REUTERS EVENTS™

TOP 100 INNOVATORS IN **HYDROGEN 2023**

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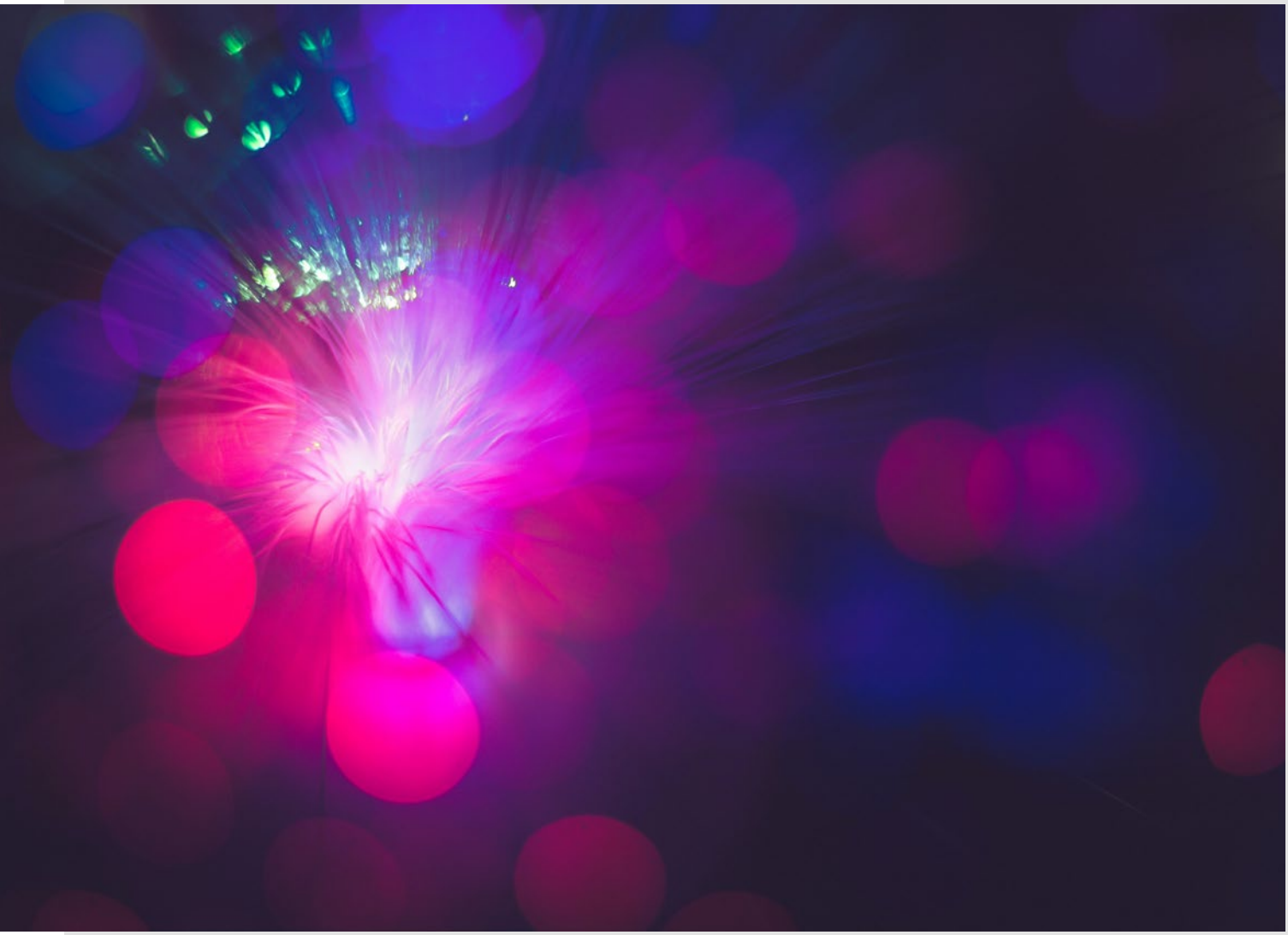
INTRODUCTION

Clean hydrogen continues to enjoy an upward trajectory. In 2023, according to the Hydrogen Council, there have been 1,000 hydrogen proposals announced across the globe of which 795 plan full or partial deployment by 2030.

Increase in production is more than impressive thanks to the understanding of international policy-makers and of course, the efforts of the companies listed below. A report from GlobalData earlier this year noted that over 393 deals related to hydrogen were closed during 2022, representing a significant increase compared to the 277 deals registered in 2021. This surge could be key to achieving over 71 mtpa capacity worldwide by 2030.

In light of that, Reuters' Top 100 Innovators in Hydrogen Report takes a look at key players in the green/clean hydrogen space today.

We have selected ten categories focussing on ten companies per category, with three companies highlighted as current 'ones to watch'. Each company featured here continues to do impressive work in the industry so our suggestions are just that. Please note that the other seven companies have been listed in no particular order.



HYDROGEN PRODUCERS

OVERVIEW:

With investment in green hydrogen at an all-time high the sky is the limit in terms of production within this clean tech space.

Why these three? Because of their commitment to innovation, action and vision.

AIR PRODUCTS AND CHEMICALS, INC.
Industrial gas supplier is investing $4.5 billion to build the world's largest blue hydrogen production facility in Louisiana, USA, producing over 750 million standard cubic feet per day.

LINDE PLC
Linde plc, the largest supplier of industrial gases by revenue, has just signed a long-term agreement to supply green hydrogen to Evonik, in Singapore. Investing $1.8 billion to supply clean hydrogen to OCI's new ammonia plant in Texas.

AIR LIQUIDE
Completed construction of the world's largest Proton Exchange Membrane electrolyser, in Bécancour, Quebec, producing up to 8.2 tonnes per day of renewable hydrogen. Built 50 hydrogen global charging stations globally.

SHELL:
Investing $1 billion per year in hydrogen and CCS in 2024 and 2025.

CHEVRON:
Pledged to invest $2.5 billion in green and blue hydrogen by 2028.

EXXONMOBIL:
Planning a blue hydrogen plant at their petrochemical complex in Texas.

EDP RENEWABLES:
Investing €630 million in hydrogen and battery storage between now and 2026.

EDF:
Constructing a solar farm in the north of England to power its hydrogen electrolyser.

ØRSTED:
Investing in a large-scale facility in Denmark to produce green hydrogen.

CF INDUSTRIES:
Developing a zero-carbon-intensity hydrogen project, in Oklahoma.

ELECTROLYSER AND FUEL CELL COMPANIES

OVERVIEW:

An expanding market primed to take center stage as zero-emission solutions.

Why these three? For consistency in innovation and ensuring market confidence globally.

PLUG POWER

Manufactured 122MW of Plug's 1MW electrolyser stack platform in Q1 2023, an all-time high for the company and for PEM electrolysers. Part of a consortium that received a $21.8 million grant to build a hydrogen production plant in Belgium.

BALLARD POWER SYSTEMS INC

Founded in 1979, Ballard will supply the FCmoveTM fuel cell engine for the hydrogen truck, and Ashok Leyland, one of the world's largest manufacturers of buses, scheduled to be launched in India.

NEL

The first 100 percent dedicated hydrogen company listed on the Oslo Stock Exchange. Recently signed a €30 million contract with HH2E AG to supply 120MW of hydrogen capacity, in the form of two 60 MW electrolyser plants in Germany.

ITM POWER:

Increasing power supply at Bessemer Park, Sheffield, by 300 percent to 30 megavolt amperes.

CUMMINS:

Producing electrolysers in Minnesota, U.S., scalable to 1 Gigawatt.

THYSSENKRUP NUCERA:

One of the few suppliers providing water electrolysis technology in the Gigawatt power range.

ENAPTER:

Their patented AEM technology enables the mass production of cost-efficient electrolysers.

LONGi:

Providing a production system to the Chinese Da'an Wind and Solar Green Hydrogen Project.

McPHY:

Developing a next-generation alkaline electrolysers Gigafactory (with €114m French Government funding).

PURE HYDROGEN:

Constructing a hydrogen plant in Queensland using wood biomass technology.

UTILITIES & ENERGY COMPANIES

OVERVIEW:

Natural gas utilities and energy companies are increasingly promoting hydrogen as a way to pre-serve their business model whilst meeting low-emission demands.

Why these three? For looking towards long-term and lower-cost solutions.

NEXTERA ENERGY RESOURCES
Established in 1925 as Florida Power & Light, NextEra is now working with CF Industries to deliver green hydrogen to its ammonia production facility, and on a $65 million green hydrogen pilot, at their Okeechobee clean energy centre, in Florida.

DOMINION ENERGY
Showing $16.8 billion in revenue, Dominion launched its ground-breaking hydrogen blending in Delta, Utah, in May. This will serve approximately 1800 customers in the city and surrounding areas.

CONSTELLATION
Plans to build a $900 million hydrogen production facility in the Midwest that would combine new nuclear and green hydrogen generation tax credits to create material long-term cash flow.

ENGIE:
Part of a consortium developing a green ammonia project in Oman.

PACIFIC GAS & ELECTRIC:
Building a hybrid battery energy storage and hydrogen fuel cell system in California.

XCEL ENERGY:
Planning construction of a sustainable hydrogen energy hub in Colorado.

NATIONAL GRID:
Completed trials to test a hydrogen-powered generator at Deeside, in the UK.

SEMPRA ENERGY:
Joined Iberdrola for the development of hydrogen and green ammonia projects in the U.S.

SOCAL GAS:
Collaborating with GTI Energy to study the use of hydrogen in hard-to-decarbonize processes.

E.ON:
Helping accelerate Germany's shift towards renewable energy, prompted by the Ukraine war.

EPCIS

OVERVIEW:

From project design and engineering to regulatory compliance, these powerful EPCIs are key to cleantech innovation.

Why these three: They are paving the way for performance optimization and efficiency improvements.

BLACK & VEATCH
Providing EPCI services to what will be the world's largest industrial green hydrogen production and storage facility, the Advanced Clean Energy Storage project in Delta, Utah.

BAKER HUGHES
Developed its first hydrogen compressor in 1962 and now has more than 2,000 global units. This year, orders of $7.6 billion for the quarter are up 12 percent year-over-year, and revenue of $5.7 billion for the quarter is up 18 percent.

BOSCH
Set to invest $1.3 billion in hydrogen technology by 2025. Has just signed a deal with PowerCell Sweden that will see them adding PowerCell's hydrogen-electric fuel cell to its own production.

WOOD:
Secured funding for first large-scale green hydrogen production facility in Mosjøen, in Norway.

BECHTEL:
Providing front-end engineering with Velocys on two projects (U.S. and UK).

McDERMOTT:
Won a contract from Gunvor Petroleum for a green hydrogen terminal in Rotterdam.

SCHAEFFLER:
Building an electrolysis plant at its Bavarian factory with a capacity of up to 15MW.

TECHNIP ENERGIES:
Working with Belgian company John Cockerill offering green hydrogen solutions.

CHIYODA CORPORATION:
Developed SPERA Hydrogen technology to enable safe storage and transportation of hydrogen.

JOHNSON MATTHEY:
Building a £80 million hydrogen Giga-factory at its UK site.

ENERGY SOLUTIONS COMPANIES

OVERVIEW:

The commitment and creativity of energy solutions companies are vital to a sustainable and low-carbon future.

Why these three? For innovative solutions and implementation capabilities.

MITSUBISHI POWER
The long-established energy solutions company announced the establishment of Eneco Diamond Hydrogen B.V. (Eneco Diamond Hydrogen) to develop green hydrogen and associated renewable energy in Europe.

SIEMENS
Commissioned one of Germany's largest green hydrogen generation plants with an electrical capacity of 8.75 megawatts in Wunsiedel. It will have the facility to generate 1,350 tons of hydrogen a year.

GENERAL ELECTRIC
The industrial giant GE has been awarded two projects from the U.S. Department of Energy totaling more than $12 million to develop and test key components required for high hydrogen combustion.

HONEYWELL:
Producing low-carbon sustainable aviation fuel from green hydrogen.

ABB:
Collaborating with Lhyfe and Skyborn to optimise Sweden's SoutH2Port renewable hydro-gen project.

WÄRTSILÄ:
Delivering biogas liquefaction for Gasum's bioLNG facility, in August 2024.

SCHNEIDER ELECTRIC:
Signed framework agreement with Storengy to offer renewable underground hydrogen storage.

ROCKWELL AUTOMATION:
Announced collaboration with Avid Solutions to help companies more efficiently produce green hydrogen.

TOTAL ENERGIES:
Designing, developing and operating France's largest renewable hydrogen production site.

EQUINOR:
With RWE developing large-scale value chains for low carbon hydrogen.

FINANCIERS

OVERVIEW:

With dedicated financiers working in clean energy, this exciting sector is attracting many prominent investors.

Why these three? For dedicating resources to clean energy investments.

HY24
The world's first clean hydrogen infrastructure fund; Hy24 is a joint venture between Ardian Europe's largest private investment house with managed assets of $114 billion and FiveT Hydrogen.

BROOKFIELD RENEWABLES
Operates one of the largest publicly traded platforms for renewable energy and decarbonization solutions. Invested $1 billion in Avaada Ventures Private Limited, in India, to fund green hydrogen ventures

CITI
Is the Strategic Financial Advisor to explore growth financing options to expand hydrogen infrastructure across North America for Mitsubishi. Created a unit in 2021 dedicated to clean energy transition.

BNP PARIBAS:
Leading an investment worth approximately $14.3 million in GenCell Energy.

LAZARD:
Produces the Levelized Cost of Energy (LCOE), Storage and Hydrogen Indexes.

SANTANDER CIB:
Has a dedicated ESG team and is the sole financial advisor to Plug Power.

CREDIT AGRICOLE CIB:
Launched Crédit Agricole Transitions & Énergies to focus on energy transition.

ANTIN INFRASTRUCTURE PARTNERS:
Owns a majority stake in German renewables company Blue Elephant Energy AG.

BANK OF AMERICA:
Invested more than $200 billion in financing low-carbon and sustainable business activities globally since 2007.

KFW GROUP:
Launched the world's first financing platform for tailored financing of infrastructure for green hydrogen.

HYDROGEN END-USERS

OVERVIEW:

Integrating hydrogen into their operations, end-users have made huge strides in recent years, compounding their importance in green energy sectors.

Why these three? Proving that long-established companies and start-ups can work towards the same goals.

ZEROAVIA
Founded just five years ago with a mission to put a hydrogen-electric engine in every aircraft, this year the Californian-based start-up flew the world's largest aircraft powered by hydrogen fuel cells (Dornier 228, 19 seats).

HYUNDAI
This year, the long-established Korean motor company launched its U.S. hydrogen fuel cell truck strategy, pitching fuel cell trucks as the zero-emission replacement for diesel big rigs by introducing a Class 8 version.

TECO 2030
Norwegian-based clean tech company developing zero-emission technology for the maritime industry. Currently building up Europe's first Giga production facility of hydrogen PEM fuel cell stacks and modules in Narvik, Norway.

UNIVERSAL HYDROGEN:
Their maiden flight of a partially-hydrogen-powered Dash 8 air-craft, took place this year.

VOLVO:
Currently extreme weather testing its Class 8 VNR electric model.

H2 GREEN STEEL:
Their Swedish Giga-scale electrolyser will bring 5 million tonnes of steel to market.

DAIMLER TRUCKS:
Celebrated the first successful liquid hydrogen (LH2) refuelling of the truck (with Air Liquide).

HYZON MOTORS:
A global supplier of zero-emission heavy-duty fuel cell electric vehicles.

AIRBUS:
Currently trialing in-flight auxiliary power entirely generated by hydrogen.

ANGLO-AMERICAN:
Sourced the supply of 100 percent renewable electricity for its operations in Australia.

LAW FIRMS

OVERVIEW:

The boom in green energy means many law firms have increased staffing levels - particularly in niche areas - to meet demand

Why these three? Because they have a strategic grasp of the unique issues.

SHEARMAN & STERLING:
This long-established multi-national represents SK Group in an investment agreement with World Energy GH2 in the construction of a green hydrogen project, in Newfoundland, Canada.

KING & SPALDING:
This 138-year-old law firm has advised on all aspects of the world's largest green hydrogen and green ammonia production facility, an $8.4 billion megaproject in Oxagon, Saudi Arabia.

DLA PIPER
Representing SG H2 in the financing of a hydrogen production facility, including the signing of the hydrogen offtake agreement with Iwatani Corporation and partnership agreement with the City of Lancaster, California.

NORTON ROSE FULLBRIGHT:
Supporting the Asian Renewable Energy Hub project, in West-ern Australia.

BAKER MCKENZIE:
Advised on negotiations for Japan's Kitakyushu Hibikinada wind farm.

GREENBERG TRAURIG LLP:
Represented Greenbacker Capital Management in its acquisition of a battery energy storage system.

K&L GATES:
Represents a German bank on the financing of a fleet of 27 Alstom hydrogen trains.

VINSON & ELKINS:
Recommended in the Renewable/Alternative Power category by The Legal 500.

LATHAM & WATKINS:
Advised Porsche on its €2.5 billion sustainability-linked syndicated loan agreement.

CLIFFORD CHANCE:
Provided legal advice to Grenergy on the sale of a 150 MW solar farm in Spain.

CONSULTANCIES AND ADVISORY

OVERVIEW:

In an ever-expanding landscape, the role of consultants in green hydrogen is an important link in the chain.

Why these three companies? For their specialist outlook and expertise

DELOITTE
Released an economic analysis to show how "green hydrogen can play a paramount role to achieve net-zero targets by 2050", as well as their "Assessment of Green Hydrogen for Industrial Heat World Wildlife Fund" report, with the Renewable Thermal Collaborative.

AFRY MANAGEMENT CONSULTING
Conducted a study with inspection and certification group RINA to look at the feasibility of exporting low-carbon hydrogen produced in the Middle East through a new pipeline under the Mediterranean Sea.

GHD
A member of the Australian Hydrogen Council, GHD conducted a feasibility study to determine the lowest price per tonne of blue hydrogen from Western Canada for export to a location in Asia. Developed the national hydrogen strategy for the UAE.

HINICIO:
Consulting on an Uruguayan project to produce synthetic gasoline from green hydro-gen.

BOSTON CONSULTING GROUP:
Supporting the world's largest green hydrogen project in Denmark.

RAMBOLL:
Investigating the feasibility of producing hydrogen offshore with NortH2 in the North Sea.

GUIDEHOUSE:
Launched the Building the Clean Hydrogen Economy consortium.

KPMG:
Advised UK clean energy company GeoPura in raising £36 million in an investment round.

RICARDO:
Worked with a UK consortium to deliver the world's first green passenger-carrying airline services.

SWECO:
Conducting feasibility study into several hydrogen routes over 70km of pipeline in Bel-gium.

U.S. STATES LEADING THE HYDROGEN RACE

OVERVIEW:

With the U.S. committed to decarbonizing by 2035, scaling up production is crucial to cost reduction.

Why these three? For pressing ahead with multiple projects and taking advantage of government funding.

TEXAS
Has three hub projects bidding for Department of Energy funding, including two in Houston which produces a third of all hydrogen made in the U.S. Texas is home to more than half the nation's hydrogen pipelines.

CALIFORNIA
Long-time champion of clean energy production-around 766,604 tons of hydrogen per year is produced across the state-California is looking to secure funding under the DoE's Regional Clean Hydrogen Hub Program.

NEW YORK
Launched a $10 million initiative to advance clean hydrogen innovation. Currently, the Danskammer Generating Station, in the Hudson Valley, is going through the state's Article 10 permitting process.

ILLINOIS:
Their Hydrogen Economy Task Force will facilitate the state's deployment of hydrogen.

LOUISIANA:
Their St. Gabriel green hydrogen plant is set to have a capacity of 15 tonnes per day.

WEST VIRGINIA:
Established a Regional Clean Hydrogen Hub in the Appalachian region.

COLORADO:
First state to codify a framework dubbed the "three pillars" of clean hydrogen production.

FLORIDA:
Started construction on the state's first clean carbon hydrogen production facility in Polk County.

MISSISSIPPI:
The proposed Mississippi Clean Hydrogen Hub will produce 150 mt/d of clean hydrogen by 2030.

GEORGIA:
Established North America's first green hydrogen supply network in 2021.

CONCLUSION

Without innovation, determination and investment, there would be no progress in the production of green hydrogen. While for so many years this form of clean energy was seen as a theoretical answer to the problem of net zero and energy transition, over the last few years it has been elevated to central contributor. It doesn't hold all the answers but alongside our climate change goals, the Ukraine war has pulled focus on why the world needs to be more mindful of how and where it sources-and stores-its power.

Using hydrogen to replace fossil fuels within the world's energy systems requires significant investment in the networks and infrastructure. As our report demonstrates, there have been an increased number of partnerships formed between companies (and government agencies) as investing and raising capital has become a priority in the race to develop this economy. With continuing advancements and deployment of new technologies and significant assistance from tax credits and funding, a sustainable, low-carbon future is becoming more of a reality as the sector evolves.

With so many resources-and so much talent-being siphoned into so many global hydrogen strategies, this can only be seen as a positive step in the right direction.