on automated fuel cell plant in China



Buses



Feb 12th – Ballard-Powered new flyer fuel cell electric buses ready to deliver Zero-Emission transit throughout the United States



HYDROGEN
ADVISORS

April 22th – Toyota to provide fuel cell parts to Chinese automaker BAIC's affiliate



June 3^d - H₂ BUs consortium was established in Northern Europe to provide hydrogen buses, hydrogen fuel and maintenance services to cities



Single Deck - 12 m

Price < €375k

Range >450 km* Extended >675 km*

*Dependent on duty cycle calculated at 10°C



Double Deck - 10.9 m

Price < €410k

Range >310 km* Extended >420 km*

*Dependent on duty cycle calculated at 10°C



Articulated - 18 m

Price < €465k

Range >520 km* Extended >750 km*

*Dependent on duty cycle calculated at 10°C

nel • BALLARD®



Everfuel®



July 20th – Indian Ministry of Transport called for proposals for hydrogen fuel cell buses



August 28th – Hydrogen produced from biomass will power 50 buses in Strasbourg city



CTs

R-GDS

HAFFNER
energy



HYDROGEN
ADVISORS

September 2^d – Flixbus Germany announced its intention to be the first long distance inter cities bus company to test hydrogen buses in Europe



Nov 20th – Foton in China announced 2,6 bUSD for the development and commercialization of 200 000 “New Energy Vehicles” (battery based, hydrogen based and hybrids) by 2025



November 26th – Paris public transport company RATP to test Portuguese Hydrogen Bus Caetano (developed with Toyota) and Polish Solaris Urbino Hydrogen Bus



December 17^h – The world first hydrogen articulated bus, Febus, started its operations in the southern city of Pau in France



Trucks



April 12th – European Premiere in Brainport region Eindhoven of the first hydrogen-powered garbage trucks



July 5th – Chereau in France hit the road with the world first hydrogen fuel cell based refrigerated trailer for road transport



HYDROGEN
ADVISORS

September 25th – Ford Motor Company JV in China JMC unveiled its class 8 - 42 ton truck developed with Horizon Fuel Cell Technologies



Horizon
Fuel Cell Technologies

September 26th – Hyundai, H2 Energy, Alpiq and Linde together in the development of hydrogen based heavy duty truck mobility in Switzerland



October 5th – H2Haul project will test 16 heavy-duty hydrogen trucks in real-world commercial operations within large supermarket fleets in Switzerland, France, Germany and Belgium



October 10th – ENGIE and Anglo American to partner in developing the world's largest mining truck running on hydrogen



October 28th – Cummins unveils an electric truck with 100 kW Li-Ion battery and 90 kW fuel cell bringing max range to 400 km. More FCs / H₂ components could be added to increase autonomy.



October 28th – Hyundai unveiled a new hydrogen based class 8 concept truck



Nov 22^d – Anheuser Bush completed the first delivery of Budweiser beer with Nikola Hydrogen Fuel Cell Truck



HYDROGEN
ADVISORS

December 23th – Weichai invested in Aradex, a German leader in powertrain energy system and electric mobility, to further develop its hydrogen activities after investing in Ballard and Ceres



Your electric mobility partner for
commercial vehicles, working machines
and ships



Trains



Jan 7th – Alstom and Eversholt Rail unveiled a new hydrogen train design for the UK, the Breeze based on a conversion of existing Class 321 trains and that could run as early as 2020



HYDROGEN
ADVISORS

Jan 30th – Korea will develop a hydrogen fuel cell train



June 5th - Japan Railways will develop and test hydrogen trains



Nov 6th – Russia plans to produce hydrogen train via a cooperation between Rosatom and Transmashholding Group with a first application case in Sakhalin Island



ROSATOM



**HYDROGEN
ADVISORS**



November 11th – Gorelektrotans Ltd. has launched a test of a first fuel cell-powered tram in St.Petersburg.



HYDROGEN
ADVISORS

December 15th – Research at Michigan University leads to North America first commercial passenger hydrogen train order (by San Bernardino County Transport Authority to Stadler US)



MICHIGAN STATE
UNIVERSITY

December 16th – PKN Orlen and Pesa Bydgoszcz sign partnership to develop hydrogen based trains in Poland



December 24th – Sweden Inlandsbanan train operator and Statkraft, EU leading provider of renewable energy, will develop heavy duty train transport based on hydrogen in Sweden



Ships



Jan 4th – Japan to start deploying first fishing boats with Toyota Fuel Cell



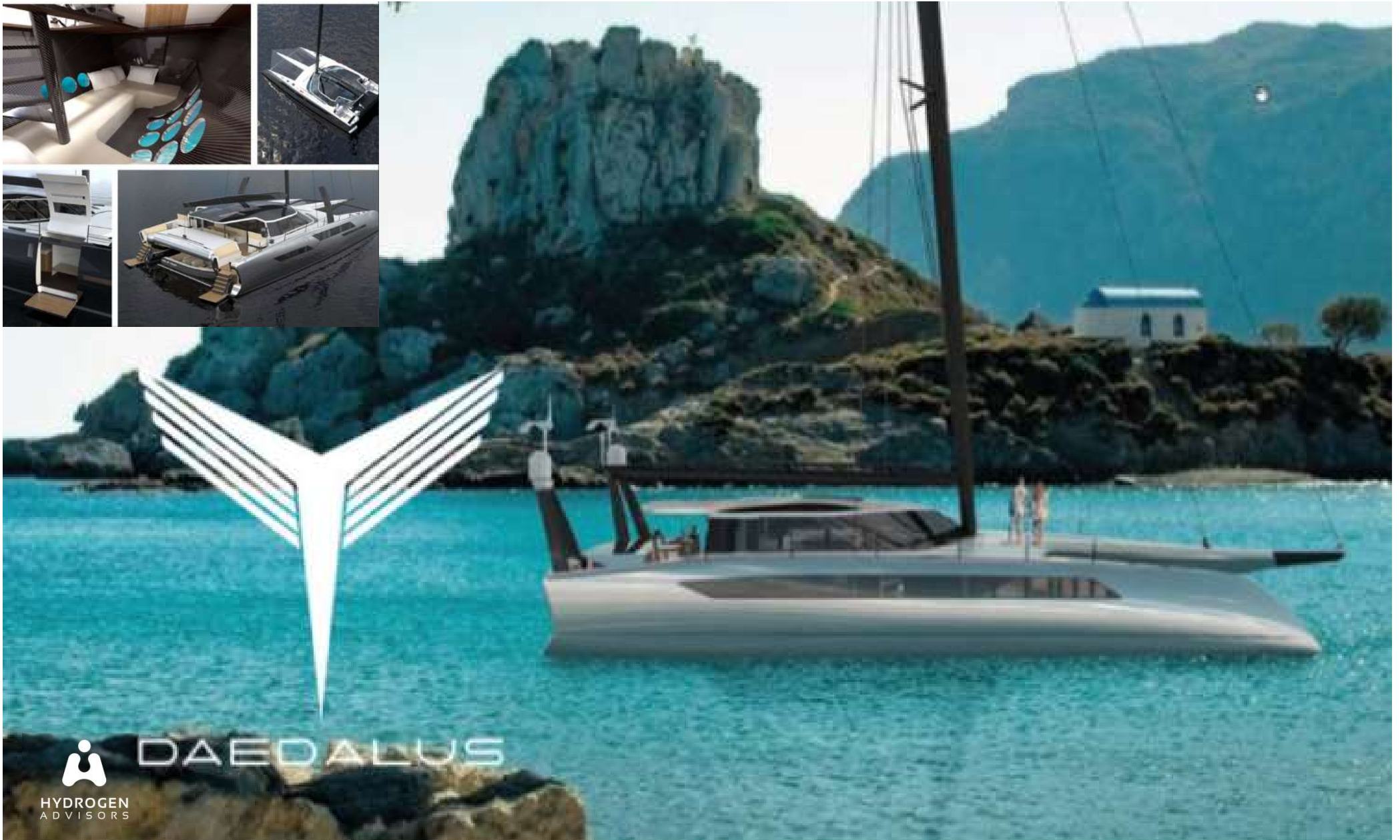
Jan 7th – Smaskip will develop a hydrogen-based sea shuttle container ship



Jan 10th – The Korean Marine Equipment Research Institute to research FC technology for ships



Feb 13th – Daedalus presented a luxury catamaran with a hydrogen fuel cell heart



March 22^d – GE and Nedstack partnership set sights on zero emission hydrogen fuel cell powered cruise vessels



April 2^d – Ballard to establish a fuel cell center of excellence in Europe to serve the marine market



April 2^d – Ballard signed a supply agreement with Norled for the first hydrogen ferry in Norway as part of the EU flagships project



May 21st – ABB and Ballard announced their cooperation with the EU flagships project to develop a hydrogen based push boat on the Rhone river in France

The ABB logo is displayed in a large, bold, red font. It consists of the letters 'A', 'B', and 'B' in a stylized, blocky typeface.The Ballard logo is prominently displayed at the bottom right in a large, bold, blue font. The word 'BALLARD' is followed by a registered trademark symbol (®).

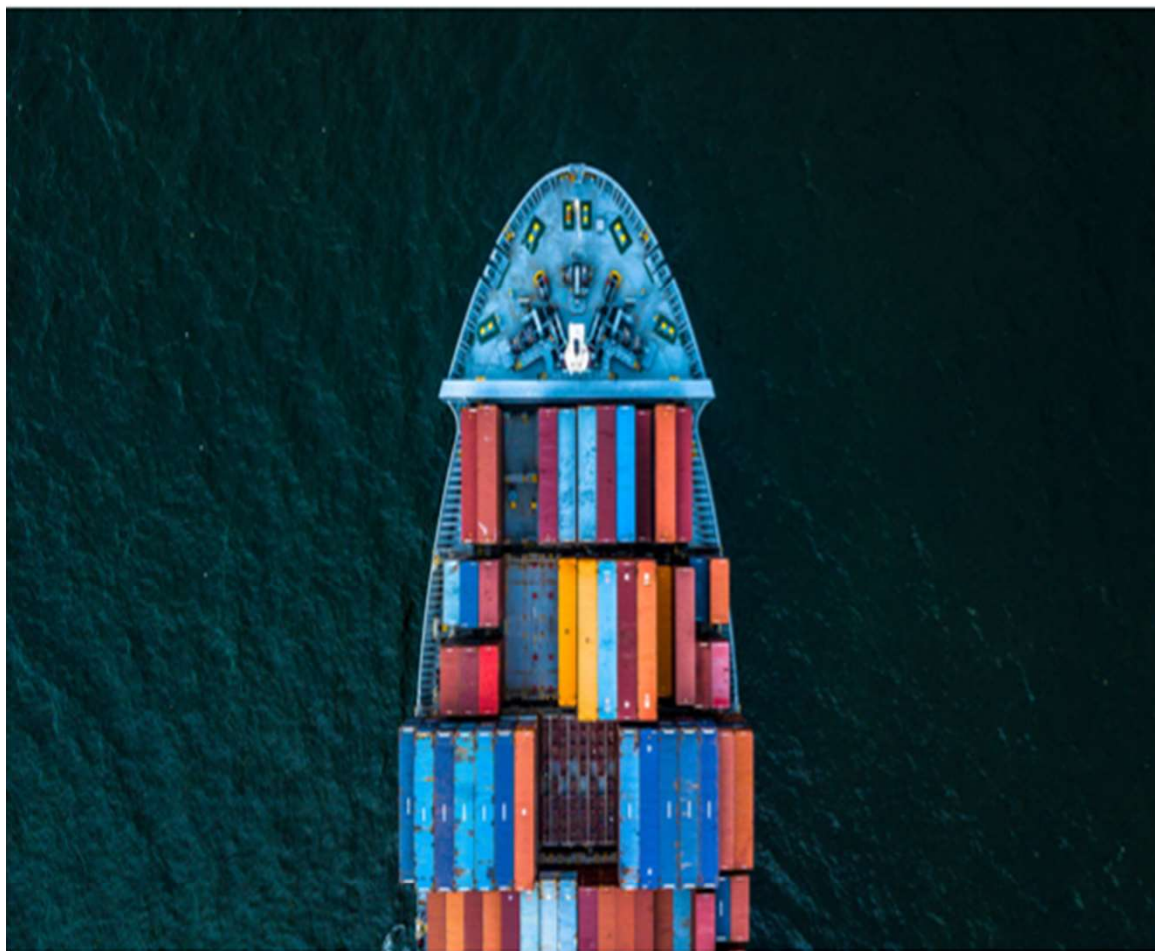
August 9th – CMB and Windcat will develop a hydrogen powered boat to maintain windfarms at sea



September 21st – Aqua hydrogen powered yacht presented as the new way of yachting



September 27th –Bloom Energy and Samsung, world leaders in stationary fuel cells and the shipping industry, partnered to develop SOFC based ships

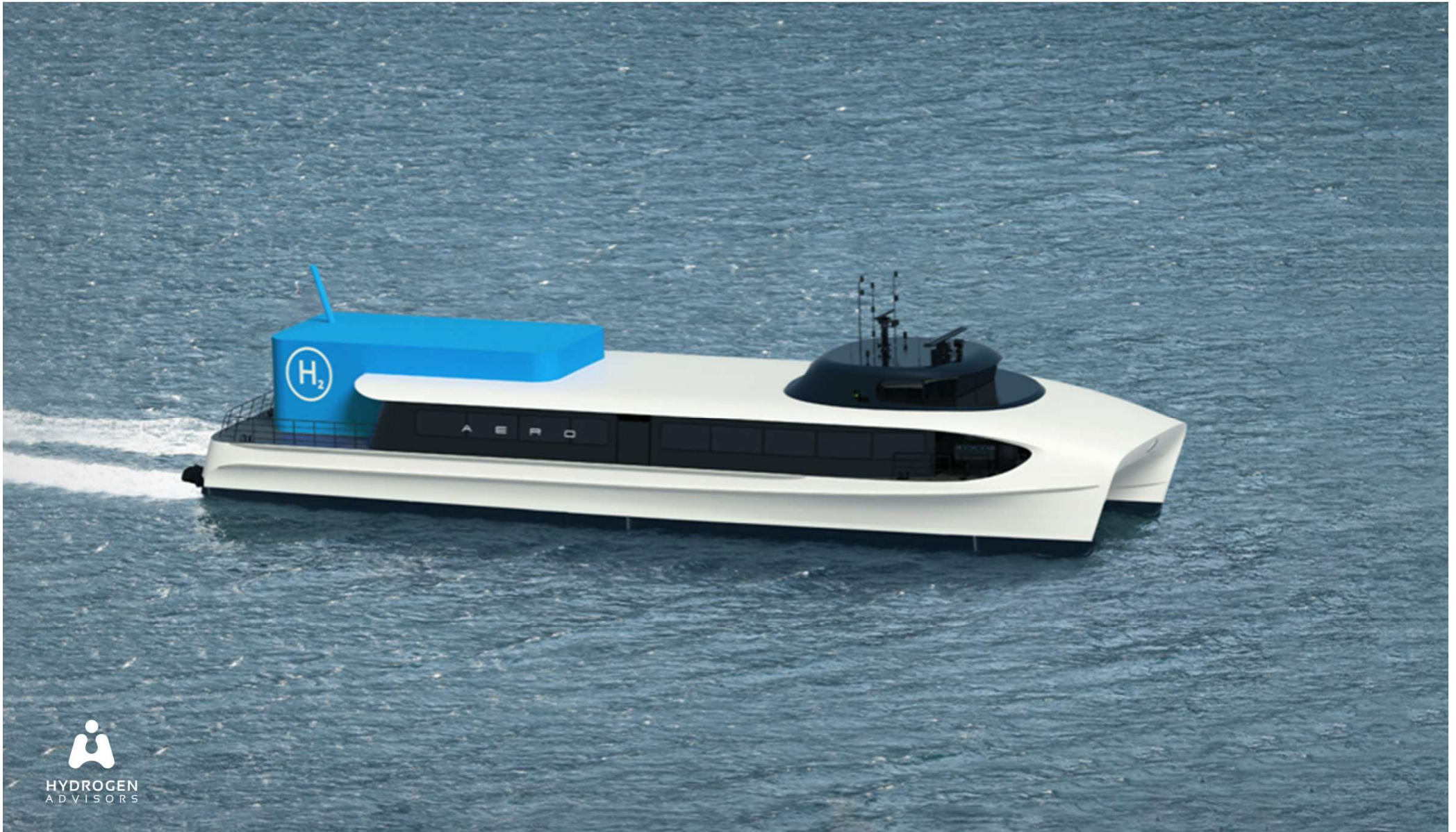


Bloomenergy®



SAMSUNG HEAVY INDUSTRIES

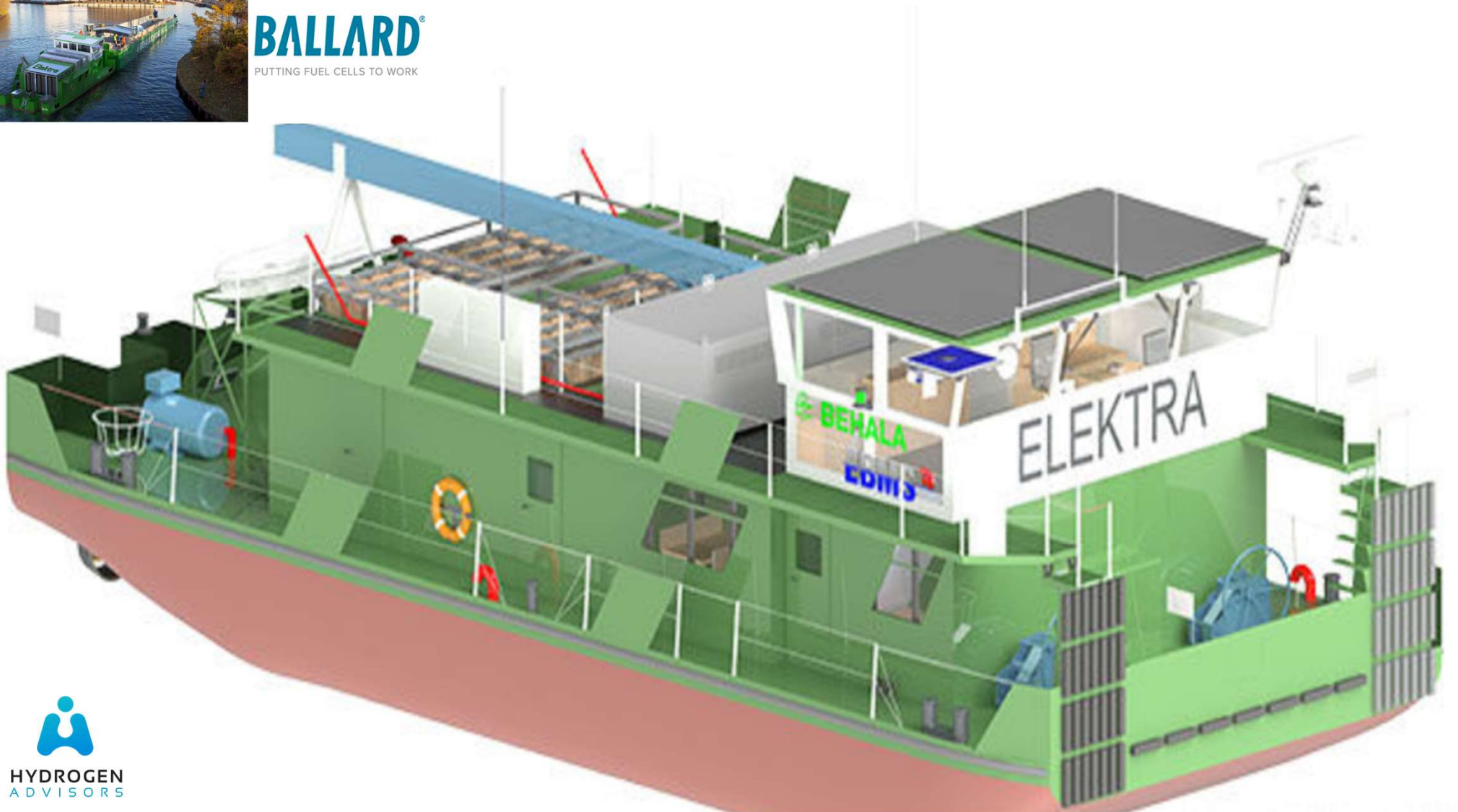
September 28th— Brodane presented the Aero hydrogen ferry concept that can reduce energy consumption by an additional 10%



October 3^d – Ballard received orders to equip with 3 x 100 kW fuel cells the first German hydrogen push boat



BALLARD
PUTTING FUEL CELLS TO WORK



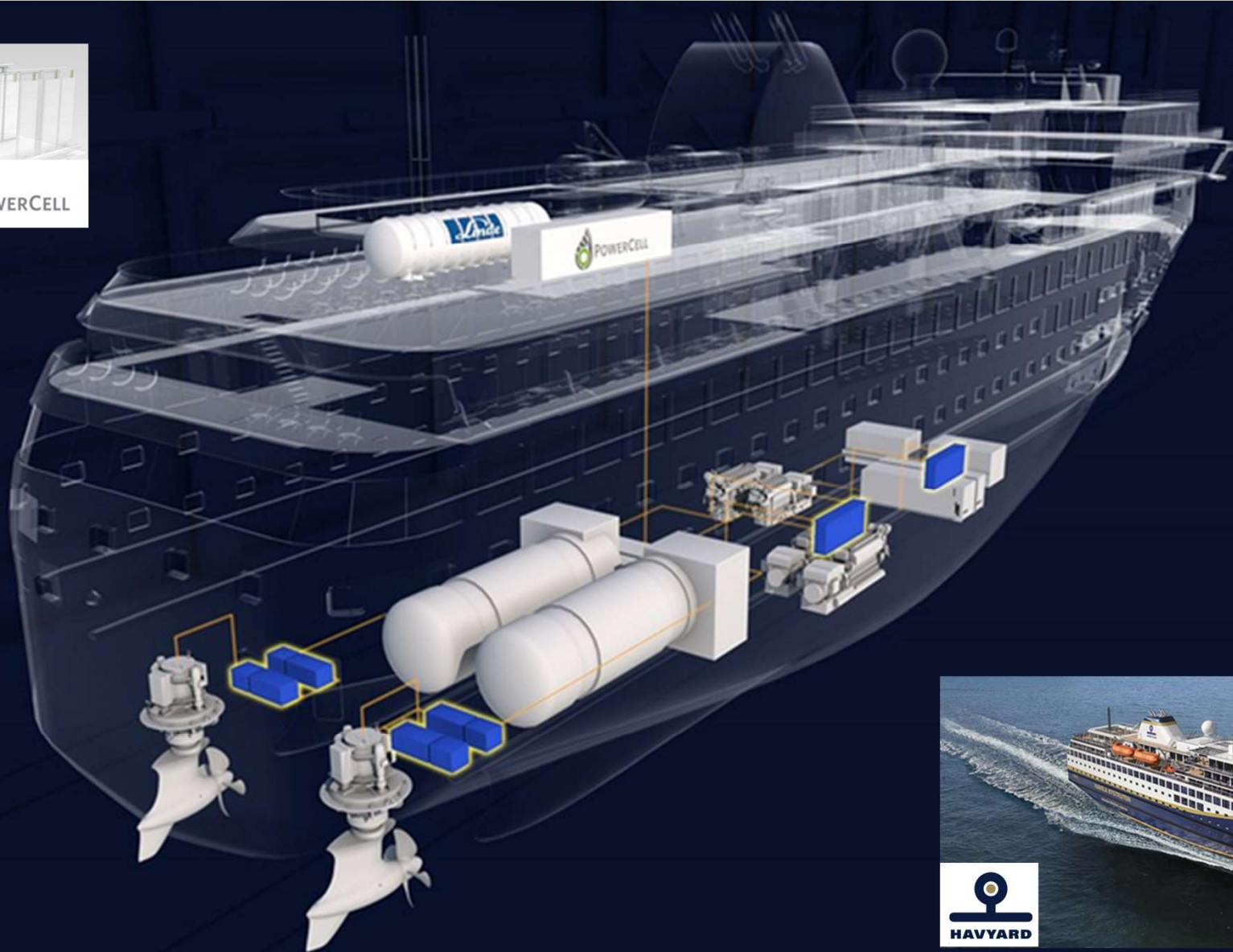
October 15th – Carnival Corp., world leader in leisure travel at sea announced it will be the first in 2021 to operate a cruise ship equipped with hydrogen fuel cell technology



Nov 1st – Helion Hydrogen Power to work in France on the project Hybarge to develop a silent and emissions free propulsion solution for river based applications



Nov 4th – Havyard and Powercell will collaborate to develop up to 3.2 MW hydrogen-based propulsion system for maritime applications (based on 200 kW fuel cell modules)



Nov 18th – Ulstein unveiled design developed in cooperation with Nedstack for maritime construction vessel that could be put to market within three years



December 2^d – Fincantieri placed an order for a 38 kWh hydrogen fuel cell from Proton Motors to power hydrogen ship pilot project



December 29th – Toshiba will deliver a 30 kW fuel cell systems for ships (derived from its stationary systems offer, and that is also intended to be provided to trains and trucks)



December 29th – SAL Heavy Lift to become world first to equip vessels with new hydrogen / methanol injection technology to reduce emissions of traditional engines



Planes



May 30th – Akai Technologies launched the world's first hydrogen powered air transport system powered by Hydrogenics



June 18th - TU delft students team unveiled hydrogen fuel cell based glider



September 21st – Test flight in Orkney (UK) of a hydrogen fuel cell powered piper plane



Other



Feb 10th – South African Post Office using hydrogen fuel cell scooters to deliver mail

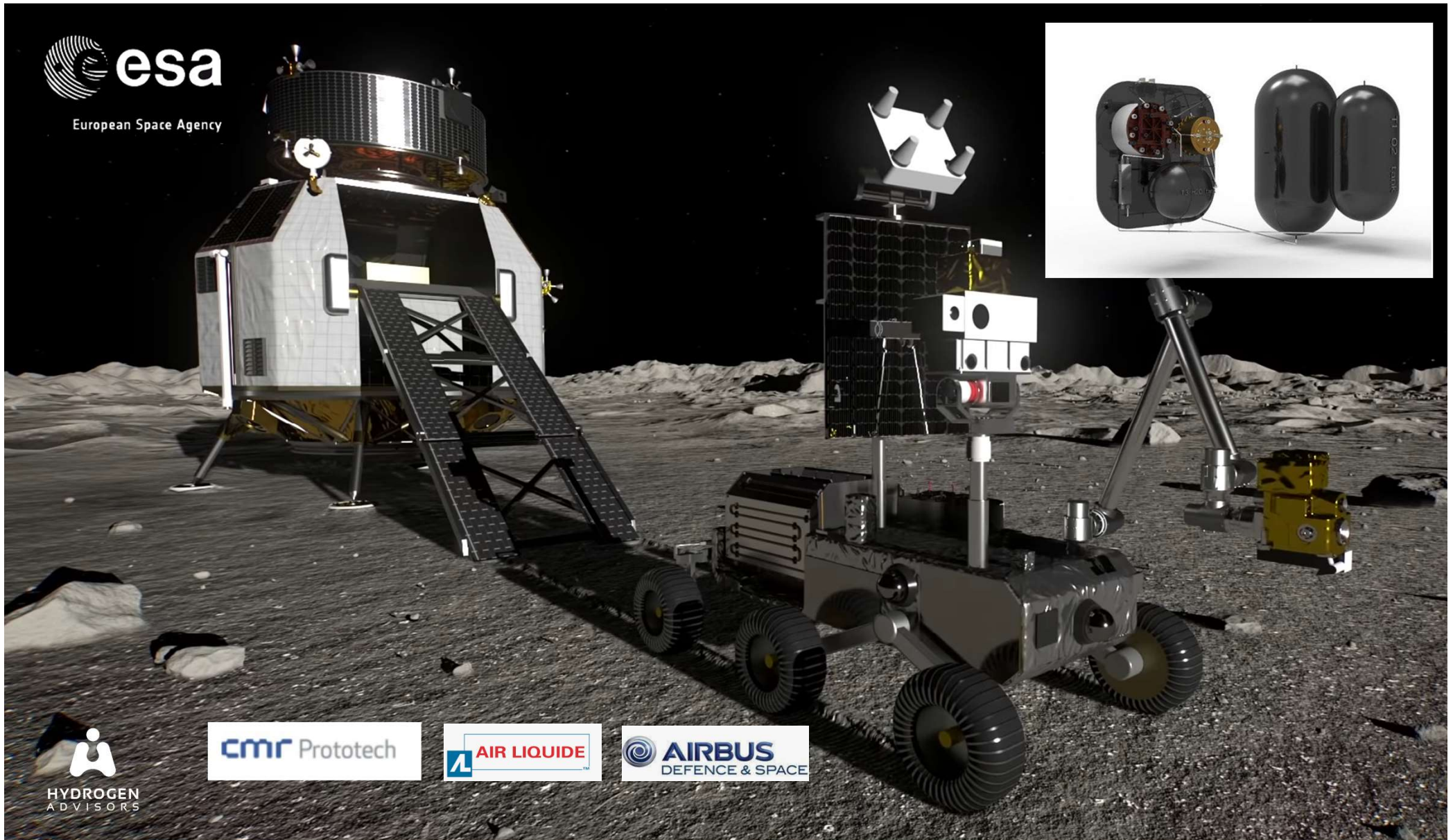


March 14th – The Japan Aerospace Exploration Agency (JAXA) and Toyota teamed up on the fuel cell powered “Moon Rover”



HYDROGEN
ADVISORS

December 1st – Prototech to develop with support of Air Liquide and Airbus Defence a solar hydrogen based closed loop system to power ESA Heracles mission to the moon in 2026



December 18th – Taiwanese United Renewable Energy (URE) launched a hydrogen scooter with 120 km range and the equivalent of a 125 cc fossil fuel motorbike



Alliances and Finance



Jan 24th – Air Liquide made a strategic 18 Meuros investment in Hydrogenics to support the production of decarbonated hydrogen by electrolysis



March 19th – Toyota unveiled plans to build USD 7.4 million hydrogen centre in Australia



April 21st – Toyota and Tsinghua University set up a research institute in China to study hydrogen



April 25th – Air Liquide and Houpu created a Joint Venture to develop a hydrogen distribution infrastructure in China



May 15th – Hydrogen Europe and Waterborne Technology Platform signed a cooperation MoU



June 26th - Hyundai and Aramco signed a cooperation on hydrogen



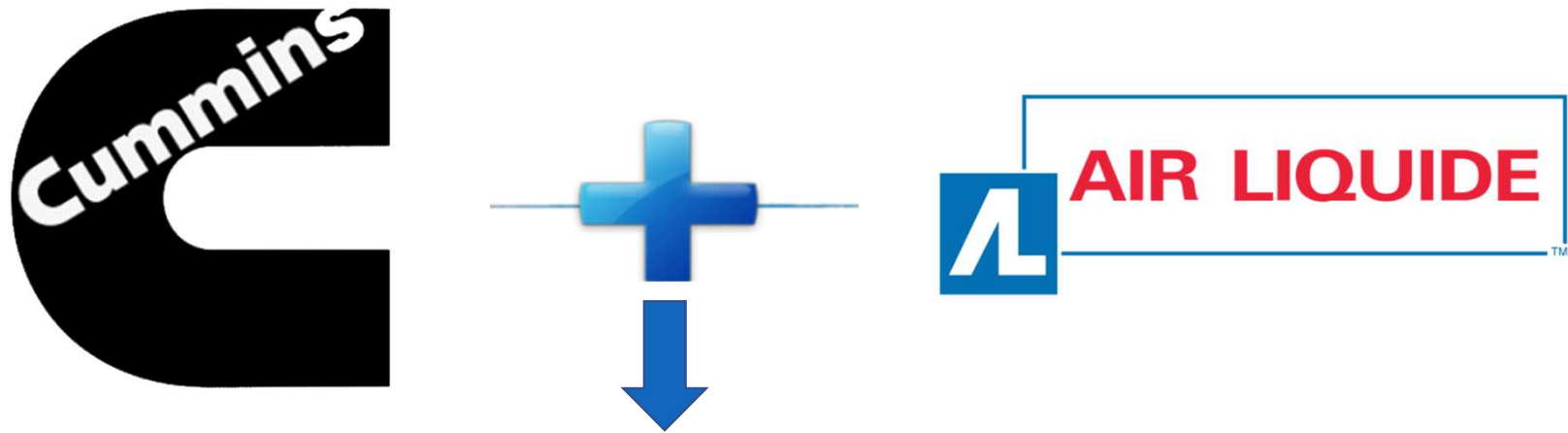
September 3th – CNH / Iveco will invest USD 250 million in Nikola Motor Company, 100 in cash and 150 in services and companies will develop Nikola Tre together



September 5th – Bosh and Hanwha have both invested over USD 100 million in Nikola Motor Company, totaling together USD 230 million of investment



September 9th – Cummins completed 81% share acquisition of Hydrogenics next to Air Liquide with 19% and a company valuation of USD 290 million



HYDROG(E)NICS
SHIFT POWER | ENERGIZE YOUR WORLD

September 27th – Hyundai and Cummins to cooperate on hydrogen fuel cell technologies



September 30th – Sinopec partnered with China leading supplier of fuel cells systems Refire

The Refire logo consists of the word 'REFIRE' in a bold, blue, sans-serif font. The 'R' is light blue, while the 'E', 'F', 'I', 'R', and 'E' are dark blue. A small, stylized blue flame icon is positioned above the 'I'.

October 3^d – Linde invested 38 M€ into ITM Power and signed a 50%/50% JV partnership to develop large hydrogen projects above 10 MW



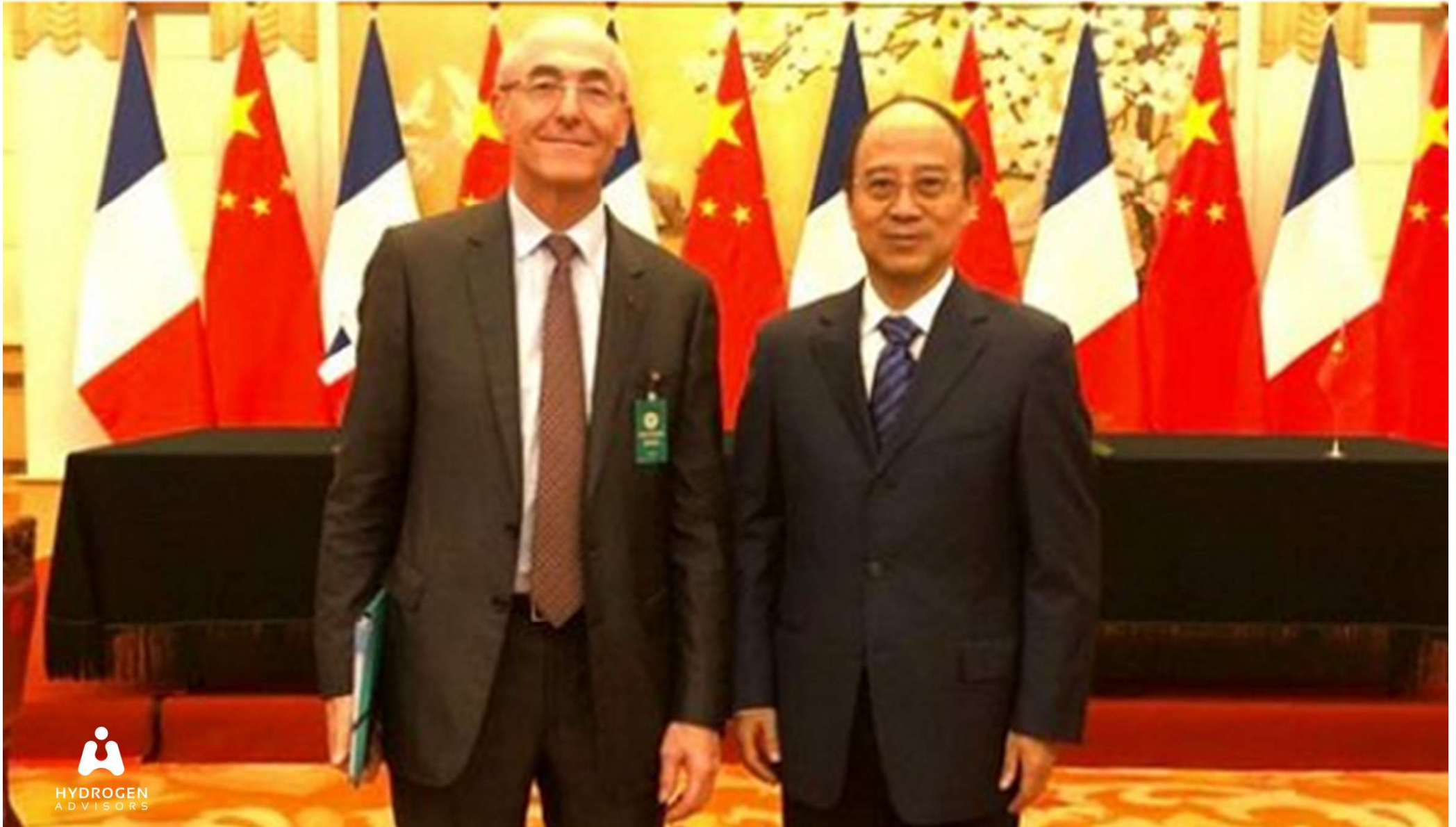
October 11th – EU Automobile Manufacturers' Association (ACEA), Hydrogen Europe and the International Road Transport Union (IRU) called for a ramp up of investment in H₂ infrastructures



European
Automobile
Manufacturers
Association



Nov 6th – Air Liquide and Sinopec signed a global partnership to promote the development of hydrogen based mobility in China



November 23^d – Bosh acquired 11% of Swedish Powercell Fuel Cell Providers following earlier announcement in spring 2019 that the two companies will cooperate on fuel cells



December 5th – The European Investment Bank and the Hydrogen Council signed an advisory agreement to address climate change with increased investment in hydrogen





HYDROGEN
ADVISORS