



Market Intel

Pathways for clean vehicles and fuels, advanced technologies, mobility and autonomous rides, and multi-modal transportation



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Looking at the broad spectrum of hydrogen and fuel cell partner companies

One reason that hydrogen and fuel cells continue to stay visible is all the deals being made by publicly traded companies (and a small number of privately held) in the field. Here's a look at these companies that are going way beyond transportation.....

AFC Energy (LSE: AFC)

AFC Energy PLC provides a flexible range of hydrogen fuel cells and hydrogen carrier fuel conversion technologies for organizations in need of affordable, flexible, clean off-grid power, such as those in construction, electric vehicle charging, shipping, and data centres. The small company with 40 employees is based in Cranleigh, Surrey, United Kingdom.

Air Liquide

A world leader in gases, technologies and services for Industry and Health, Air Liquide is present in 75 countries with approximately 66,400 employees and serves more than 3.8 million customers and patients and a headquarters in Paris. Oxygen, nitrogen and hydrogen are essential small molecules for life, matter and energy. They embody Air Liquide's scientific territory and have been at the core of the company's activities since its creation in 1902. Thanks to its unique hydrogen expertise developed in industry (space, aeronautics, heavy industry) over the last 50 years, Air Liquide is engaged with the entire value chain: production, transport, storage and distribution. This unique positioning and technological expertise, particularly in extreme cryogenics, makes Air Liquide a key player in the implementation of hydrogen projects, enabling it to meet all the needs of its customers in many sectors of activity.

Air Products and Chemicals, Inc. (NYSE:APD)

Air Products and Chemicals, Inc. (Air Products) is an American international corporation whose principal business is selling gases and chemicals for industrial uses. Air Products' headquarters is in Allentown, Penn. The company has partnered with the AES Corp. (NYSE: AES) to invest approximately \$4 billion to build, own, and operate a green hydrogen production facility in Wilbarger County, Texas. This mega-scale renewable power to hydrogen project includes approximately 1.4 gigawatts (GW) of wind and solar power generation, along with electrolyzer capacity capable of producing over 200 metric tons per day (MT/D) of green hydrogen, which would make it the largest green hydrogen facility in the U.S., according to the company.

Amazon

Amazon has become a Tier 1 member with industry group Fuel Cell & Hydrogen Energy Association (FCHEA). The company has made some big moves in the field, including the announcement on Aug. 25, 2022, that its deal with Plug Power will provide enough annual power for 30,000 forklifts or 800 heavy-duty trucks as it continues on the path to be net-zero carbon by 2040. Amazon has signed an agreement with Plug Power, a

developer of fuel cell systems for e-mobility, to supply 10,950 tons per year of green hydrogen for its transportation and building operations starting in 2025. The company will start to use green hydrogen to replace grey hydrogen, diesel, and other fossil fuels as it works to decarbonize its operations, and this green hydrogen supply contract will provide enough annual power for these forklifts and heavy-duty trucks.

Ballard Power (NASDAQ:BLDP)

The Vancouver, BC-based company's zero-emission PEM fuel cells are enabling electrification of mobility, including buses, commercial trucks, trains, marine vessels, and stationary power. Amogy Inc., a Brooklyn, NY-based pioneer of emission-free, energy-dense ammonia power solutions, recently announced the signing of a contract to purchase fuel cell engines from Ballard for ammonia-to-power maritime applications. Ballard's FCwave™ engine is a scalable fuel cell system certified for operation in marine environments. Amogy's proprietary ammonia-to-power platform relies on unique ammonia cracking technology, facilitating the extraction of hydrogen onboard for fuel in a hydrogen engine. Amogy's platform was successfully demonstrated in several industrial applications. The Amogy team is currently scaling the technology for use in maritime vessels, with plans for a tank barge and tugboat operations. Under this contract, Amogy agrees to purchase an initial order of three, 200kW FCwave™ engines and Ballard will support integration of the fuel cell engines with Amogy's proprietary ammonia reforming system.

Bosch

Bosch is now a Tier 1 member with FCHEA. Parent company Robert Bosch GmbH, commonly known as Bosch and stylized as BOSCH, is a German multinational engineering and technology company headquartered in Gerlingen, Germany. Bosch is a leading global supplier of technology and services in four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT provider, Bosch offers innovative solutions for smart homes, Industry 4.0, and connected mobility. In the area of fuel cell, Bosch is developing both stationary and mobile fuel-cell solutions and from 2021 to 2024, Bosch plans to invest one billion euros in fuel cell technology.

Cummins Inc. (CMI) has become a FCHEA Tier 1 member. The company's products range from diesel and natural gas engines to hybrid and electric platforms, as well as related technologies, including fuel cell and hydrogen generation systems. The company's solutions are based on two main platforms – fuel cells for power and electrolyzers for hydrogen generation and storage. Cummins' HyPM™ fuel cell power modules offer a flexible and robust platform for easy integration with medium and heavy-duty mobility applications including trucks, buses, trains, boats and planes to backup, stationary and continuous power. It's the leading supplier of PEM and alkaline electrolyzers for on-site renewable hydrogen production, fueling stations and megawatt scale Power-to-Gas energy storage systems.

FuelCell Energy, Inc. (NASDAQ:FCEL)

FuelCell Energy is a global leader in sustainable clean energy technologies that address some of the world's most critical challenges around energy, safety, and global urbanization. It collectively holds more than 450 fuel cell technology patents in the U.S. and globally. As a leading global manufacturer of proprietary fuel cell technology platforms, FuelCell Energy is uniquely positioned to serve customers worldwide with sustainable products and solutions for businesses, utilities, governments, and municipalities. The Company's solutions are designed to enable a world empowered by clean energy, enhancing the quality of life for people around the globe.

GTS Leasing is now a FCHEA Tier 1 member.

Green Trucking Solutions LLC, dba GTS Leasing, is a team of professionals from the Transportation and Logistics industry with over 50 years of experience. GTS develops infrastructure for renewable fuel sources such as CNG, EV, and hydrogen for heavy-duty trucks and the general public. At GTS Leasing, the company is known for leasing some of the most popular semi-trucks in the industry such as the 2023 Kenworth T680 Next Gen. Its family-owned company ITM Equipment produces one of the most popular Solar APU Systems in America.

ITM Power (OTCPK:ITMPF, LSE:ITM)

ITM Power, a UK-based company, manufactures integrated hydrogen energy solutions for grid balancing, energy storage, and the production of renewable hydrogen for transport, renewable heat, and chemicals. ITM Power operates from the world's largest operational electrolyser factory in Sheffield with a capacity planned to reach 1.5 GW (1,500 MW) per annum and has an ambition to grow capacity in line with demand to 5 GW per annum. Partners include Linde, Shell, Snam, and Vitol among others.

Linde plc (NYSE:LIN)

Linde plc is a global multinational chemical company founded in Germany and, since 2018, has been operationally based in Ireland and headquartered in the U.K. Linde is a leading global industrial gases and engineering company with 2021 sales of \$31 billion. The company serves a variety of end markets including chemicals & energy, food & beverage, electronics, healthcare, manufacturing, metals, and mining. Linde's industrial gases are used in countless applications, from life-saving oxygen for hospitals to high-purity and specialty gases for electronics manufacturing, hydrogen for clean fuels, and more. Linde also delivers state-of-the-art gas processing solutions to support customer expansion, efficiency improvements and emissions reductions.

Plug Power (NASD:PLUG)

Plug Power is part of building the hydrogen economy as a leading provider of comprehensive hydrogen fuel cell (HFC) turnkey solutions. The Company's innovative technology powers electric motors with hydrogen fuel cells amid an ongoing paradigm shift in the power, energy, and transportation industries to address climate change and energy security, while providing efficiency gains and meeting sustainability goals. Plug created the first commercially viable market for HFC technology. As a result, the Company has deployed over 50,000 fuel cell systems for e-mobility, more than any other supplier in the world, and has become the largest buyer of liquid hydrogen, having

built and operated a hydrogen highway across North America, the company says. Plug delivers a significant value proposition to end-customers, including meaningful environmental benefits, efficiency gains, fast fueling, and lower operational costs. Plug's vertically integrated GenKey solution ties together all critical elements to power, fuel, and provides service to customers such as Amazon, BMW, The Southern Company, Carrefour, and Walmart. The Company is now leveraging its know-how, modular product architecture, and foundational customers to rapidly expand into other key markets including zero-emission on-road vehicles, robotics, and data centers.

Proton Power Systems (LSE:PPS)

Proton Motor Fuel Cell GmbH has been developing its own hydrogen fuel cells for a quarter of a century and combines them with selected components tailored to the customer's area of application to form fuel cell systems and hybrid solutions ready for integration. These complete solutions from a single source distinguish Proton Motor from pure system integrators. Only through this holistic approach with optimal bundling of know-how – from the fuel cell stack to the hybrid complete solution – can customers always be offered a very economical solution from this German company.

Quantum Fuel Systems LLC (QTWWQ)

Quantum Fuel Systems LLC, based in Lake Forest, CA says that it's engineering the future of alternative fuel storage by designing, developing and bringing innovative transport trailers, and industry-leading Type 4 cylinders for Hydrogen and CNG to market. Quantum is at the forefront of the industry with decades of experience in gaseous fuel storage and systems solutions. Quantum and Renewable Innovations, a firm dedicated to clean, green hydrogen power solutions, announced a partnership to bring to market new solutions for hydrogen distribution. As the world quickly moves to Hydrogen as a clean, green source of power, the infrastructure must also accelerate to meet the needs of the growing hydrogen economy, the two companies said. To help address this challenge, Renewable Innovations will incorporate Quantum Hydrogen storage vessels in its mobile Fuel Cell and H2 transport systems.

Southern Company (NYSE:SO)

Southern Company Gas is a wholly owned subsidiary of Atlanta-based Southern Company, a major American energy company. Southern Company Gas serves approximately 4.2 million natural gas utility customers through its regulated distribution companies in four states with approximately 700,000 retail customers through its companies that market natural gas. Other nonutility businesses include investments in interstate pipelines, asset management for natural gas wholesale customers, and ownership and operation of natural gas storage facilities. Southern Company and its Southern Company Gas subsidiary have helped to start a new research and development (R&D) initiative, known as HyBlend, to address the technical barriers to blending hydrogen in natural gas infrastructure and study life-cycle emissions of hydrogen blends. As the leading energy industry sponsor, Southern Company Gas will spearhead the initiative. The HyBlend project will utilize expertise in Southern Company's industry-leading R&D organization, along with industry partners, research

consortia, academia and national laboratories, and encompass more than \$15 million in hydrogen research.

What's really going on with autonomous vehicles these days?

If you take a good look at where self-driving passenger cars, drones, and autonomous transport is going these days, there are a few positive stories. But most of what's coming



out implies that AVs still have a few years left before gaining mass market approval.

- **Alphabet Inc.'s Waymo division** is ready to take its valuable experience learned from its Phoenix experience with its Waymo One autonomous ride service over to San Francisco. The company just applied for the final permit it needs in California before it can sell fully autonomous rides. It could take months for the California Public Utilities Commission to rule on the request. General Motors' Cruise is the only company with a permit so far for autonomous rides in San Francisco since June. Cruise is seeking permission to test its purpose-built robotaxi, the Origin, on public roads in San Francisco. That was just submitted to the California Department of Motor Vehicles (DMV) this month. Waymo says that Los Angeles will be the next city it sets up a Waymo One store within.
- **Drones continue to be the most used** autonomous vehicles out there, whether that be by land or sea. Amazon and other companies continue testing delivery drop offs by air. One of the more contentious parts of it is use of drones and robots by law enforcement. Nigeria's national police recently received their first shipment of armed drones from Turkey. The San Francisco PD had **a temporary constraint placed** on its access to deployed robots that are able to use lethal force. Finding and deconstructing bombs has been in use by Cleveland and other police departments since 1974. But the "robocop" method is still in question, and San

Francisco officials want to take a closer look at what's happened with law enforcement agencies using them.

As for the areas of concern.....

- Even after \$100 billion being invested in the technology by several companies, autonomous vehicles are going nowhere for now, according to a few experts. **One of them is Anthony Levandowski** who co-founded Google's self-driving car program in 2009, now known as Waymo, and was a technical lead until 2016. In 2016, he co-founded and sold Otto, an autonomous trucking company, to Uber Technologies. Government safety investigations are part of it — but the worst part is that the test vehicles are nothing more than glorified tech demos, Levandowski said.
- **Shenzhen, China, is the bright spot** for the country in putting together a sophisticated set of test vehicles and getting fully autonomous vehicles in full test mode. Pony.ai, Baidu, DeepRoute, AutoX, and other startups, want very much to go that level. So far, they've been required to have a safety driver in the test car, sitting right at the steering wheel. The Shenzhen government is moving it closer to that level, but it appears it will be taking a while.
- **San Francisco-based Embark had been the shining star** of autonomous driving for the trucking industry. But it's gone through about a 98% share price decline since going public a year ago. That's wiped out about \$5 billion in market capitalization. Now Embark and a few other companies that carried out SPAC mergers are in the delicate place of trading below the value of cash reserves.
- **Argo AI was an autonomous driving technology company** headquartered in Pittsburgh, Penn., that was getting a lot of backing. Amazon planned to use Argo's self-driving technology to automate some of the electric delivery vans it's buying from Rivian Automotive Inc., setting up a test fleet in multiple US cities. Long-time supporters Ford and Volkswagen were pleased to see Amazon come into the game. **But it all fell apart recently** due to a sputtering economy, concerns about control, and flagging faith in autonomous vehicles. The three companies couldn't come up with a viable governance structure for how they could jointly oversee and manage Argo. Amazon was also turned off by the high cost of Argo's technology as well, one source said.
- **The disappearance of Argo AI will set Ford back** a few years in its own plans. Ford's BlueCruise and Lincoln's counterpart ActiveGlide have done very well with car buyers, with nearly 100,000 of them choosing the option. The hands-free driving assist feature has gone over very well, and it got Ford developing a Level 3 version of the software. **Ford CEO Jim Farley recently said** that with Argo AI shutting down, it doesn't look like a Ford self-driving vehicle feature is coming up anytime soon. Ford North America Product Communications director Mike Levine recently confirmed that statement from the CEO via Twitter.

Ever since the 2019 fatality in which an Uber test car with an onboard observer hit and killed a pedestrian, the technology has been under more pressure to prove itself. A few more fatal crashes involving Tesla's AutoPilot has also kept safety concerns high on

the list. The big picture question of who will be liable and responsible for serious damage being done to people and property will need to be somehow resolved before autonomous vehicles are allowed on roads in any type of significant numbers.

For now, most experts and observers expect the testing to continue, and that the most likely scenarios will be autonomous buses and vans providing limited transport in contained spaces — workplace, senior living community, and university campuses are the most commonly mentioned spaces for it to be viable.