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2019

happy new year

# Hydrogen in 2018

A review of some of the major developments

Prepared for you by Raphael Schoentgen



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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 creation of a first company, 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 diligences



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

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



## ***Large and mid size companies***

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



## ***Start ups***

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

# Executive Summary



2018 has been marked first by an impressive array of political commitments to the hydrogen economy. Several nations (France / UK / Australia / Korea/ ..) and regions (California, Wallonia, ...) tabled hydrogen plans and related public financial support, with a record of 2 billion Euros decided by the government of Korea. At international level, mission innovation (a group of 23 countries and the EU looking for solutions to reach the COP 21 targets) decided to launch an international challenge on hydrogen and fuel cells. The EU energy ministers also signed a declaration stating hydrogen will be part of the future of energy in Europe, and Japan organized the first ministerial meeting dedicated to the topic. Next year the G20 summer summit in Tokyo will have hydrogen on the agenda and the International Energy Agency is preparing a dedicated report to nourish the debates.

All these political commitments are of course related to major developments of the hydrogen economy happening in parallel on the ground.

In the field of industry, where hydrogen is a major entrant in several processes, 2018 has showed us that major international companies owning refineries, chemical plants and steel plants are now moving to green hydrogen - produced from renewable power – to manufacture their products instead of hydrogen produced from natural gas as previously (which releases CO<sub>2</sub> in the air).

In the field of energy, 2018 brought to live an impressive array of green hydrogen related projects that capture green power to turn it into green gas. Productions levels are now massive and in the range of several times 10 MW. We see also several new “hydrogen networks” projects appearing downstream of the electrolyzers. They are spanning across several cities. Hydrogen is injected in gas pipelines and stored underground. Its use aims at decarbonizing millions of homes, thousands of commercial buildings and tens of industrial sites.

In the field of mobility 2018 also brought major developments:

- Regarding hydrogen filling stations, new alliances were formed or further developed between companies to implement large networks of stations in Japan, Switzerland and Germany. We also saw the emergence of the first green hydrogen (produced from renewable power) filling stations in several countries like Austria, Belgium and Iceland.
- Regarding cars and light duty vehicles, two new models came to life : the Nexa of Hyundai and the GLC F Cell of Mercedes Benz. Hyundai also committed 6 billion Euros in the 10 coming years to its hydrogen developments. Volkswagen and Daimler presented projects of hydrogen mobile homes, while Plastic Omnium launched a 500 Meuros dedicated R&D center in Brussels, and a group of French companies launched a concept of last mile deliveries in cities based on hydrogen vehicles fleet that will be further expanded to other cities in Europe. Last but not least, Le Mans racing circuit launched a process to homologate hydrogen cars for a first race in 2024.
- Regarding logistics large hydrogen forklifts fleets are now visible in Europe while Hyster & Nuvera, recently merged, are now tapping into the Chinese market.
- Regarding hydrogen buses, we moved from small orders in the past to orders now in tens of vehicles (for one single client in Europe), then hundreds of vehicles (for a European project) and finally thousands vehicles (for Shandong province in China). This shows that hydrogen buses are a now clear option for many cities next to traditional battery based buses.
- Regarding trucks, the first large order for US hydrogen truck pioneer Nikola was received from Anheuser Bush with 800 trucks. It was later followed by the announcement by Hyundai it will deliver 5000 hydrogen trucks to Switzerland in the coming 5 years with operations starting in 2019 with a thousand. In parallel several consortia started working on hydrogen based refuse trucks.

- Regarding trains, 2018 saw a world premiere with Alstom starting the commercial operation of its hydrogen train in Germany. The CEO of French railways said afterwards his company would start using them in 2022. Several other alliances to develop other hydrogen trains were also announced across the world and industrial players, like in Japan, UK and Germany.
- Regarding marine applications, projects of hydrogen ferries and hydrogen ships blossomed in the UK, California and Scandinavia with more to come in other counties in 2019. In parallel industrials started developing alliances for hydrogen based propulsion systems (Siemens/Powercell and ABB/Ballard) while some are developing their own (MAN Marine).
- Last but not least, regarding planes, hydrogen fuel cell based auxiliary power systems - on which the plane runs when on standby - received prizes and/or funding, two European airports launched projects on hydrogen ecosystems, and two companies declared working on hydrogen planes to be operational before 2025.

Quite naturally all these developments are backed by industrials alliances and production sites openings or expansions. Weichai from China partnered both with Ballard (163 MUSD) and Ceres (28 M£) while EDF partnered with McPhy ( 16 MEuros) and Air Liquide partnered with Hydrogenics (20 MEuros). Next to these alliances, NEL has the best example to describe how the industry is expanding: the company announced a 10 times increase of its electrolyzers plant (to produce 360 MW a year).

To end this review and make it complete with elements on the financing side, Hyundai launched the first fund dedicated to hydrogen technologies for mobility applications (in China with 100 MUSD and a partnership with Beijing Tsinghua university).

# Countries



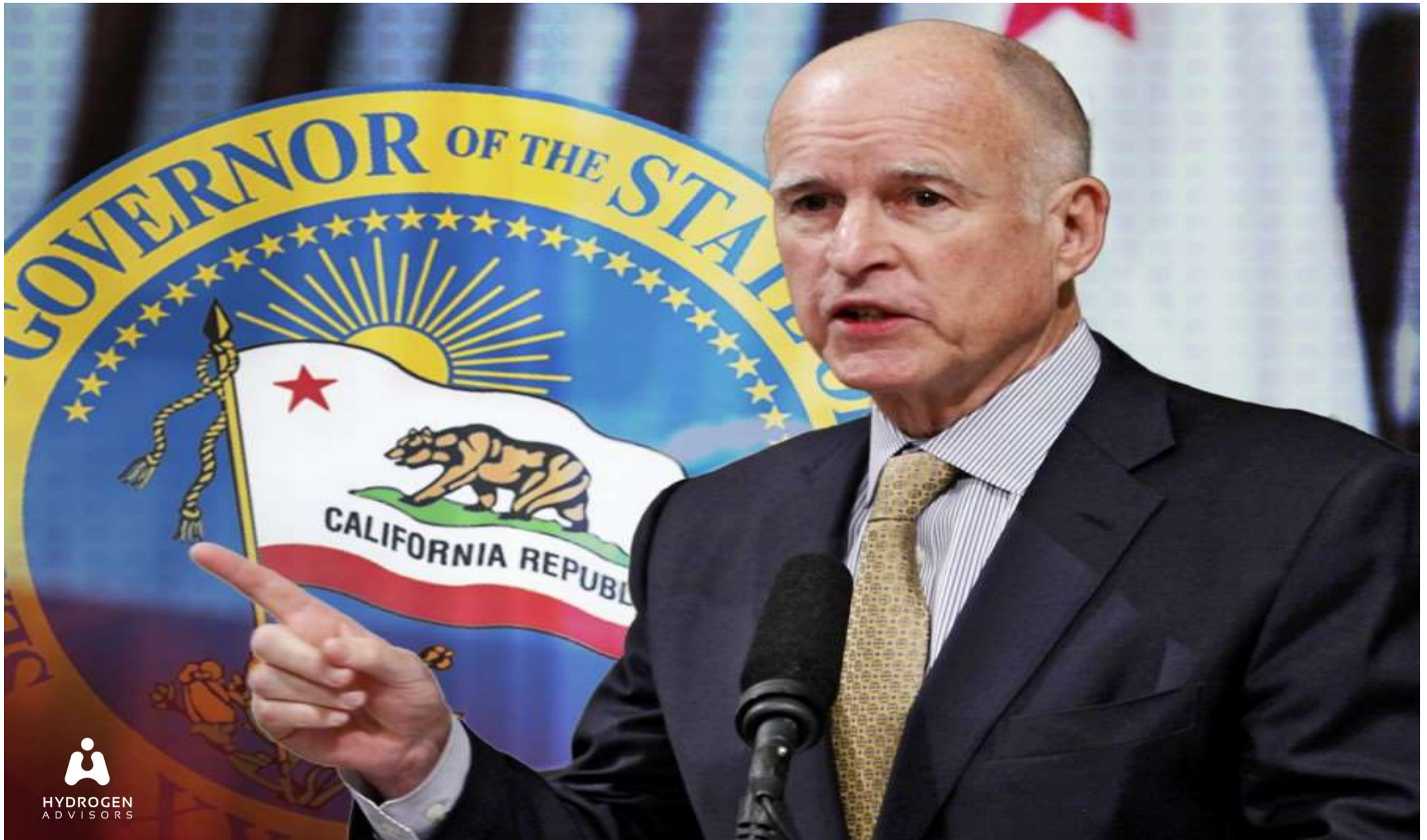
Jan 21<sup>st</sup> – Xinhua tells that Wuhan will become the « Hydrogen City » of China by 2025 with 3-5 world leading hydrogen companies, 100 fuel cells manufacturers, and 30-100 filling stations.



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Jan 27<sup>th</sup> – Governor Brown announces a \$2.5 billion plan to increase zero-emission vehicles in California by adding 250,000 EV charging points and 200 hydrogen refilling stations



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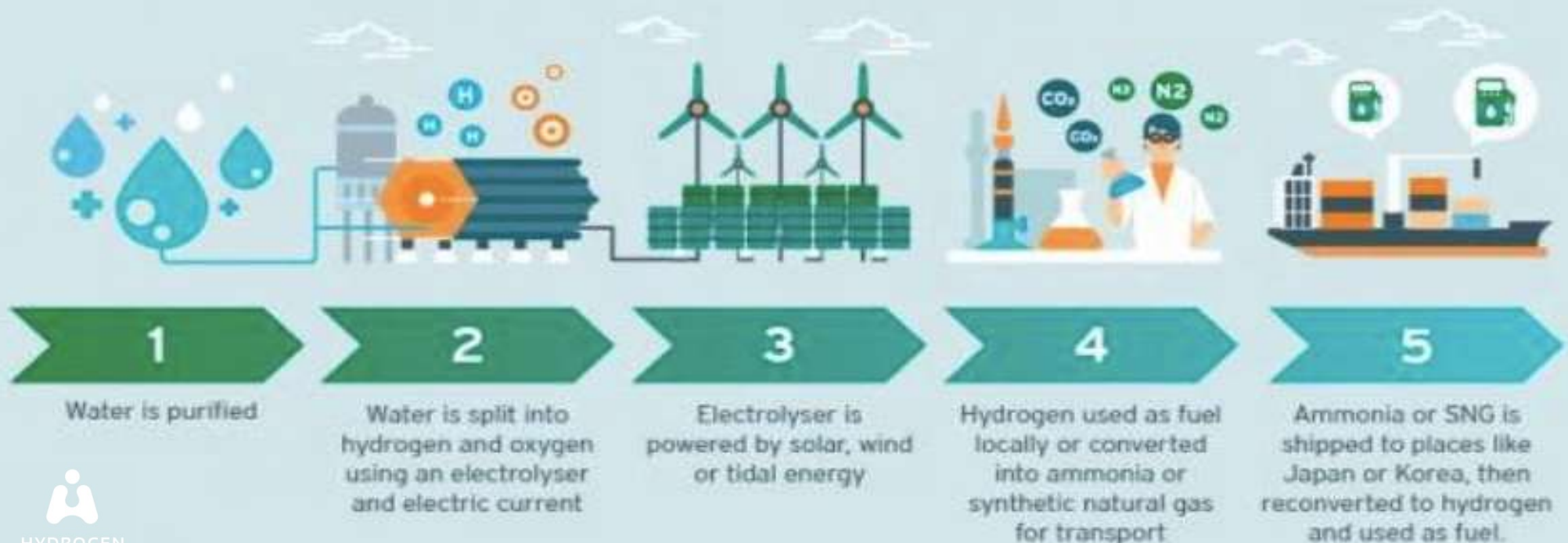


Feb 28st – ARENA, the Australian Renewable Energy Agency, closes its first AUD 20 million funding round to support projects that help the production and export of renewable hydrogen worldwide



# OUR NEXT GREAT EXPORT?

As a nation, we've long shipped coal to the world. But could renewable energy be our next great export industry? ARENA has set exporting renewable energy as one of its four priorities. Here's how it might work.



May 11th – a £20 million fund is set up by the UK Department for Business, Energy & Industrial Strategy to boost business innovators powering the UK's hydrogen economy



May 23<sup>d</sup> – Mission Innovation (23 countries & the EU Commission post COP 21 supporting technologies to tackle climate change) launches a new challenge on hydrogen and fuel cells

**3<sup>rd</sup> Mission Innovation Ministerial**

Energy Integration and Transition:  
towards a competitive and  
innovative low carbon economy

**MISSION INNOVATION**  
Accelerating the Clean Energy Revolution

**23-24 May 2018**  
**CEM9/MI-3**  
COPENHAGEN

**Raphael Schoentgen**  
@rschoentgen

Let's work together to make it a topic for a new challenge ! [mission-innovation.net/our-work/innov ...](https://mission-innovation.net/our-work/innov...)

**Hydrogen Europe** @H2Europe  
R. Schoentgen advocating #hydrogen as a solution for #climatechange in Mission Innovation public private partnership workshop Mexico

6:27 AM - 16 Sep 2017

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June 1<sup>st</sup> – France unveils its first national plan for Hydrogen development with 100 MEuros / year

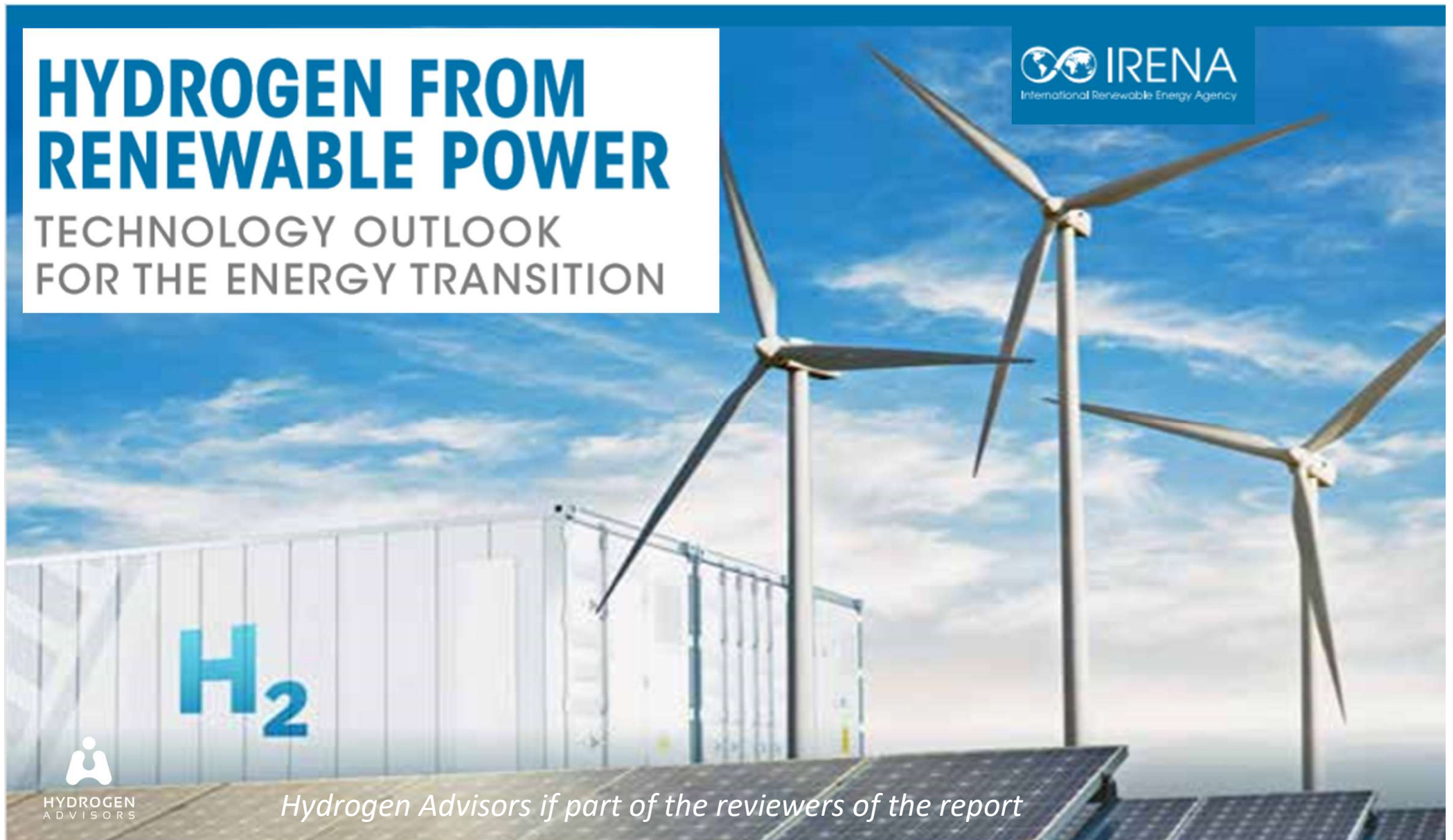


June 28<sup>th</sup> – the Korean government will invest 2 billion euros to support hydrogen development with targets of 16000 hydrogen vehicles, 1000 hydrogen buses and 310 filling stations by 2022.





Sep – The International Renewable Energy Agency publishes a report on hydrogen from renewable power and its role in the energy transition



Sep 10<sup>th</sup> – The Hydrogen Council, an international group of CEOs advocating hydrogen adds 14 members after having welcomed 11 in March, now totalling 53 members





Sep 17<sup>th</sup> – EU energy ministers along with private companies and NGOs sign the Linz Hydrogen Initiative stating that Hydrogen will be part of the future of energy in Europe





Oct – Noe Van Hulst, Chairman of the International Energy Agency, becomes special envoy of The Netherlands for the Hydrogen Economy



Oct 23<sup>th</sup> – First Hydrogen Energy Ministerial Meeting in Tokyo with representatives from 20 countries to step up cooperation in promoting hydrogen and share standards and technologies



Oct 23<sup>th</sup> – New Zealand and Japan sign an agreement on the development of the hydrogen economy





Nov 16<sup>th</sup> – “The question regarding hydrogen is not anymore if or why, but how ?” – EU Vice President for the Energy Union Maros Sefcovic in Brussels at the FCHJU Stakeholders Forum



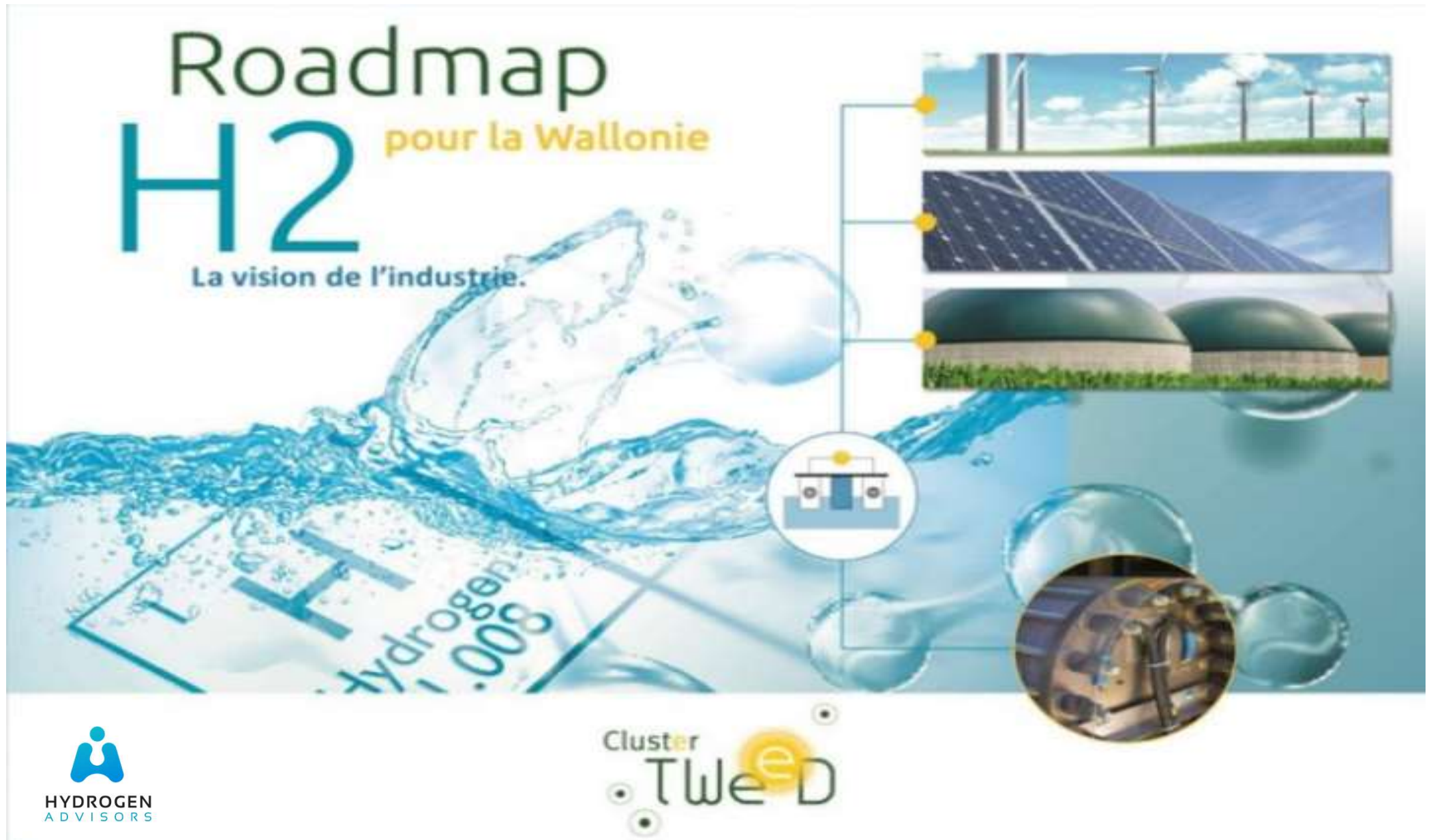
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Nov 18<sup>th</sup> – Dr Fatih Birol, Director of the International Energy Agency announces IEA will prepare a major report on hydrogen for the next G20 in Tokyo at the demand of Prime Minister Abbe





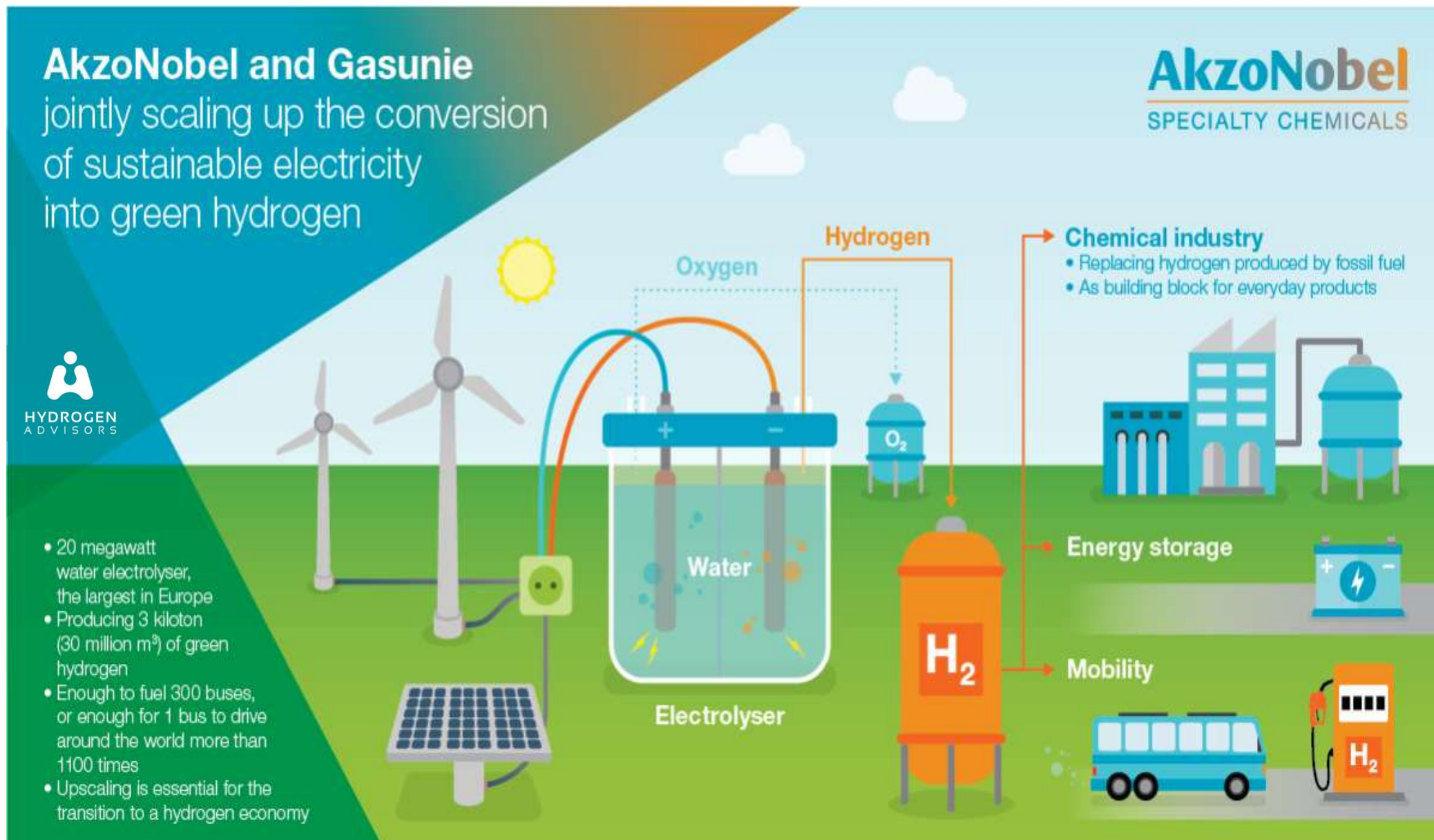
Dec 27<sup>th</sup> – Cluster Tweed releases the Hydrogen Roadmap for Belgian Wallonia



# Industry



Jan 9<sup>th</sup> – Akzo Nobel and Gasunie join hands to develop a 20 MW electrolyser plant that will provide hydrogen to a chemical site in the Netherlands and hundreds of hydrogen buses





Jan 18<sup>th</sup> – Launch of the Refhyne project, a 10 MW electrolyser to produce green hydrogen for a refinery, the first European project of its kind to green the refining process

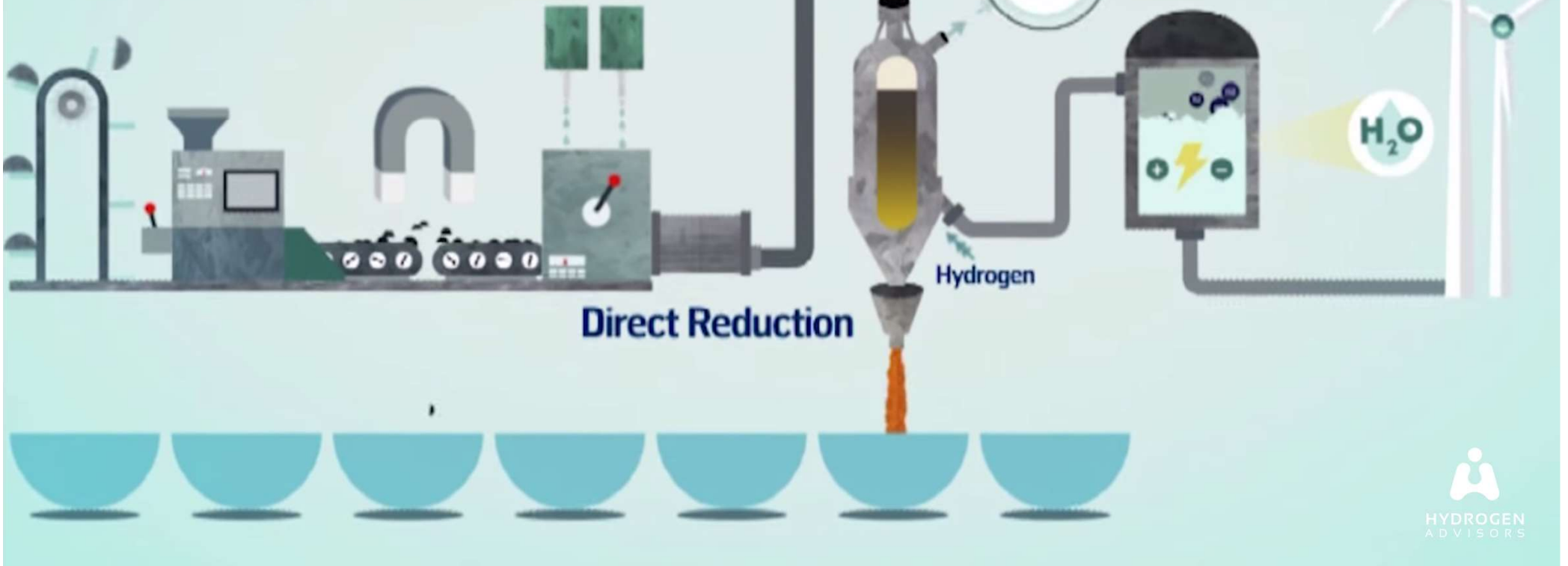


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June 20<sup>d</sup> – Launch of the Hybrit project in Sweden by Vattenfall, SSAB and LKAB to develop a green hydrogen based production of steel without CO<sub>2</sub> emissions.



July 3<sup>d</sup>– Thyssengroup /H2U will develop in Australia a 30 MW electrolyzer plant to provide green hydrogen to an ammonia plant + 20 MW hydrogen turbine + 10 MW fuel cell (76 MEuros project)



Oct 30<sup>th</sup> – Salzgitter Flachstahl , Avacon and Linde to partner on the development of 50 MW wind farm and PEM electrolyser to supply green hydrogen for steel production in Germany



# Energy

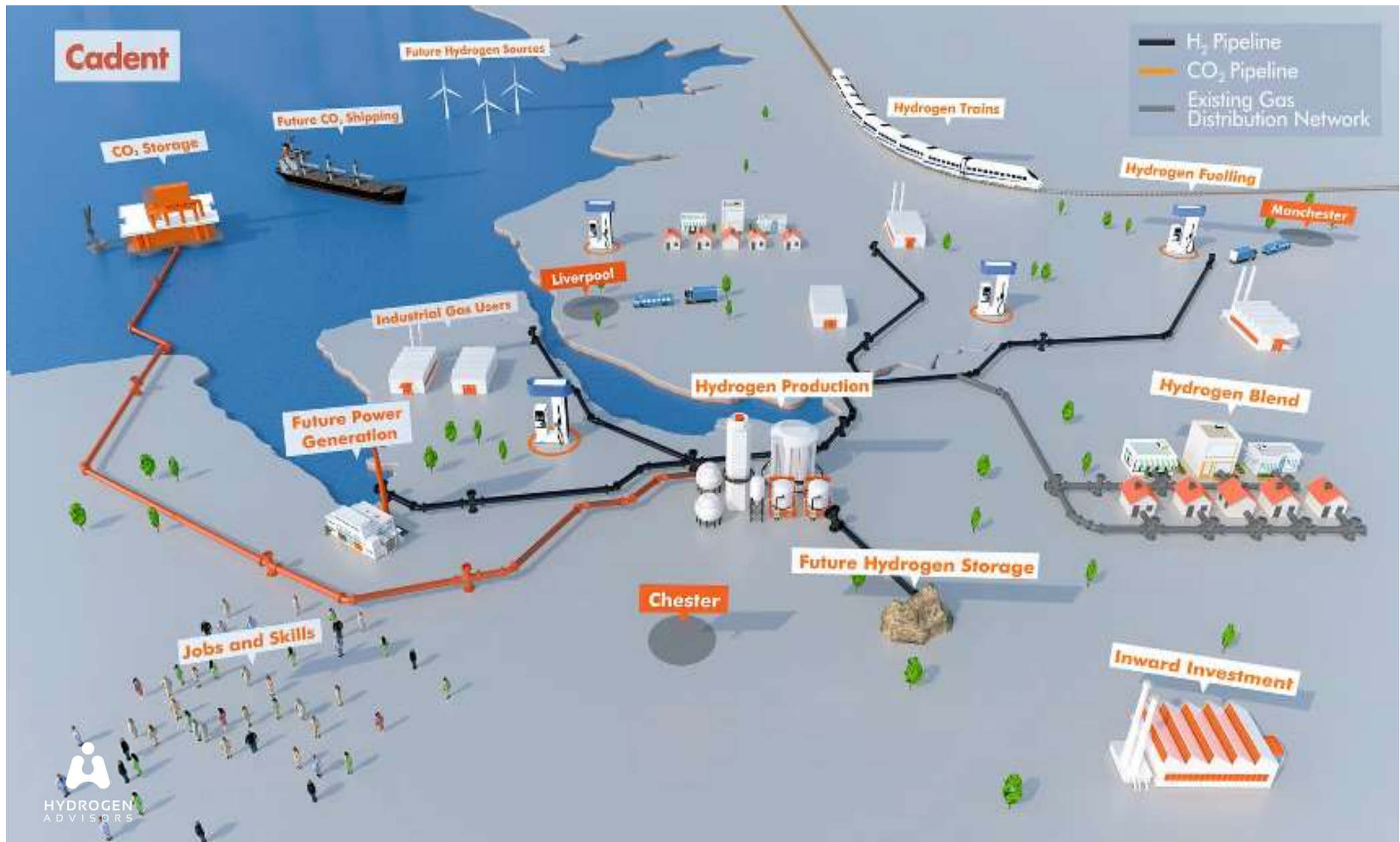




April 26<sup>th</sup> – Eoly (Colruyt Group Energy), Fluxys, and Parkwind announce they will develop a first 25 MW wind to hydrogen (power to gas) project in Belgium



May 11<sup>th</sup> – a Hynet £ 0,9 billion project is announced, a fully integrated green hydrogen (produced from natural gas with CO<sub>2</sub> capture) network and economy in Liverpool & Manchester



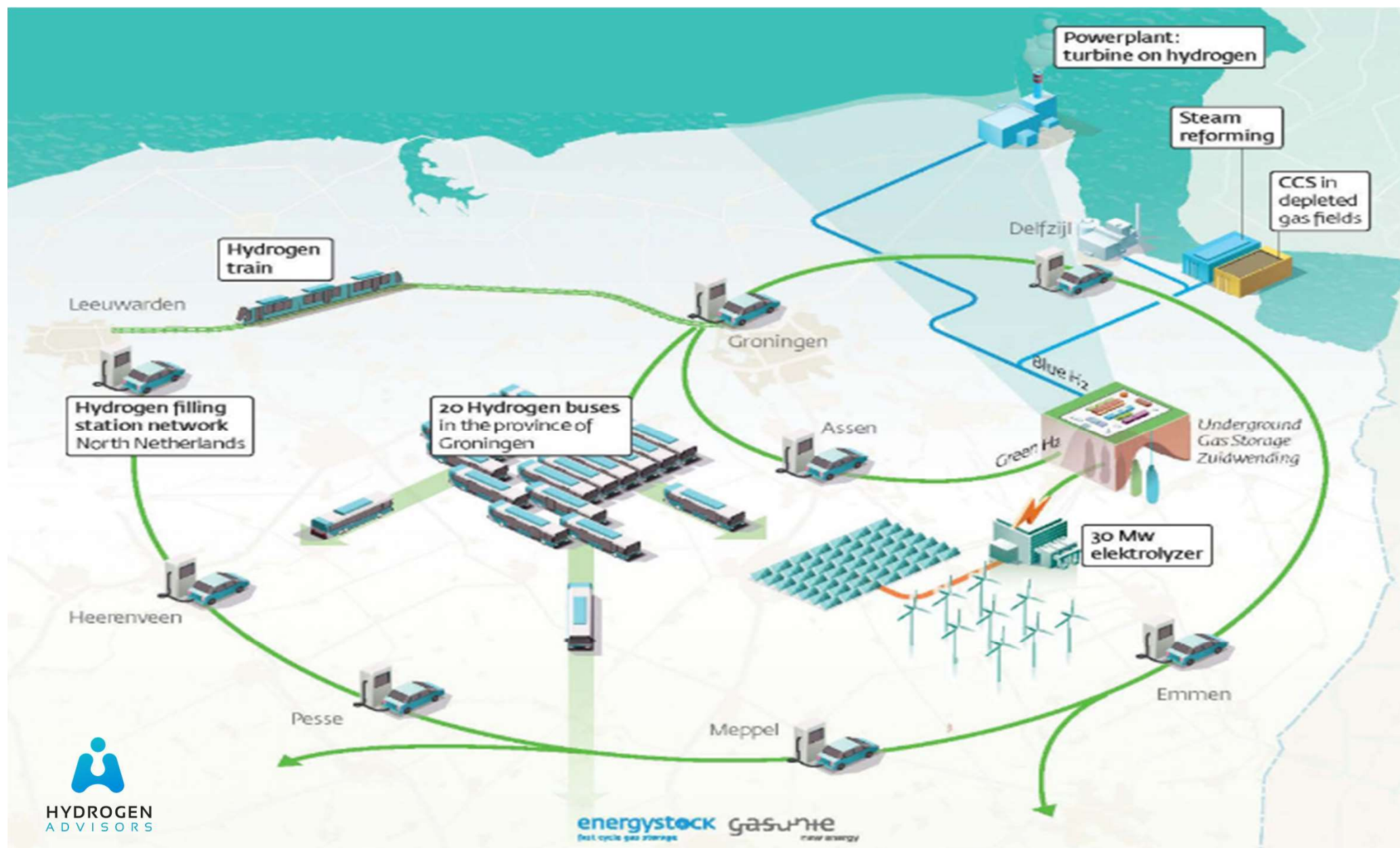


June 11<sup>th</sup> – France starts its first hydrogen injection project (Ghryd) into the gas distribution network in top northern city of Dunkirk





Jul 3<sup>d</sup>– Gasunie starts building the electrolyser of Zuidwendling for the Energy Stock major hydrogen hub project around Groningen



Aug 9<sup>th</sup> – Toshiba, Iwatani, Tohoku Electric Power and NEDO (New Energy & Industrial Technology Development Organization) to develop a 10 MW hydrogen ecosystem in Fukushima





Aug 24<sup>th</sup> – Doosan will supply a 50 MW Fuel Cell Power Plant, the world's first large-scale fuel cell utilizing H<sub>2</sub> as a by-product in order to provide 160 000 homes with green energy



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Sep 12<sup>th</sup> – HDF and Meridiam will develop in French Guyane a 55 MW photovoltaic park with the world's largest 140 MWh hydrogen-based renewable energy storage capacity next to batteries

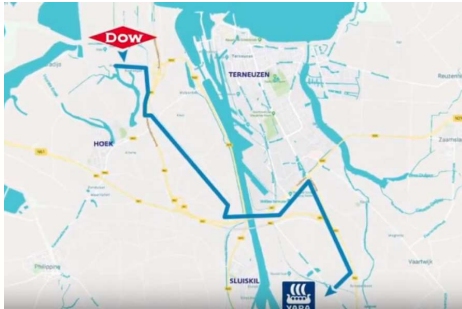




Nov 23d – “H21 North of England” report sets out how 3.7 million homes and 40,000 businesses in the north of England, currently heated by natural gas, could be converted to hydrogen



Nov 27<sup>th</sup> – World Premiere - Gasunie converts a natural gas pipeline to hydrogen and puts it into operation between Dow (hydrogen producer) and Yara (hydrogen user) in Zeeland, Netherlands



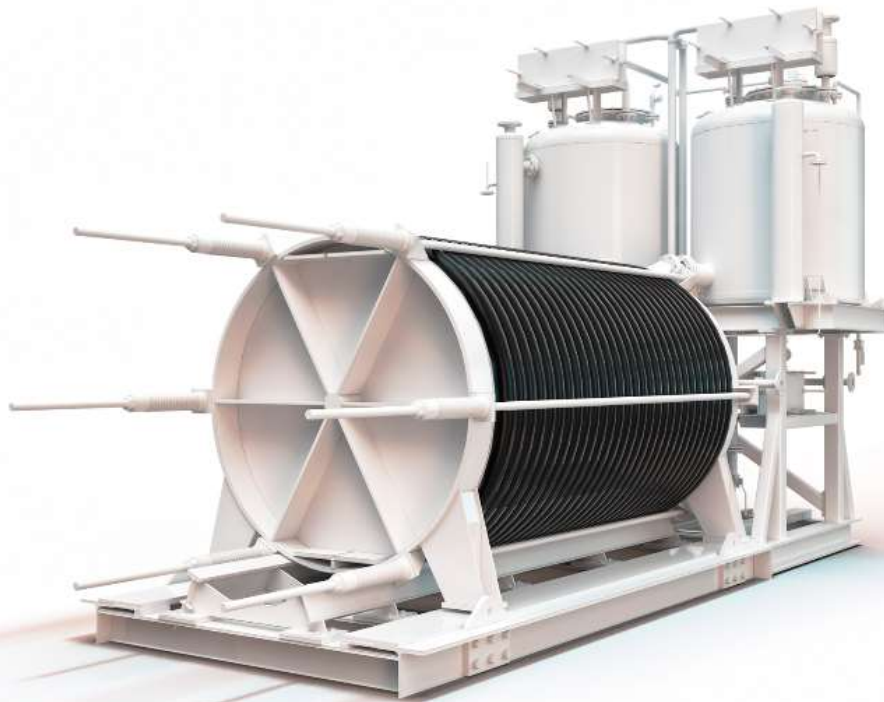
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# Hydrogen production





August 28<sup>th</sup> – NEL announces the construction of the world's largest electrolyzers plant with a yearly capacity of 360 MW (10 times the current production level)



nel



# Filling stations

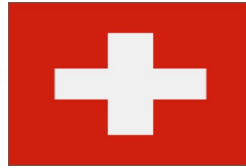


March 5<sup>th</sup> – Japan's top auto and energy firms tie up under Japan H2 Mobility (JHyM) to develop hydrogen stations (80 new by 2021), while Japan has currently ~100 and aims at ~900 by 2030





May 18th– Seven Swiss companies active in fuel and distribution will develop a nationwide network of hydrogen refueling stations. They represent together 1500 stations and 1700 trucks.



June 15<sup>th</sup>– Orkan opens the first green hydrogen refilling station in Iceland





June 15<sup>th</sup>– Shell and HTEC launch Canada's first retail hydrogen vehicle refilling station



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Sept 20<sup>th</sup> – Spain fills its first commercial hydrogen vehicle



October 10<sup>th</sup> – First green hydrogen station is opened by Fronius in Austria





Oct 10<sup>th</sup> - the Colruyt supermarkets chain opens its first public green hydrogen refilling station in Belgium and commits 35 Meuros to the further development of hydrogen and 4 other stations



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Oct 25<sup>th</sup> – China Great Wall Motors signs a MoU to become the 7<sup>th</sup> investor after Air Liquide, Daimler, Linde, OMV, Shell and TOTAL in H<sub>2</sub> Mobility (company rolling out stations in Germany)



# Cars



Jan 9<sup>th</sup> – Hyundai unveils Nexo, the latest hydrogen car, at CES (Consumers Electronic Show) in Las Vegas. 5 minutes filling time for 666 km



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June 20<sup>d</sup> – Audi and Hyundai become partners in fuel cell technologies (patent cross-licensing agreements and mutual access to components in the field of fuel cell electric vehicles)



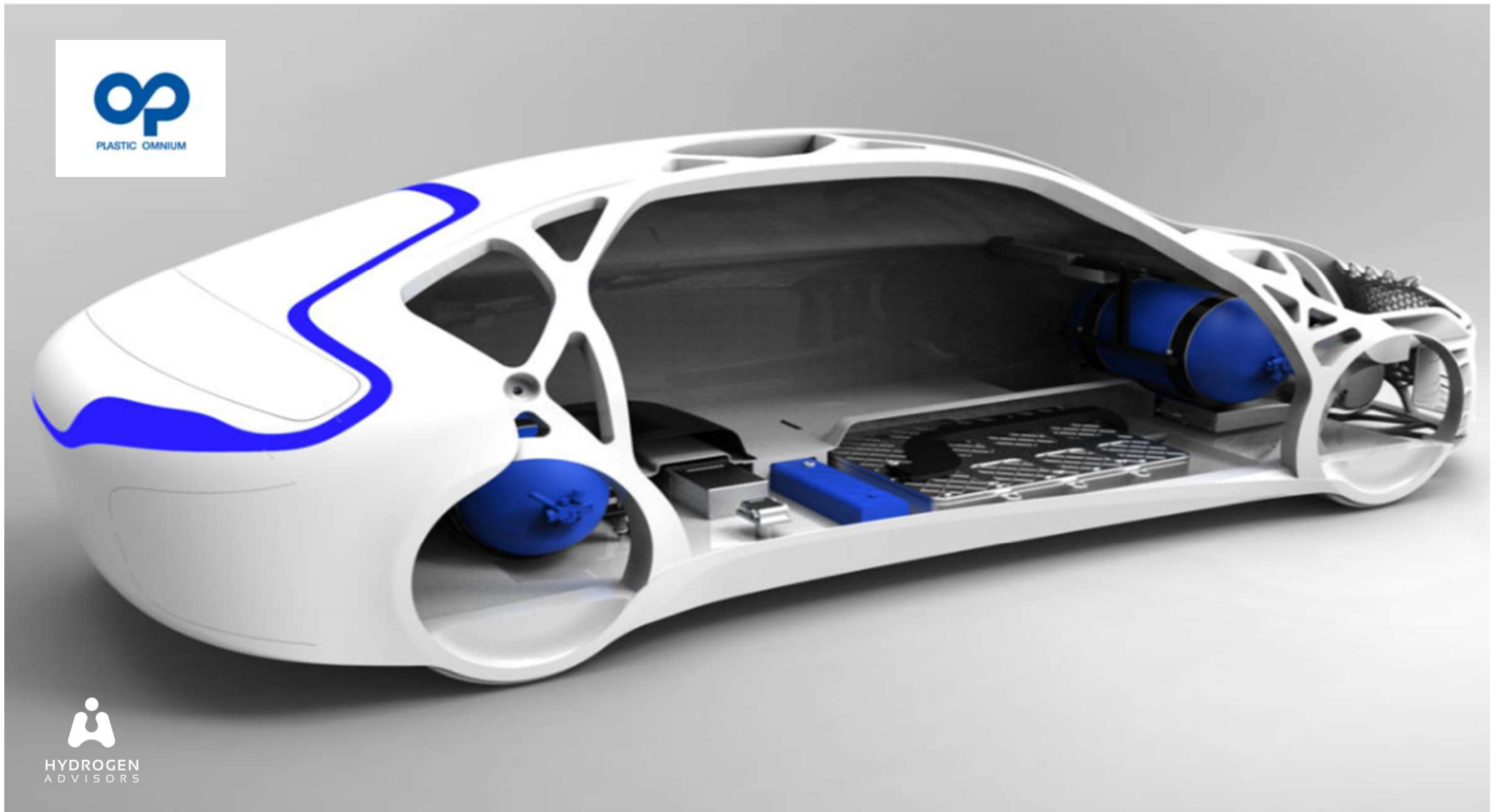
July 2<sup>d</sup> – Daimler unveils the Sprinter F Cell, a new camping car running on hydrogen with 300 to 500 km autonomy (with an additional tank)



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July 28<sup>th</sup> – Plastic Omnium invests 50 MEuros in a R&D centre with 200 engineers dedicated to hydrogen and fuel cells in Brussels that will open in 2019





Sep 7<sup>th</sup> – Germany opens its 50<sup>th</sup> hydrogen refuelling station on its journey to reach a hundred



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Sept 20<sup>th</sup> – Volkswagen presents the Hymotion concept van, with an autonomy of 500 km compared to its predecessor (the battery electric one with 150 km autonomy)





Sep 23<sup>d</sup> – World Premiere - ACO launches “Mission H24” in Spa-Francorchamp, a process to homologate a hydrogen racing car to run Le Mans 24 hours race in 2024





Nov 13<sup>th</sup> – Market launch of the worlds first electric vehicle featuring both fuel cell and plug-in hybrid technology – the Mercedes-Benz GLC F-CELL



Dec 10<sup>th</sup> – JC Decaux, Galeries Lafayette, Akuo Energy and Atawey to develop last mile coverage with light duty hydrogen vehicles - 350 in France first, then in Europe (7 MEuros grant from EU)



Dec 11<sup>th</sup> – Hyundai Motor Group announces \$7bn to develop fuel-cell technologies and a target to reach 500 000 fuel cells vehicles production level per year by 2030





# Logistics



Nov 28<sup>th</sup> – The largest fleet of hydrogen forklifts in operation in Europe (120) is inaugurated at Carrefour in Northern France, with Still, Plug Power, Air Liquide and FCHJU as partners



Dec 12<sup>th</sup> – Nuvera (hydrogen and fuel cell subsidiary of Hyster/Yale handling materials company) announces setting up in 2019 a production plant in Fuyang, Zhejiang province, to supply China





# Buses



March 1<sup>st</sup> – Van Hool and Ballard receive their largest ever order for hydrogen buses from a European client – 50 buses for the cities of Köln and Wuppertal



June – Solaris unveils its new Urbino 12 hydrogen bus with 350 km range on one fill





Aug – China Shangdong province announces it will produce and roll out 2000 hydrogen buses as from 2019



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Sep 26<sup>th</sup> – Toyota will supply its hydrogen technology to Caetanobus SA Europe, the Portuguese leader of bus developments



Sep 27<sup>th</sup> – Europe grants 40 Meuros funding to NEL and a consortium of other industrial players to help unroll 600 hydrogen buses across Europe.





# Trucks



Jan 18<sup>th</sup> – Launch of the Revive project to develop fuel cell trucks for waste transportation and deploy hydrogen garbage trucks throughout eight sites in Europe



May 3d– Anheuser Busch orders 800 hydrogen trucks from Nikola to transport Budweiser beer across the United States without emissions





July 20th – Toyota unveils the second version of its hydrogen heavy duty truck, the Beta, with an increased range of 480 km (Alpha version had 320 km range)



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June 28<sup>th</sup> – NEL awarded multi billion NOK (several hundred millions of Euros) purchasing order from Nikola for electrolyzers and fuelling stations to deploy hydrogen trucks in the USA



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Sep 19<sup>th</sup> - Hyundai will supply 1000 fuel cell trucks to the Swiss company H2 Energy, and launch the service at the end of 2019. 4000 additional trucks are planned over the 4 following years.





Nov 6<sup>th</sup> - Nikola unveils the Nikola Tre for the European market with operations starting in 2020 in Norway. Range between 500 km and 2000 km.



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Dec 10<sup>th</sup> – Scania, Renova, Power Cell and local waste company in Göteborg announce a new collaboration on a refuse truck equipped with a fuel cell



# Trains





Feb 26<sup>th</sup> – Ballard and Siemens multimillions cooperation on hydrogen train based on the Mireo platform receives an additional 12 MEuros support from German Federal Ministry of Transport



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**SIEMENS**  
*Ingenuity for life*



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Sep 16<sup>th</sup> – World Premiere for an Hydrogen train – Alstom Hydrogen train enters in service in Lower Saxony, Germany.



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Sep 17<sup>th</sup> – Toyota and East Japan Railways sign an hydrogen-based mobility partnership between railways and automobiles to low-carbon societies in the face of global warming





Nov 16<sup>th</sup> – French Railway Company SNCF announces it will step out of diesel trains and will have its first hydrogen trains by 2022



Dec 13<sup>th</sup> – Ballard receives an order from Porterbrook (leading participant in the UK rail leasing market) for Fuel Cell Module to Power U.K. HydroFLEX Train



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# **Ships**





Feb 5<sup>th</sup> – Boreal Sjø and Wärtsilä Ship Design enter into a co-operative agreement to jointly work on developing hydrogen-powered ferries, with the first operational in 2021



March 18<sup>th</sup> – Energy Observer, the first solar, wind and hydrogen powered autonomous boat, departs from Marseille to tour the Mediterranean sea





June 19<sup>th</sup> – Launch of HYSeas III project to develop the world's first sea-going car and passenger ferry fueled by hydrogen (12,6 MEuros)





June 27<sup>th</sup> – ABB and Ballard sign a MoU to develop megawatt scale fuel cell power systems for the marine market, with an initial focus on the cruise ship segment



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July 12<sup>th</sup> – Bay Ship and Yacht will build first US Hydrogen Fuel Cell Passenger Vessel for Golden Gate Zero Emission Marine (GGZEM), a company active in reducing air pollution in the Bay area



Aug 14<sup>th</sup> – PowerCell and Siemens (that sells Blue Drive Plus system for ships) will jointly develop a fuel cell-based system that can be integrated in ships such as ferries, yachts and cruise ships





Dec 5<sup>th</sup> – MAN Cryo dedicated propulsion system based on liquid hydrogen developed by MAN energy for maritime applications is granted a preliminary approval in principle by the DNV-GL



Dec 14<sup>th</sup> – Hyon (JV between Powercell, NEL and Hexagon) has been awarded grants to develop two R&D projects of Zero-Emissions Maritime Transport using Hydrogen Fuel Cells

HYON



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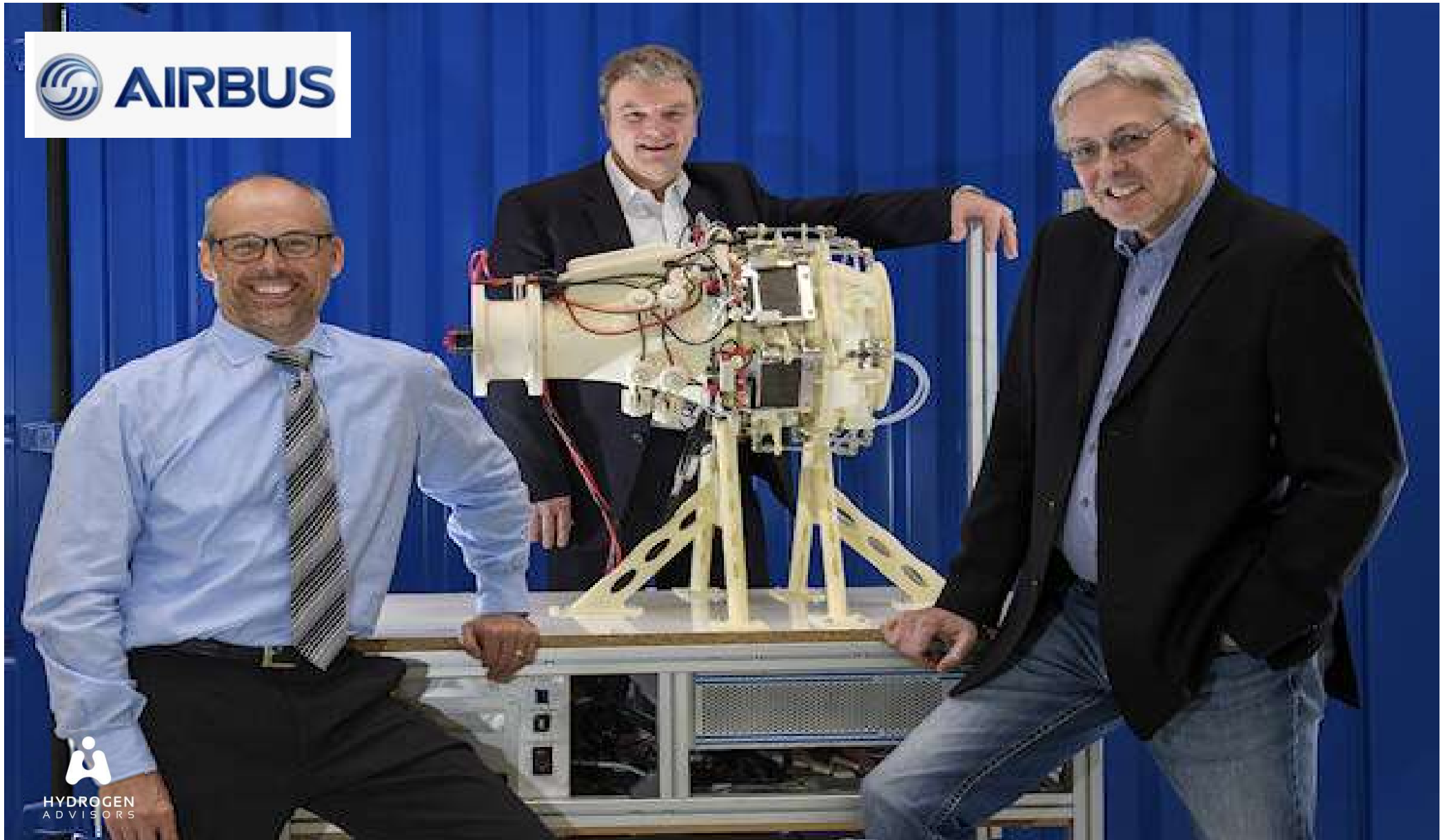


# Planes





April 26<sup>th</sup> – Airbus wins German Aviation Innovation Award with a project to bring a fuel cell aboard aircrafts to replace the auxiliary power unit which services the plane when on standby



June 18<sup>th</sup> – Liebherr Aerospace & Transportation and GM will coordinate efforts and expertise in fuel cells to develop a next-generation auxiliary power unit (APU).



July 5<sup>th</sup> – Belgian Liege Airport and CMI announce working together on a hydrogen solution for green mobility for the airport





Sep 26th– Hyport, the company that will develop the hydrogen ecosystem around the Toulouse airport is officially launched by Region Occitanie and the ENGIE Group



Oct 1<sup>st</sup> - HES announces its aim to build the first hydrogen powered passengers plane by 2025 with a range from 500 kms to 5000 kms



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Dec 4<sup>th</sup> – Hydrogenics announces it has been selected to design and supply fuel cell power modules for a new lightweight aircraft under development (customer wish : remain undisclosed)



*Picture of H2FLY project, a previous project in which Hydrogenics has been involved with German DLR*



# Alliances and Finance



May 16<sup>th</sup> – Weichai invests £28m into Ceres Power and both companies will create a JV to manufacture fuel cells China under license (a £9m joint development program).



June 5<sup>th</sup> – EDF and McPhy enter into a partnership agreement to develop carbon-free hydrogen in France and worldwide including a €16 million investment from EDF in McPhy



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June 28<sup>th</sup> – Air Liquide signs a partnership with SNTE, a start up in Shanghai active in logistics, to unroll hydrogen trucks and hydrogen filling stations and invests 10 MEuros in it.



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Aug 21<sup>th</sup> – Fuel Cell Developer Ceres Power and Bosch announce collaboration with a £9m equity investment



Aug 29th – Weichai (Chinese engine, auto parts and logistics conglomerate) takes 19,9% of Ballard for \$163 million, sets up a JV and targets 2000 fuel cells / year for the Chinese EV market.



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Oct 29<sup>th</sup> – Hyundai Motor establishes 100 MUSD “Hydrogen Energy Fund” with Top Chinese R&D Institute BTIRDI (Beijing-Tsinghua Industrial R&D Institute) focusing on start ups in China & Korea



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Dec 21<sup>st</sup> – Hydrogenics announces US\$20.5 million private placement by Air Liquide and a technology and business development partnership to jointly develop PEM electrolysis worldwide





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