



**HYDROGEN**  
A D V I S O R S

# Hydrogen in 2019

A review of some of the major developments

Prepared for you by Raphael Schoentgen



2020

— HAPPY NEW YEAR —



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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 H<sub>2</sub> production for mobility, next to offshore wind conversion to H<sub>2</sub> massive projects, new electrolyser players appeared (small and large systems), while interest in natural H<sub>2</sub> also increased.
- Regarding H<sub>2</sub> transportation, both LOHC technology (hydrogen mixed in an organic liquid carrier) and LH<sub>2</sub> (liquefied hydrogen) progressed, while pipeline projects and underground storage projects increased. The world first LH<sub>2</sub> ship was also put to sea in Japan just before Christmas.
- Regarding H<sub>2</sub> filling stations, one can notice that Saudi Arabia opened its first one, Poland & Italy showed new developments, and independent H<sub>2</sub> 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 H<sub>2</sub> refrigerated trailers and H<sub>2</sub> garbage trucks came to the market. Finally the first H<sub>2</sub> 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, H<sub>2</sub> 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, H<sub>2</sub> 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 H<sub>2</sub> based glider and a H<sub>2</sub> 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 H<sub>2</sub> solutions. Finally, the Hydrogen Council partnered with the European Investment Bank to push H<sub>2</sub> 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 7<sup>th</sup> – Korean Announces Roadmap to Become the World Leader in the Hydrogen Economy

# Korean HYDROGEN Road Map



Jan 21<sup>th</sup> – 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 21<sup>th</sup> – Air Liquide, Khalifa University and Toyota released a study on H<sub>2</sub> mobility in the UAE



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



Feb 11<sup>th</sup> – Launch of Certify, the Green Certificates for Hydrogen in Europe



April 2<sup>d</sup> – Merkel: We need to switch to electric or hydrogen-powered fuel-cell cars



May 3<sup>d</sup> – 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<sup>d</sup> – the Occitanie Region in France launched a green hydrogen plan of Euro 150 million



May 29<sup>th</sup> - 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**



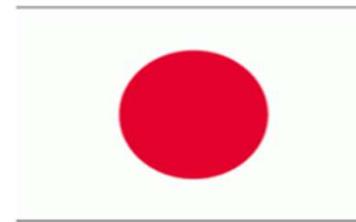
Canada



European Commission



India



Japan



Korea



New Zealand - Observer



Norway



Saudi Arabia



United States

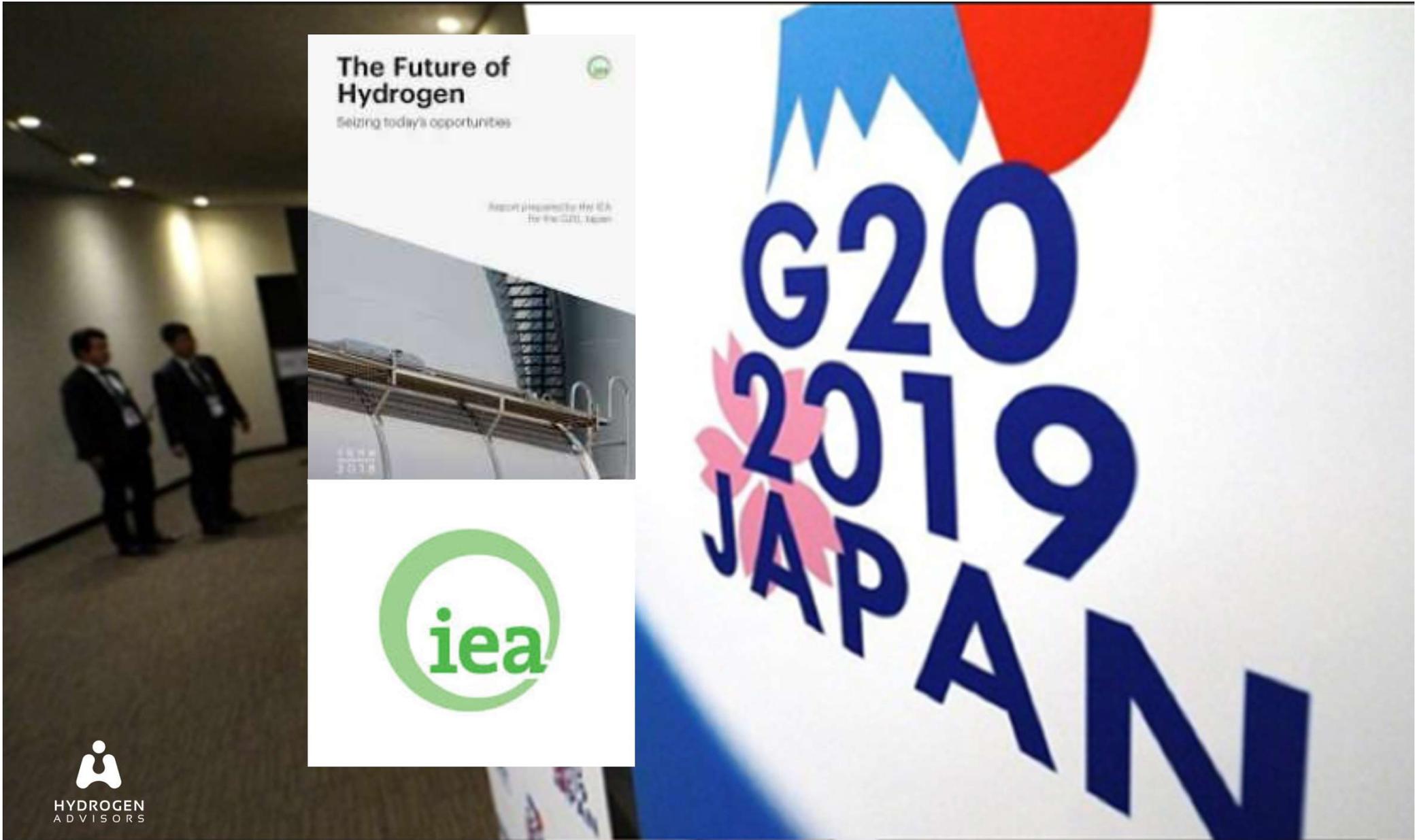


Netherlands

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



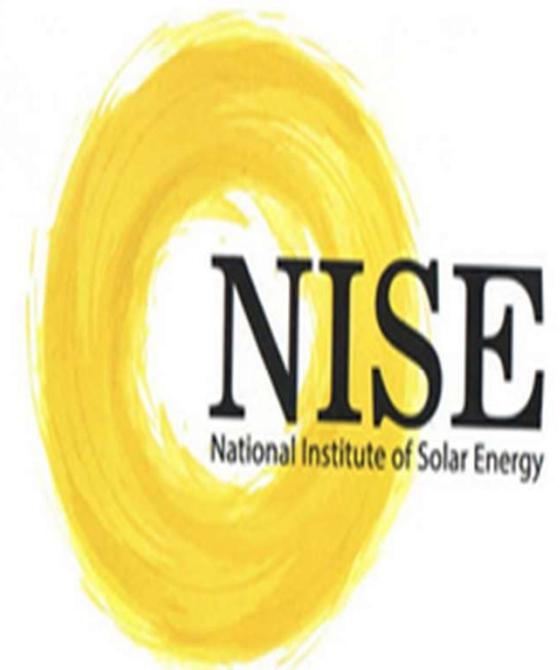
June 26<sup>th</sup> - Hydrogen took the centre stage at the Osaka G20 meeting, while the IEA produced a report stating that hydrogen could be the future LNG



July 16<sup>th</sup> – Korea and Israel signed a cooperation agreement on hydrogen



August 30<sup>th</sup> – 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 5<sup>th</sup> – Federal Minister of Economics Peter Altmaier and Dutch counterpart Eric Wiebes agreed to Cooperate on the Hydrogen Economy during a Germany-Netherlands Summit



October 9<sup>th</sup> – 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 11<sup>th</sup> – 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 5<sup>th</sup> - “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 20<sup>th</sup> – The World Energy Council launched a global hydrogen charter to align global efforts for the development of a low carbon hydrogen economy



## Hydrogen global



25<sup>th</sup> 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



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November 25<sup>th</sup> - 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<sup>d</sup> – 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



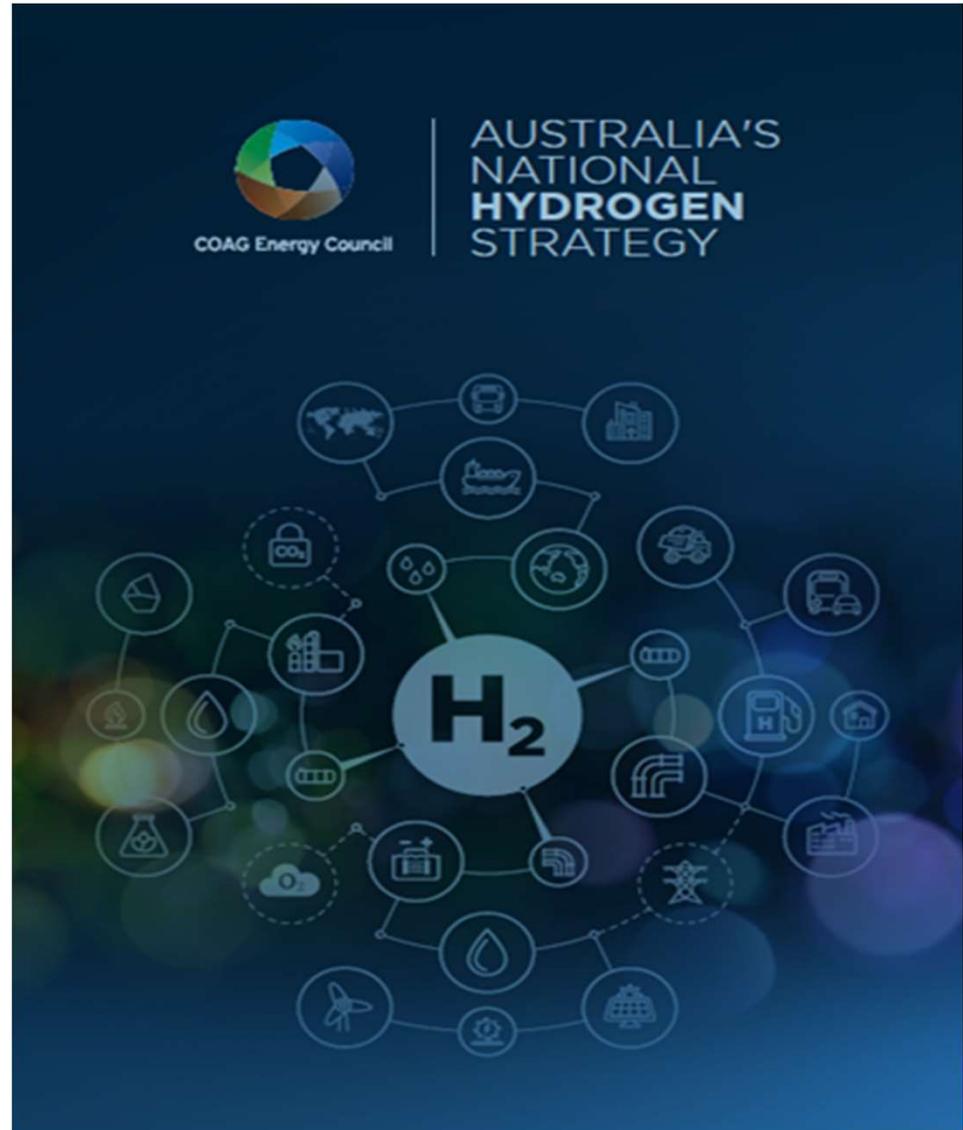
November 23<sup>d</sup> – the Australian State and federal energy ministers formally approved the National Hydrogen Strategy prepared by Chief Scientist Alan Finkel



**Australian Government**



**COAG  
Energy Council**



December 6<sup>th</sup> – Hyundai started a feasibility study for hydrogen based mobility in India



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# Industry



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



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



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



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



# Energy



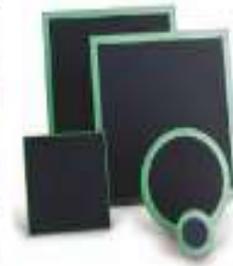
Feb 1<sup>st</sup> – H2U and Baker Hughes (GE group) announced a collaboration to deploy 100% hydrogen-fired gas turbines at Port Lincoln, South Australia



Feb 1<sup>st</sup> – Umicore will expand its production capacity for fuel cell catalysts



Feb 12<sup>th</sup> – 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 8<sup>th</sup> – South Korea: 200 MW Hydrogen Fuel Cell Power Plant to be built in Gyeongju



April 2<sup>d</sup> – EDF to launch a dedicated company active in the field of hydrogen - Hynamics



**hynamics**  
GROUPE **edf**

April 28<sup>th</sup> – 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 25<sup>th</sup> – £ 110 million to test hydrogen in 550 homes in Aberdeen

Aberdeen



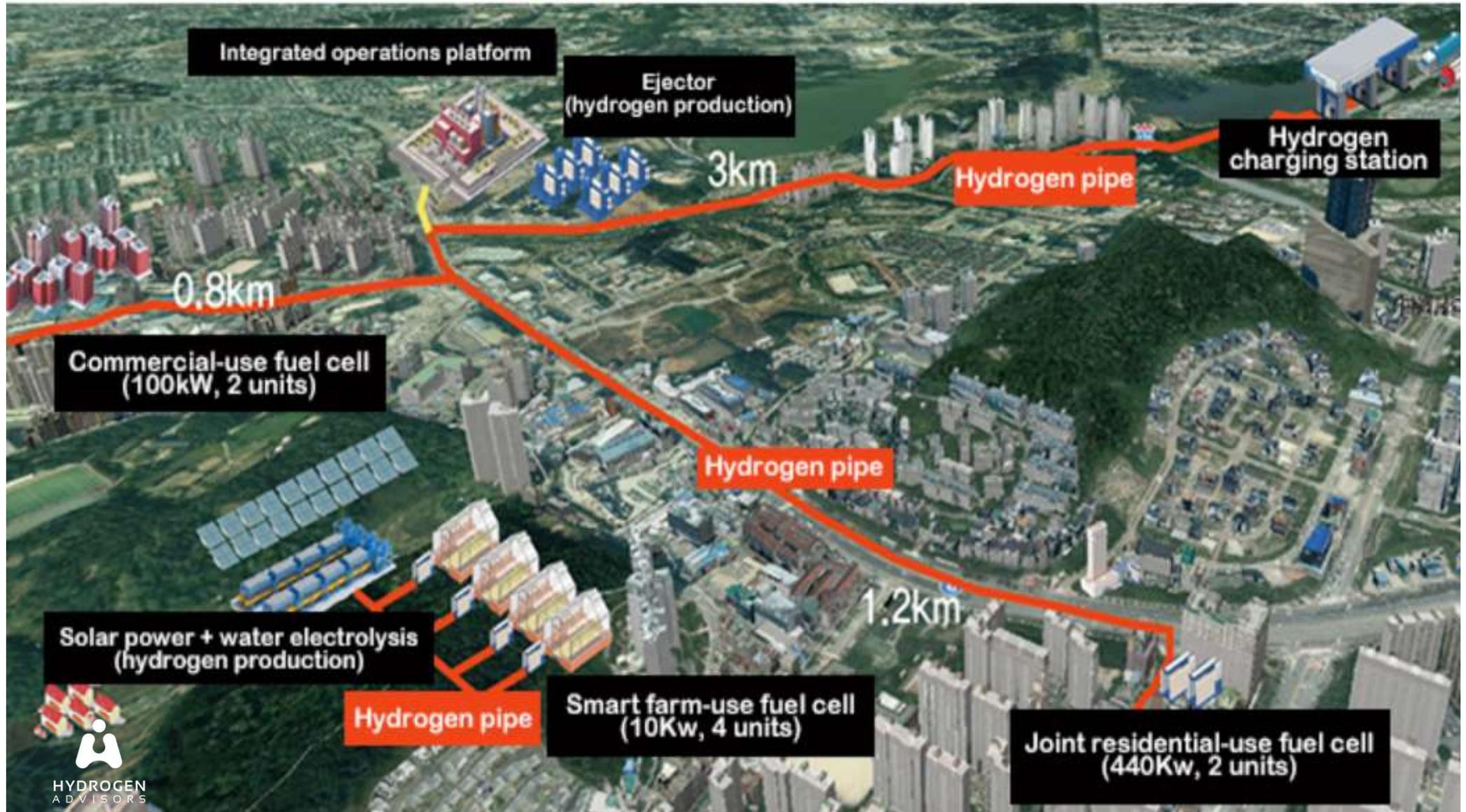
October 9<sup>th</sup> – the world’s largest indoor fuel cell (20 MW) will be deployed for Stanley Black & Decker USD 1 billion new data hub in New Britain, Connecticut USA



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

# Hydrogen city plan

\*Based on 6 square kilometer area



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



equinor



Nov 30<sup>th</sup> – 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 5<sup>th</sup> – 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 7<sup>th</sup> – 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 10<sup>th</sup> – 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



**BALLARD**<sup>®</sup>  
PUTTING FUEL CELLS TO WORK



**HDF**  
INDUSTRY

**HYDROGEN**  
ENERGY



December 20<sup>th</sup> – 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



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# Hydrogen production



Jan 7<sup>th</sup> – Air Products to build second liquid hydrogen production facility in California



Feb 11<sup>th</sup> – Amprion and OGE push ahead with 100 MW electrolyzer hydrogen plant



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



March 14<sup>th</sup> – Ørsted will establish green hydrogen from Dutch offshore wind farms



March 26<sup>th</sup> – launch of a gigawatt alliance in the Netherlands around hydrogen



October 3<sup>d</sup> – Tractebel Engineering develops a new hydrogen offshore platform



November 22<sup>d</sup> – 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 15<sup>th</sup> – First LHOC project to go to scale in China (Euro 300 million investment)



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



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



April 30<sup>th</sup> – 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 1<sup>st</sup> – Hypos Consortium launched in Germany to develop R&D in hydrogen underground gas storage systems



July 31<sup>th</sup> – Vopak, Mitsubishi Ventures, Covestor and AP Ventures invest in Hydrogenious LOHC hydrogen transport solution



October 11<sup>th</sup> – 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 H<sub>2</sub> in gas transmission grid



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



December 11<sup>th</sup> – World first LH<sub>2</sub> carrier is put to sea in Japan by Kawasaki and will rotate first between Australia and Japan



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



# Filling stations



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



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



**Auvergne  
Rhône-Alpes**

May 6<sup>th</sup> – France: 11 hydrogen mobility projects selected for public funding



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MINISTÈRE  
DE LA TRANSITION  
ÉCOLOGIQUE  
ET SOLIDAIRE

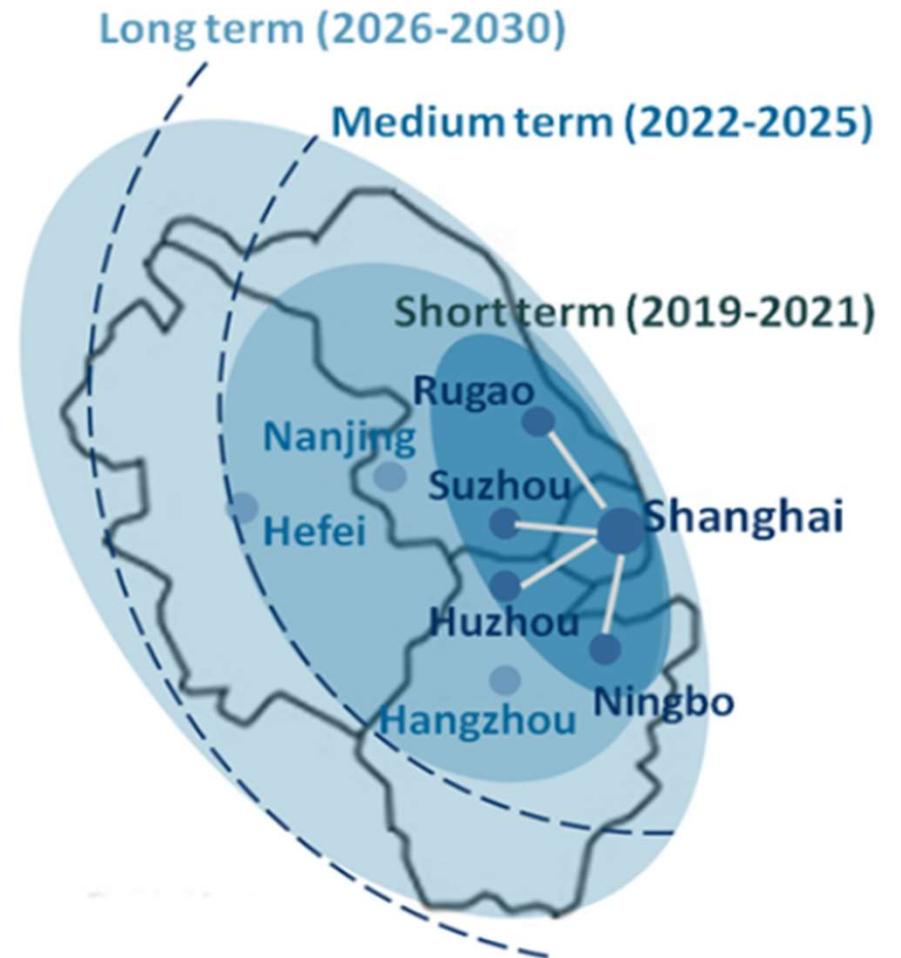


**ADEME**



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

May 24<sup>th</sup> – 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<sup>d</sup> - Toyota and Eni announced a collaboration to speed up the development of hydrogen stations and cars in Italy



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



August 29<sup>th</sup> – Linde took 10% in Swiss Hydrogen that will produce hydrogen from hydropower to deploy an H<sub>2</sub> filling stations network for 1600 hydrogen trucks to be delivered by Hyundai



December 16<sup>th</sup> – 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 16<sup>th</sup> – Orlen will start construction of hydrogen filling stations in Poland in 2021



December 23<sup>th</sup> – 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



# Cars



Feb 26<sup>th</sup> – 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



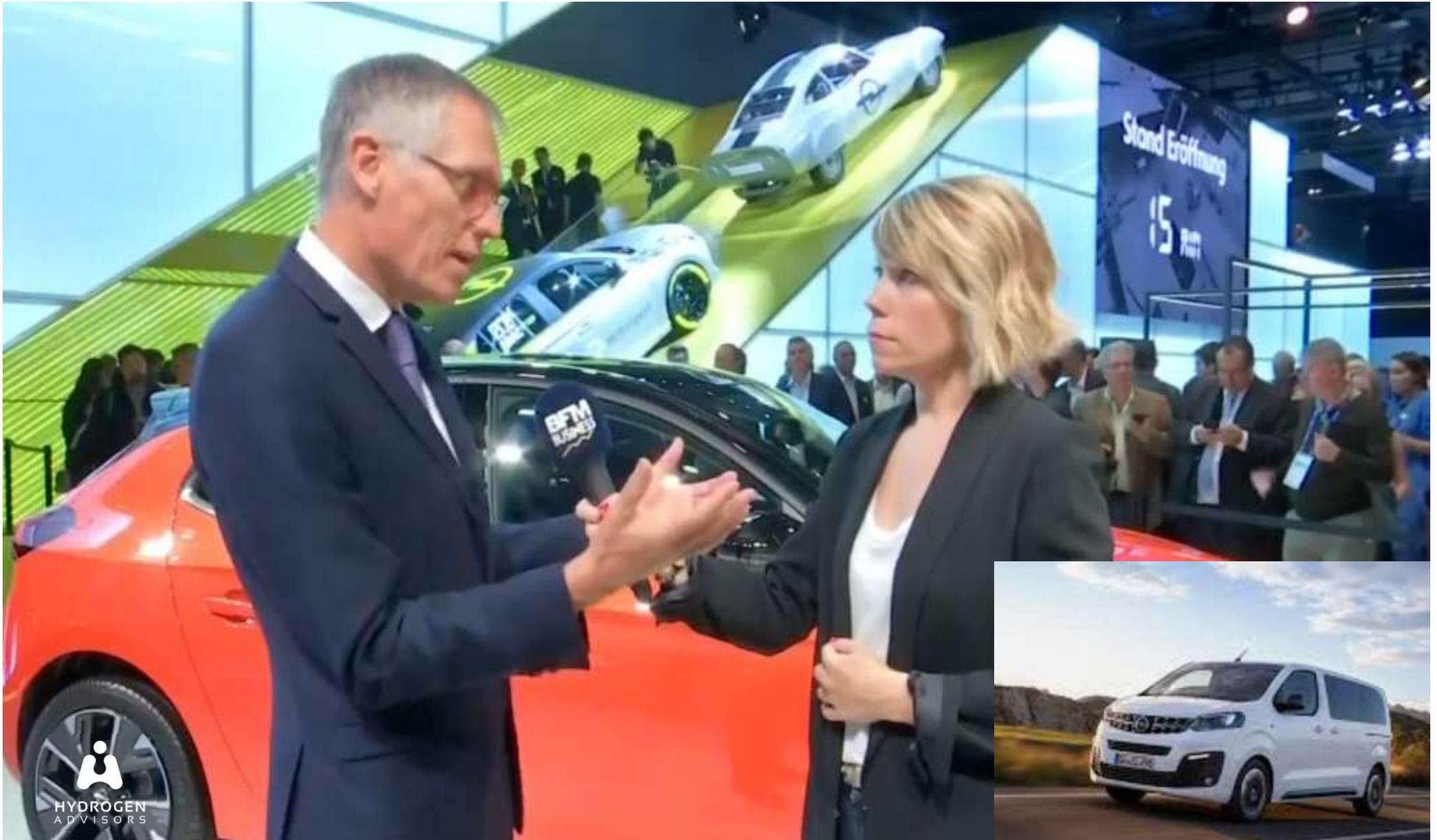
April 26<sup>th</sup> – Pininfarina and Grove set up a partnership to develop a premium H<sub>2</sub> car for China



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



Sep 14<sup>th</sup> – 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 10<sup>th</sup> – the new Toyota Mirai (Mirai 2) hydrogen car design was revealed



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



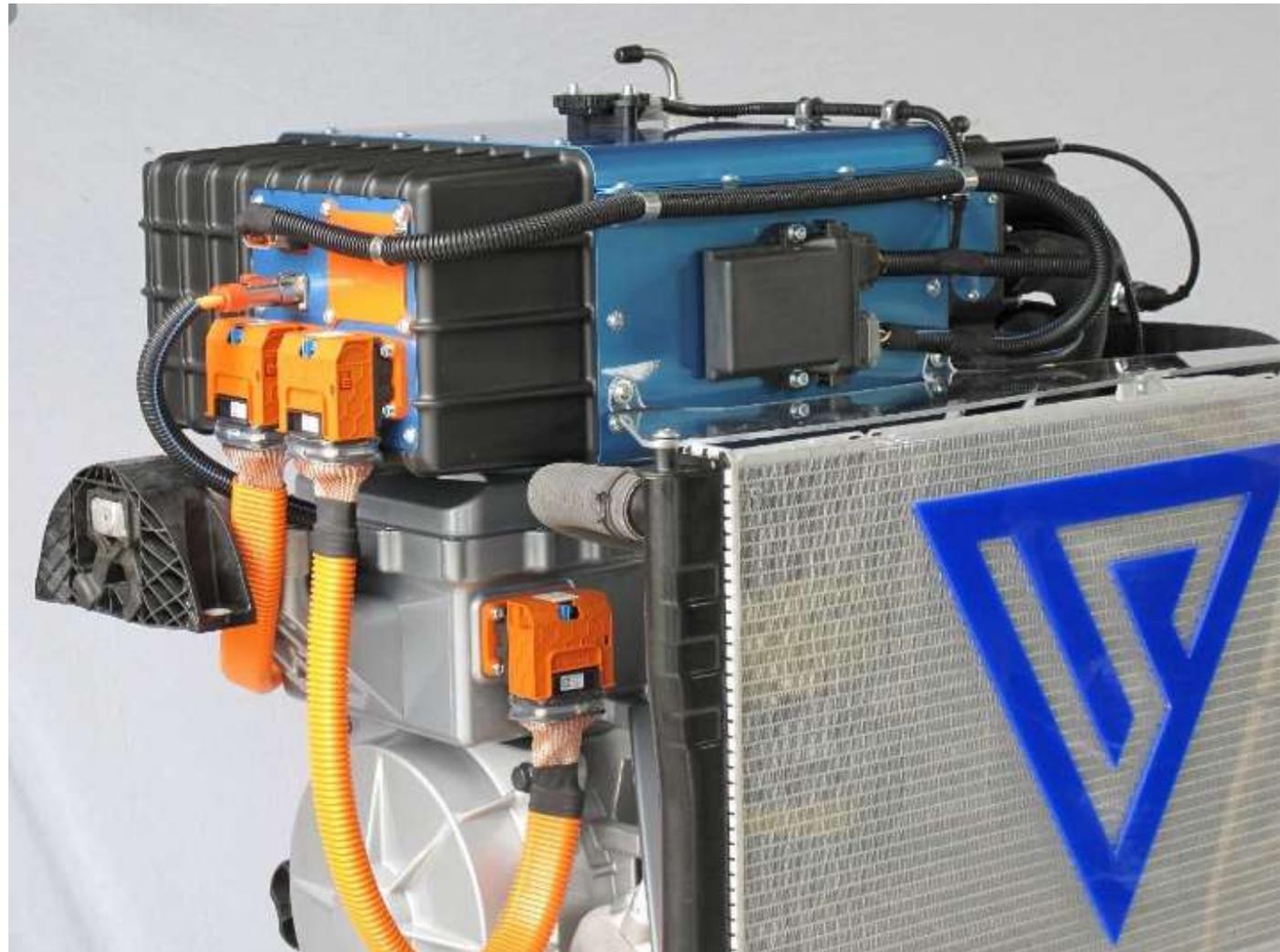
October 24<sup>th</sup> – Great Wall announced it is ready for mass production of hydrogen fuel cell cars



Nov 29<sup>th</sup> – 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 29<sup>th</sup> – Symbio, a JV between Michelin and Faurecia, announced the establishment of the largest European fuel cell plant in Europe in Lyon



# Logistics



Jan 2<sup>d</sup>– Port of Valencia first port in EU to integrate hydrogen in its operations



  
valenciaport  
Autoridad Portuaria de Valencia

  
H<sub>2</sub>  
PORTS



  
HYDROGEN  
ADVISORS

Nov 29<sup>th</sup> – Terberg new generation of yard tractors will integrate hydrogen fuel cells



December 18<sup>th</sup> – Nuvera breaks ground on automated fuel cell plant in China



# Buses



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

# BALLARD®

PUTTING FUEL CELLS TO WORK



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



June 3<sup>d</sup> - H<sub>2</sub> 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



July 20<sup>th</sup> – Indian Ministry of Transport called for proposals for hydrogen fuel cell buses



August 28<sup>th</sup> – Hydrogen produced from biomass will power 50 buses in Strasbourg city



**CTs** **R-GDS** **HAFFNER**  
energy

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



Nov 20<sup>th</sup> – 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 26<sup>th</sup> – Paris public transport company RATP to test Portuguese Hydrogen Bus Caetano (developed with Toyota) and Polish Solaris Urbino Hydrogen Bus



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



# Trucks



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



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



September 25<sup>th</sup> – 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 26<sup>th</sup> – Hyundai, H2 Energy, Alpiq and Linde together in the development of hydrogen based heavy duty truck mobility in Switzerland



October 5<sup>th</sup> – 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 10<sup>th</sup> – ENGIE and Anglo American to partner in developing the world's largest mining truck running on hydrogen



October 28<sup>th</sup> – Cummins unveils an electric truck with 100 kW Li-Ion battery and 90 kW fuel cell bringing max range to 400 km. More FCs / H<sub>2</sub> components could be added to increase autonomy.



October 28<sup>th</sup> – Hyundai unveiled a new hydrogen based class 8 concept truck



Nov 22<sup>d</sup> – Anheuser Bush completed the first delivery of Budweiser beer with Nikola Hydrogen Fuel Cell Truck



December 23<sup>th</sup> – 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 7<sup>th</sup> – 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



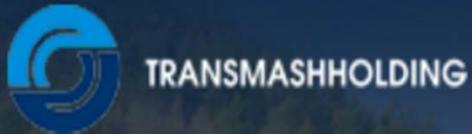
Jan 30<sup>th</sup> – Korea will develop a hydrogen fuel cell train



June 5<sup>th</sup> - Japan Railways will develop and test hydrogen trains



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



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



December 15<sup>th</sup> – 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**  

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**UNIVERSITY**

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



December 24<sup>th</sup> – 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 4<sup>th</sup> – Japan to start deploying first fishing boats with Toyota Fuel Cell



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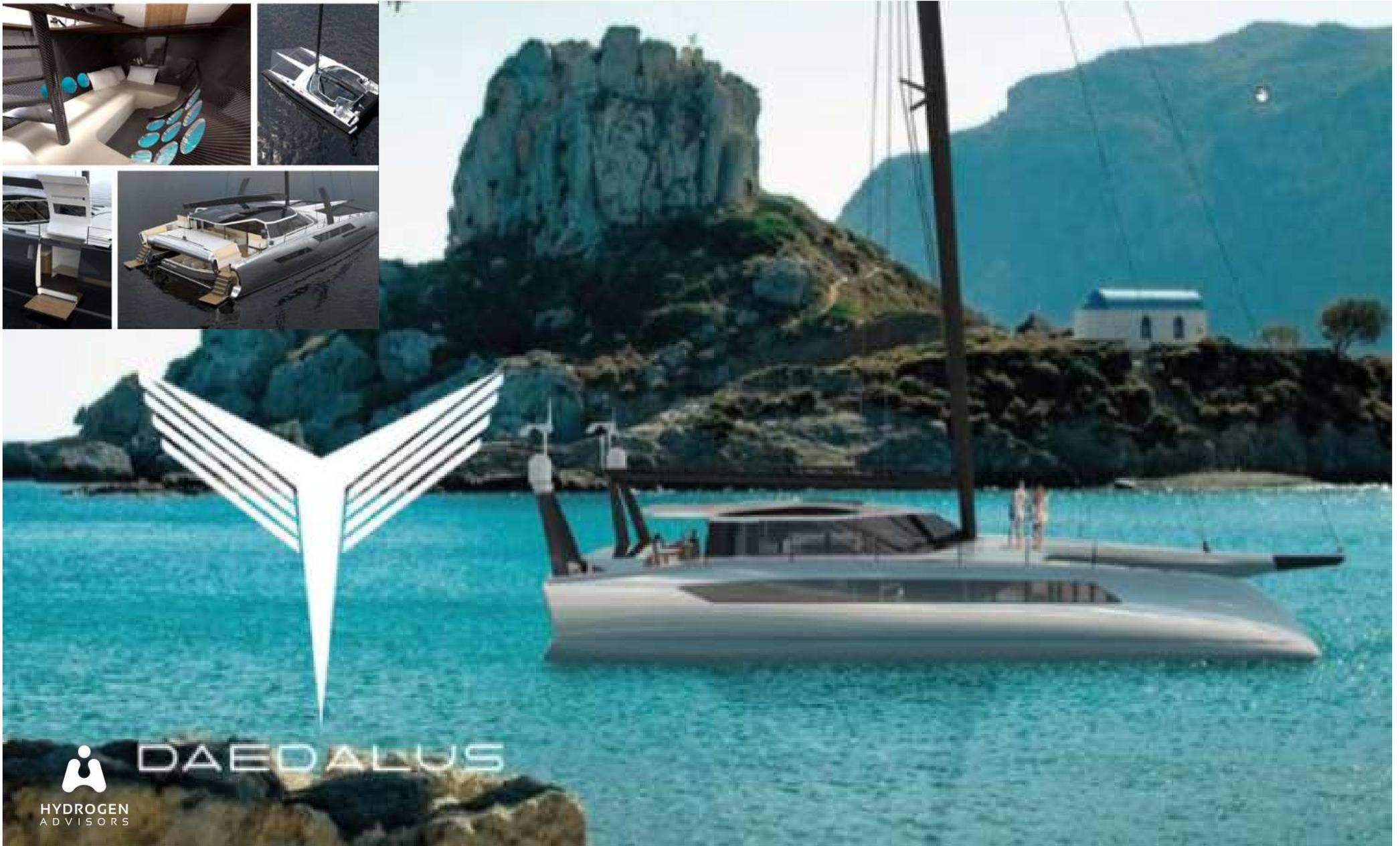
Jan 7<sup>th</sup> – Smaskip will develop a hydrogen-based sea shuttle container ship



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



Feb 13<sup>th</sup> – Daedalus presented a luxury catamaran with a hydrogen fuel cell heart



March 22<sup>d</sup> – GE and Nedstack partnership set sights on zero emission hydrogen fuel cell powered cruise vessels



GE Power



Nedstack

PEM FUEL CELLS



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April 2<sup>d</sup> – Ballard to establish a fuel cell center of excellence in Europe to serve the marine market

**BALLARD**<sup>®</sup>



**HYDROGEN  
ADVISORS**

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

**BALLARD**<sup>®</sup>



**HYDROGEN  
ADVISORS**

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

**ABB**



**FLAGSHIPS**



**BALLARD®**

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



**CMB**

**VATTENFALL**



**WINDCAT**  
WORKBOATS



**HYDROGEN**  
ADVISORS

September 21<sup>st</sup> – Aqua hydrogen powered yacht presented as the new way of yachting



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



# Bloomenergy®



**SAMSUNG HEAVY INDUSTRIES**

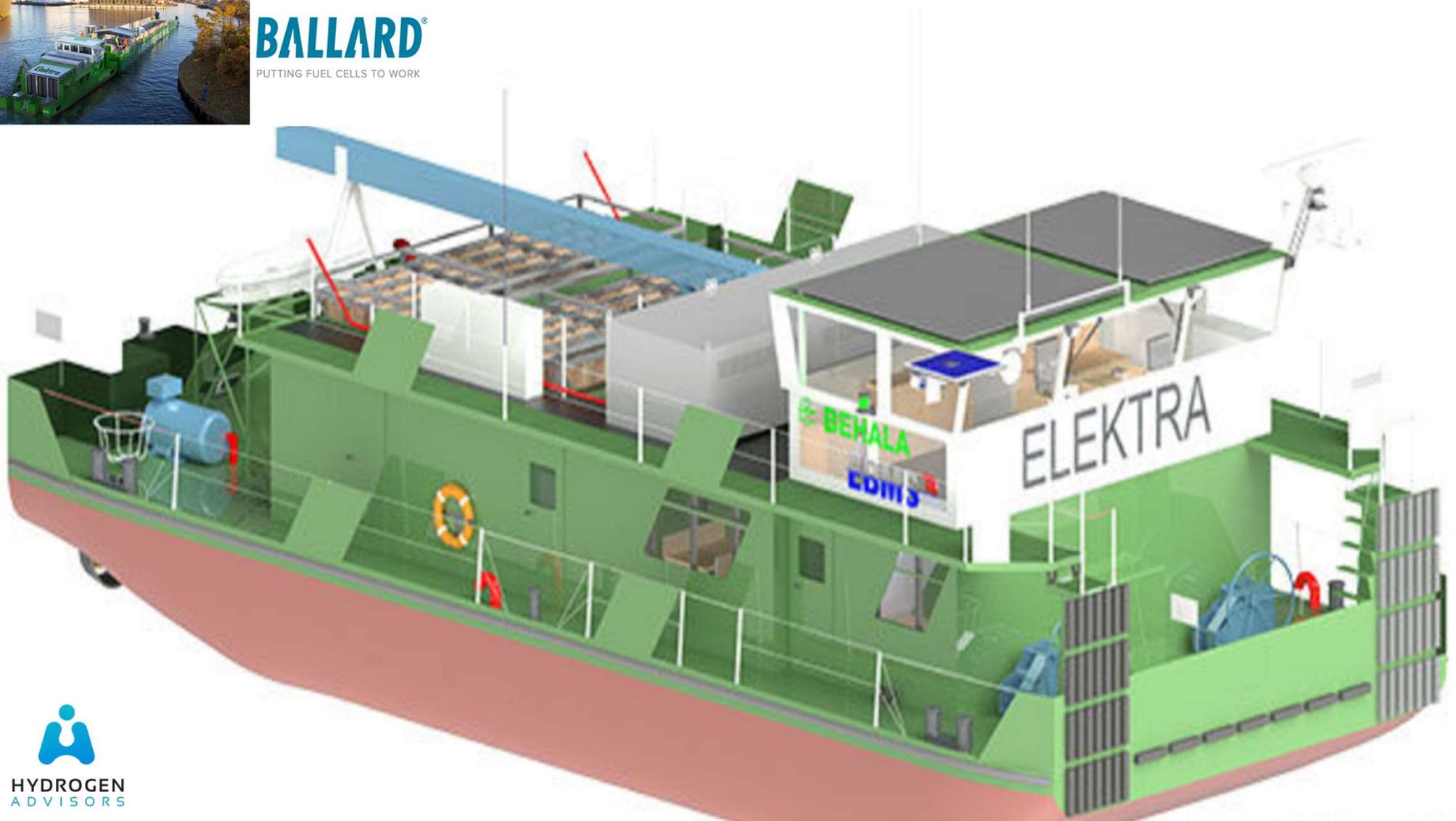
September 28<sup>th</sup>– Brodane presented the Aero hydrogen ferry concept that can reduce energy consumption by an additional 10%



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



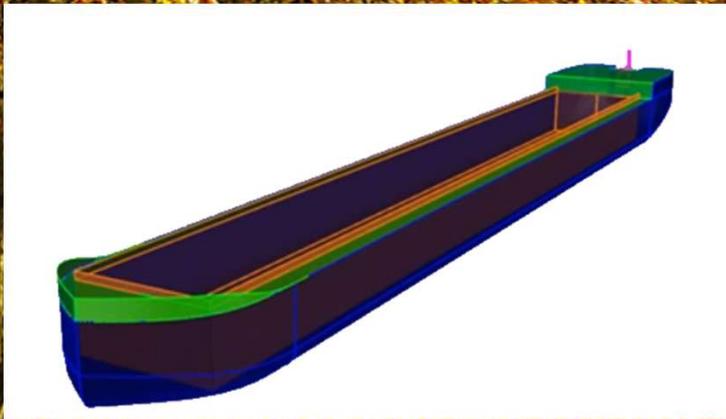
**BALLARD**<sup>®</sup>  
PUTTING FUEL CELLS TO WORK



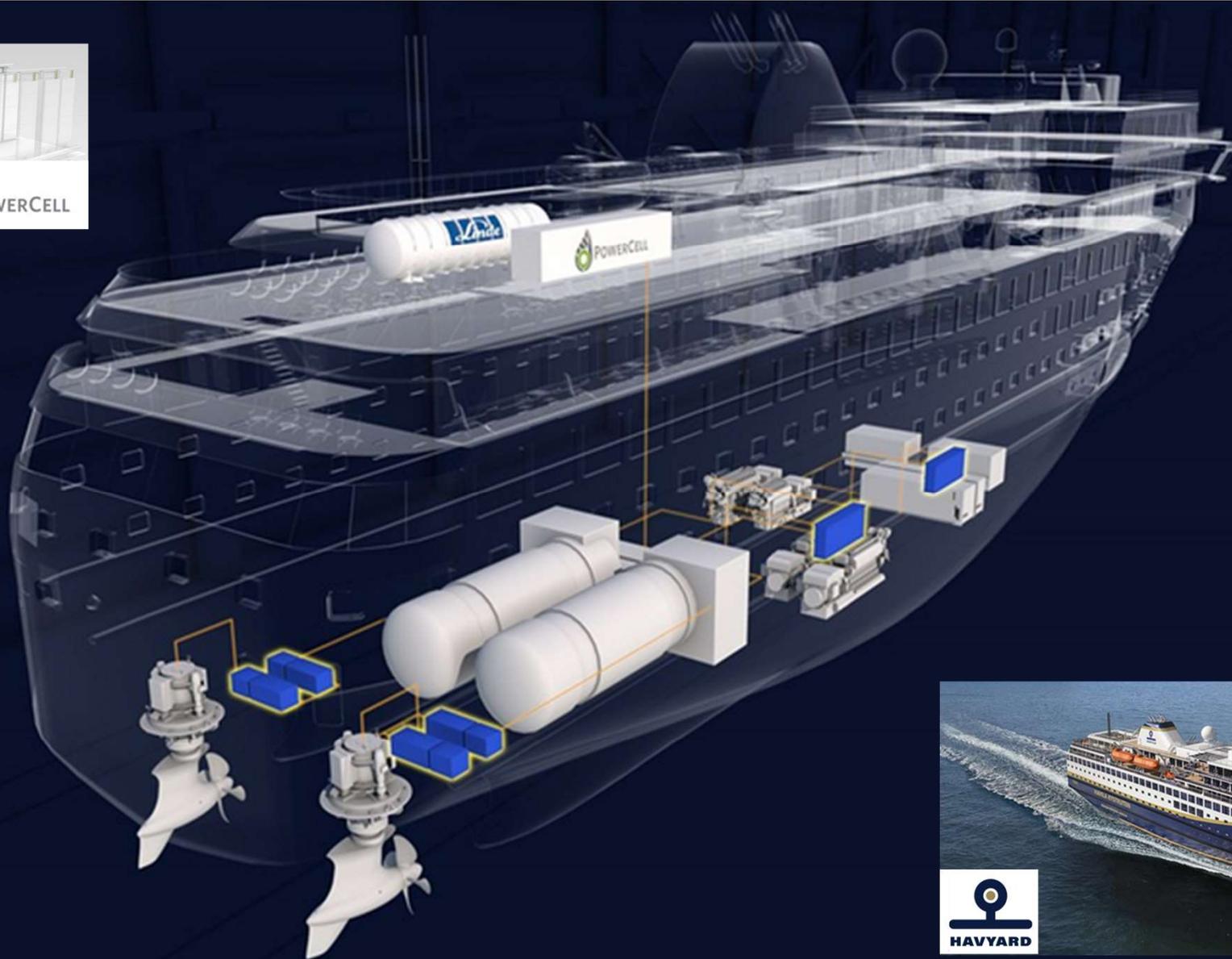
October 15<sup>th</sup> – Carnival Corp., world leader in leisure travel at sea announced it will be the first in 2021 to operate a cruise ship equipped with hydrogen fuel cell technology



Nov 1<sup>st</sup> – 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 4<sup>th</sup> – 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 18<sup>th</sup> – Ulstein unveiled design developed in cooperation with Nedstack for maritime construction vessel that could be put to market within three years



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



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



# Planes



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



June 18<sup>th</sup> - TU delft students team unveiled hydrogen fuel cell based glider



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



# Other



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

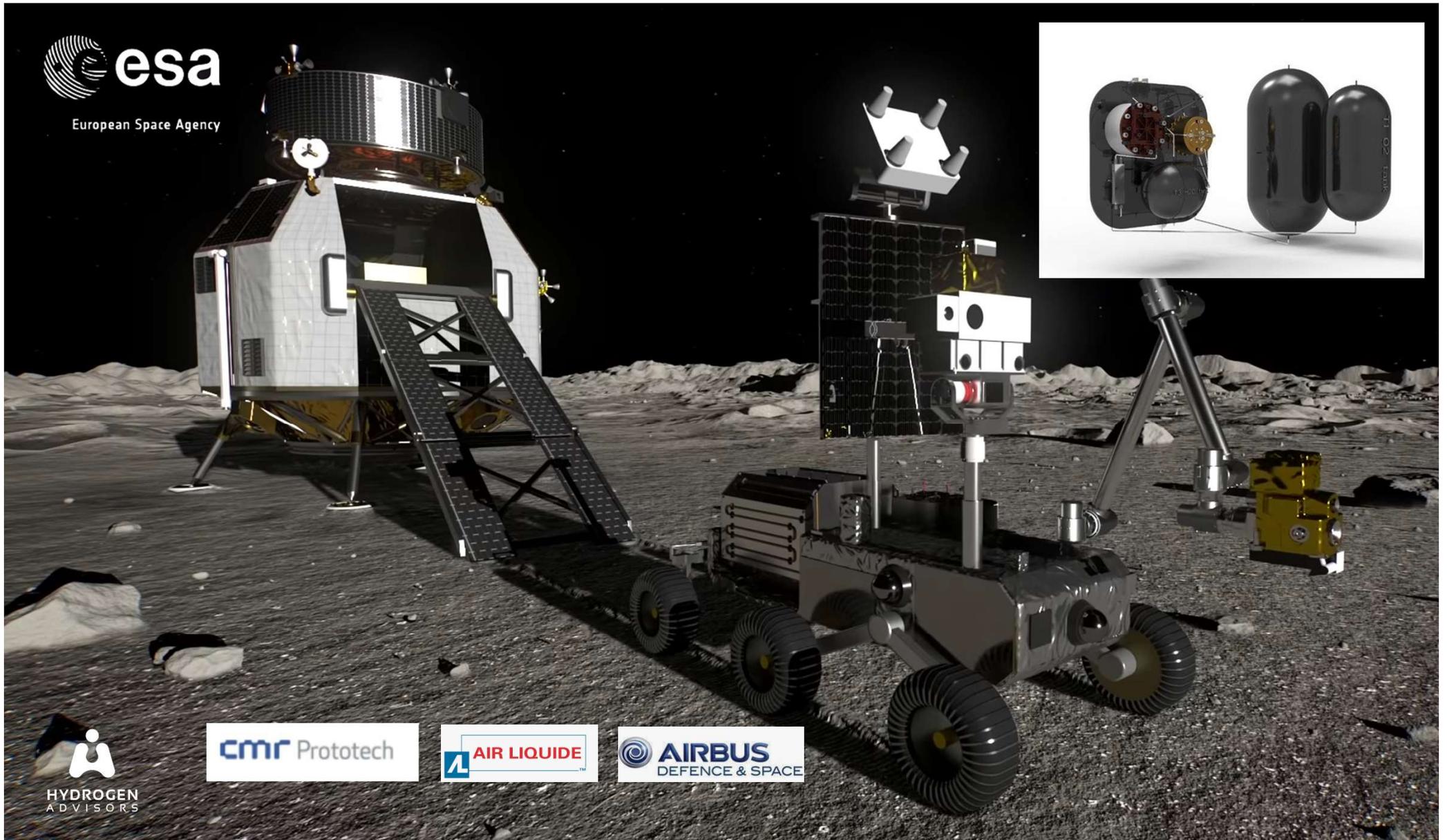


March 14<sup>th</sup> – The Japan Aerospace Exploration Agency (JAXA) and Toyota teamed up on the fuel cell powered “Moon Rover”

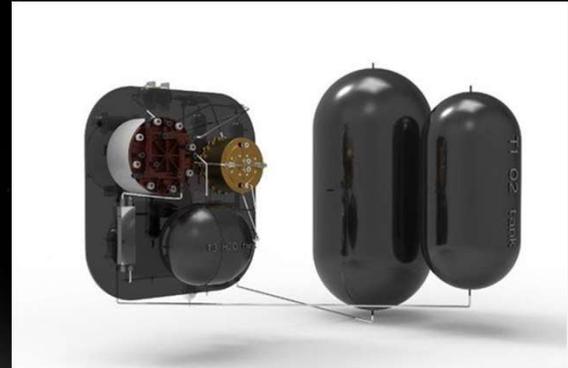


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December 1<sup>st</sup> – Prototech to develop with support of Air Liquide and Airbus Defence a solar hydrogen based closed loop system to power ESA Heracles mission to the moon in 2026



**esa**  
European Space Agency



**HYDROGEN  
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**cmr** Prototech

**AIR LIQUIDE**

**AIRBUS**  
DEFENCE & SPACE

December 18<sup>th</sup> – 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 24<sup>th</sup> – Air Liquide made a strategic 18 Meuros investment in Hydrogenics to support the production of decarbonated hydrogen by electrolysis



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



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



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



May 15<sup>th</sup> – Hydrogen Europe and Waterborne Technology Platform signed a cooperation MoU



June 26<sup>th</sup> - Hyundai and Aramco signed a cooperation on hydrogen

# Saudi Aramco and Hyundai Motor Company

June 2019

Seoul, Korea



Eui sun Chung

Executive Vice Chairman  
Hyundai Motor

Amin Nasser

President and Chief Executive Officer  
Saudi Aramco

September 3<sup>th</sup> – 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 5<sup>th</sup> – Bosh and Hanwha have both invested over USD 100 million in Nikola Motor Company, totaling together USD 230 million of investment



**NIKOLA**<sup>TM</sup>  
MOTOR COMPANY



**BOSCH**

Invented for life

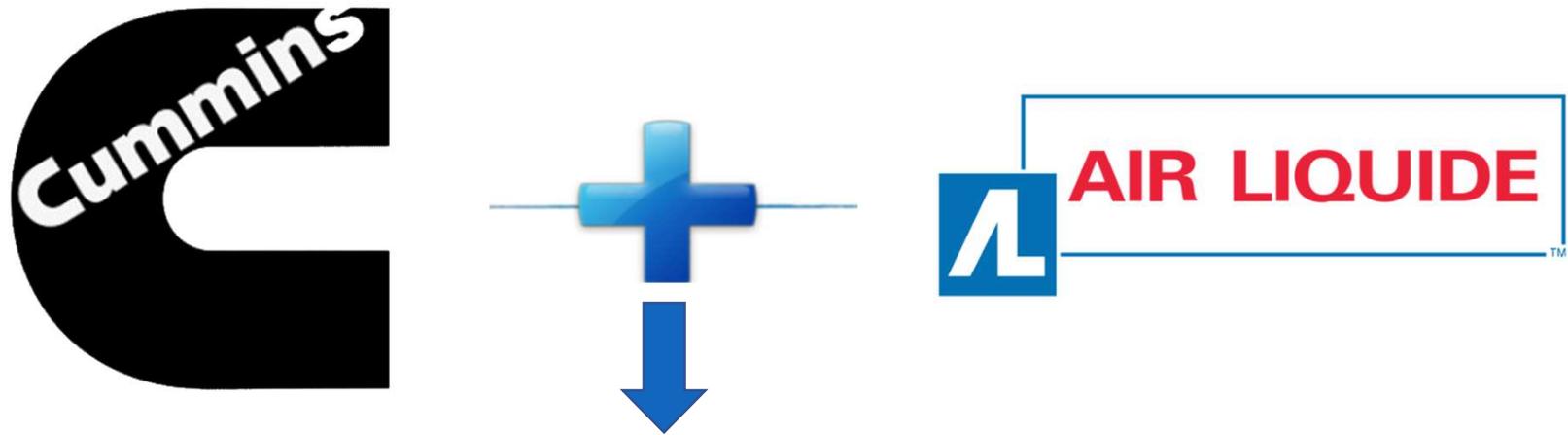


Hanwha Solar



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



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September 27<sup>th</sup> – Hyundai and Cummins to cooperate on hydrogen fuel cell technologies



September 30<sup>th</sup> – Sinopec partnered with China leading supplier of fuel cells systems Refire



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



October 11<sup>th</sup> – EU Automobile Manufacturers' Association (ACEA), Hydrogen Europe and the International Road Transport Union (IRU) called for a ramp up of investment in H<sub>2</sub> infrastructures



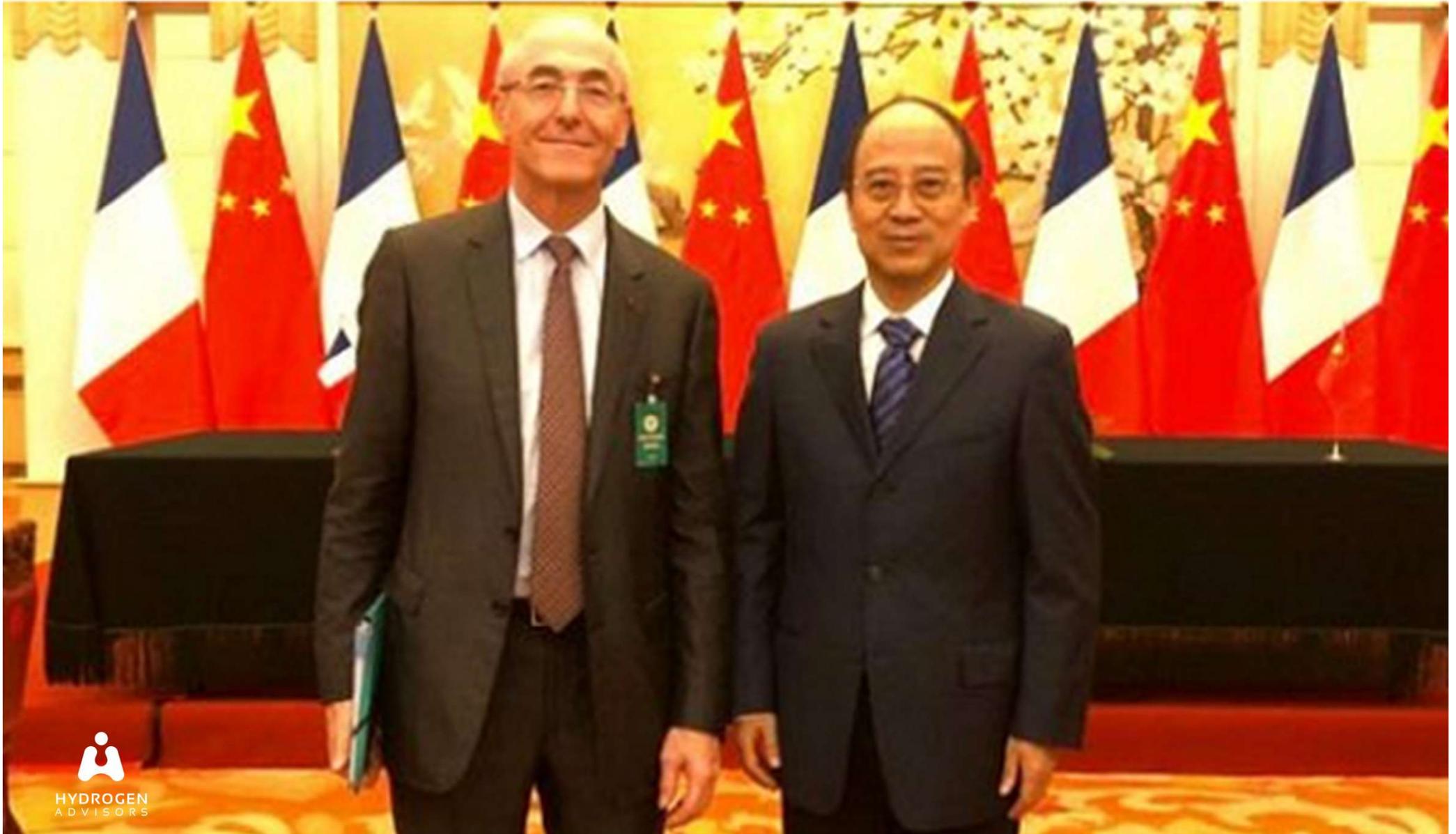
European  
Automobile  
Manufacturers  
Association



Hydrogen  
Europe



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



November 23<sup>d</sup> – 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 5<sup>th</sup> – The European Investment Bank and the Hydrogen Council signed an advisory agreement to address climate change with increased investment in hydrogen





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