MOBILITY INDUSTRY INSIDER

Bulletin - MAY 2020

Alternate Fuels

Major developments, COVID-19's impact and Startup Highlights

What's inside ?

- Major developments in Alternate fuels in May 2020
- Efforts made by governing bodies to minimize the impact of COVID-19 pandemic in the automotive industry
- Spotlight on: COVID-19 recovery strategies taken by major economies
- Startup highlight : Hyzon Motors

FutureBridge

THEMES AND KEY TAKEAWAYS IN Bulletin

01 **Major developments in Alternate fuels**

02 **COVID-19 recovery strategies taken by: US, EU, Asia**

03 **Strategies to overcome COVID-19: US & EU**

04 **Startup highlight for the month: Hyzon Motors**

05 **Appendix**

Contents covered in this Bulletin	Key Takeaways
Major developments in Alternate fuels ▪ COVID-19 recovery plans announcements: USDA, IEA and Diesel Forum ▪ Investments and competency building for fuel cell vehicles ▪ Research work for advanced hydrogen fuel cells ▪ Collaborations and partnerships for hydrogen fuel cells	▪ Coronavirus is negatively affecting the Alternate fuels sector. New recovery methods are going to be implemented in the US and EU. ▪ New startups are evolving to compete with leaders in fuel cell vehicles. ▪ Researchers are focusing on advancements in fuel cell design and hydrogen production ▪ Collaborations between fuel cell suppliers and manufacturers for FCEVs
Spotlights on: Recovery strategies for COVID-19 impact on alternate fuels, taken by major economies in the world ▪ Analysis of strategies taken by major economies such as the US and EU	▪ Governing bodies and related associations, across the world, are implementing new strategies to overcome the COVID-19's impact on the Alternate fuel sector ▪ The U.S Biofuel sector is badly affected by the pandemic and associations such as USDA, IEA, and Diesel Forum are announcing recovery strategies. ▪ The European Union is showing commitment to improving the continent's energy infrastructure by announcing a carbon-neutral plan of €750 billion.
Startup highlight for the month: Hyzon Motors ▪ Technology analysis of a startup which recently launched and working on fuel cell-powered commercial heavy-duty trucks	▪ Hyzon Motors officially launched as a spin-off of Horizon Fuel Cell Technologies in March 2020. They are planning to manufacture hydrogen-powered fuel-cell heavy-duty trucks and announced their plans to expand their business to Australia and Europe.

Strategies to overcome COVID-19's impact

Coronavirus is negatively affecting the Oil&Gas industry. There is no difference in the Alternate fuels sector as well. The demand for vehicles, as well as fuels, has decreased due to locked down restrictions implemented by governments across the world to contain the pandemic.

04-May-2020

USDA announces $100 million in competitive grants for American Biofuels Infrastructure

- The U.S. Department of Agriculture plans to make available up to $100 million in competitive grants to expand the availability and sale of renewable fuels.
- They are aiming to grant $86M for implementation activities related to higher blends of ethanol, and $14M for implementation activities related to higher blends of biodiesel.

Analyst Comment

- The Higher Blends Infrastructure Incentive Program (HBIIP) intends to increase significantly the sale and use of higher blends of ethanol and biodiesel by expanding the infrastructure for renewable fuels derived from the U.S. agricultural products. This grant would help US bio crop farmers and fuel manufacturers to overcome the loss caused due to the Coronavirus pandemic.
- U.S gasoline includes 10 percent ethanol. But the demand for gasoline is decreasing due to COVID-19 restrictions. As governments urge people to stay indoors to curb the outbreak, fuel demand has tapered.
- Covid-19 is hitting badly on the biofuel sector and is already depressing corn and other grain prices. Many US ethanol plants have slashed production over March 2020 or idled entirely as the coronavirus outbreak cut into fuel consumption.
- Weaker demand for diesel is causing a reduction in demand for biodiesel, which is indirectly leading to reductions in demand for biodiesel feedstock.

04-May-2020

IEA: Green energy could drive Covid-19 recovery with $100tn boost

- The International Energy Agency has praised the economic and environmental potential of renewable hydrogen and batteries as it urges governments to consider the decarbonization commitments they made before the outbreak of COVID-19.
- According to the IEA report, renewable energy could power an economic recovery from COVID-19 by spurring global GDP gains of almost $100tn (£80tn) between now and 2050.
- The agency highlighted the bulk of hydrogen produced today is done via coal or gas, releasing 800 million tones of CO_2 per annum globally.

Analyst Comment

- The impact of the crisis on energy demand is heavily dependent on the duration and stringency of measures to curb the spread of the virus. Full lockdowns have pushed down electricity demand by 20% or more, with fewer impact from partial lockdowns. Electricity demand is set to decline by 5% in 2020. After 10 years of uninterrupted growth, natural gas demand is on track to decline by 5% in 2020.
- According to a study conducted by Shell, 113 million fuel cell, electric vehicles (FCEVs) could save up to 68 million tonnes of fuel and almost 200 million tonnes of carbon emissions, making a significant contribution to reducing energy consumption and greenhouse gas emissions in the transport sector.

Players are building competency on fuel cell vehicles

New startups are evolving to compete with leaders in fuel cell vehicles. BMW continuing its commitment towards FCEVs.

18-May-2020

Hyzon Motors aims to compete in hydrogen heavy-duty vehicles

- Hyzon Motors signed an MOU with an undisclosed company for the manufacture of 1000 fuel cell-powered 40-foot single cab buses.
- The company announced that it is capable of producing up to 10,000 buses and trucks a year, with 370 kW (500 horsepower) Horizon fuel cells.

Analyst Comment

- Hyzon Motors was launched by Horizon Fuel Cell Group, to develop heavy-duty FCEVs and fuel cell stacks exceeding 100kW. Under the Hyzon brand, Horizon launched its first fuel-cell electric vehicles in January 2020, with semi-prototype trucks for Australian consumers. The company has signaled its ambitions of providing fuel cells for a wide range of vehicles. The vehicle line will include trucks from 15 tons to 40 tons, powered by fuel cell stacks between 100kW and 200kW.
- The company claims that fuel efficiency can vary between 3 and 12 km/kg, with its standard range of trucks expected to offer 500 km of range with 48 kg of hydrogen, up to 2000km with 192kg. Next year the company aims to add other light commercial vehicles and types on the van platform. This includes road-trains with a gross weight of up to 140 tonnes set for commercialization in 2021 in Australia. Hyzon aims to compete with FCEV forerunners such as Nikola, Toyota, and Hyundai.

07-May-2020

BMW hydrogen fuel cell investment confirms commitment to EVs

- BMW is planning to continue its focus on both electric cars and hydrogen fuel-cell vehicles.
- The company is going to invest more than €30 billion ($32 billion) into research and development, especially for hydrogen fuel cell passenger cars.

Analyst Comment

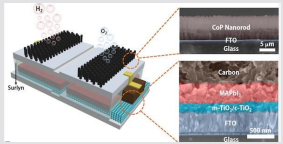
- BMW is showing faith in hydrogen fuel cell technology with the help of Toyota. They are jointly developing the BMW iHydrogen NEXT that generates up to 125 kW from fuel cell reaction. The company remains committed to meeting both the new EU fleet emission targets and Euro 6d emissions standards.
- Other carmakers such as Honda, Hyundai, and Toyota are showing commitment to FC passenger cars. On the other hand, Daimler shut down the FC passenger car development program in April and focusing on FC based heavy-duty vehicles.
- According to the 2019 sales report, FCEV sales have improved to 7500 globally. Hyundai NEXO leads the sales with 4,818 number of cars followed by Toyota Mirai (2407), and Honda Clarity Fuel Cell (349). BMW Group sales were down 20.6% globally in the first three months of 2020, including an 18% decline in Europe due to COVID-19. Various European countries are beginning to slowly ease restrictions, which could lead to car dealerships opening with social-distancing protocols in place.

Research work for advanced hydrogen fuel cells

Researchers are focusing on advancements in fuel cell design and hydrogen production

15-May-2020

Rice University's artificial leaf creating breakthrough in hydrogen fuel production



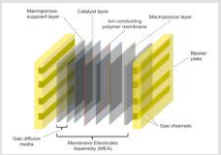
- Researchers from Rice University developed a new technology called, "artificial leaf" that could potentially be used as an alternative to the current common methods for obtaining hydrogen.
- It is a hydrogen generation process, able to produce H2 fuel from sunlight and water. It has the potential to be far more economical than previous iterations of hydrogen fuel cell technology.
- The fuel cell includes catalytic electrodes and perovskite solar cells that, when triggered by sunlight, produce electricity. The current flows to the catalysts that turn water into hydrogen and oxygen, with a sunlight-to-hydrogen efficiency as high as 6.7%.

Analyst Comment

- Photocatalytic water splitting converts water into hydrogen and oxygen and is a major research topic of artificial photosynthesis. In this technology, a photoelectrochemical cell used for the dissociation of water into hydrogen (H2) and oxygen (O2), using either artificial or natural light. Light-driven carbon dioxide reduction is another process studied that replicates natural carbon fixation.

18-May-2020

Scientists discover new polymer glass to boost support for hydrogen fuel cells



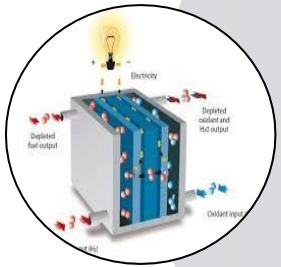
- Researchers from the Institute for Integrated Cell-Material Sciences (iCeMS) have found a new polymer glass offering solid support for hydrogen fuel cell membranes.
- Scientists are researching ways to synthesize more efficient and stronger hydrogen fuel materials. Currently, the majority of hydrogen fuel cells use liquid membranes. The new polymer glass membrane appears to function equally as effective as the conventional liquid materials while adding flexibility and strength.

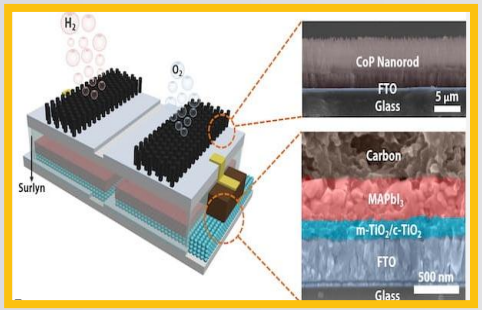
Analyst Comment

- A proton conducting membrane is necessary for a fuel cell. Their function is to facilitate separating the positive and negative hydrogen particles, protons, and electrons. That is was results in electricity generation. The liquid membranes currently used cannot effectively operate under dry conditions.
- As a result, manufacturing is expensive and complex. Whereas, solid membranes made from electrolytes without water efficiently conduct protons and are cost-efficient. It has better thermal and mechanical stability when compared to conventional liquid membranes.

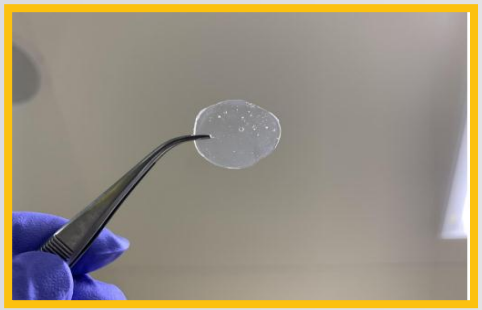
Research work for advanced hydrogen fuel cells

Researchers are finding new materials for advanced fuel cell operations.





- Artificial leaf technology: The technology uses artificial photosynthesis process with photocatalysis in a photoelectrochemical cell used for the dissociation of water into its constituent parts, hydrogen (H2) and oxygen (O2), using either artificial or natural light. Theoretically, only light energy (photons), water, and a catalyst are needed.
- The fuel cell which is made with Perovskites are crystals with cube like lattices that are known to harvest light. The most efficient perovskite solar cells produced so far achieve an efficiency above 25%, but the materials are expensive and tend to be stressed by light, humidity and heat.



- Polymer glass membrane for fuel cell: The research team fabricated this new membrane by combining a “protonic ionic liquid” with zinc ions. Those liquids are essentially liquid salts created by combining an acid and a base.
- The team used a specific version called diethylmethylammonium dihydrogen phosphate and added zinc to it which resulted in solid, elastic polymer glass. Its molecular structure allows protons to move across its membrane under dry conditions at 120ºC (about 250ºF). It produced high voltage (0.96 volts) when tested in a hydrogen fuel cell.

Collaborations and partnerships for hydrogen fuel cells

Collaborations between fuel cell suppliers and manufacturers for advanced FCEVs.

21-May-2020

HyPower to use Honeywell's technology for Hydrogen fuel cells

- Beijing HyPower Energy Technology Ltd is going to adopt Honeywell UOP technologies to supply high-purity hydrogen for fuel cells.
- Through the agreement, HyPower will deploy a range of Honeywell solutions such as Polybed™ PSA, thermal swing adsorption to purify hydrogen fed into fuel cells.

Analyst Comment

- China focuses on new energy vehicles (such as BEVs and FCEVs), and its market is expected to grow up to 7 million by 2025. In 2015, the Chinese government published the Made in China 2025 initiative to upgrade Hydrogen fuel infrastructure, including more number of production units.
- Production of high-quality pure hydrogen: Pressure Swing Adsorption (PSA) technology is the process for hydrogen recovery/purification applications where the feed stream is at low to an intermediate pressure (<1000 psig) and where downstream process requirements require minimum pressure reduction and high purity hydrogen product. UOP Polysep™ Membranes offer low-cost solutions for high-pressure hydrogen separations. In today's economic environment, with constrained capital expenditure, Polybed PSA systems are a relatively low-cost investment that can allow facilities to meet their increased production targets with a short payback period. Moreover, High-purity hydrogen increases energy-efficiency reduces environmental impact.

23-May-2020

ITM Power and Partners to deploy H2OzBus across Australia

- ITM Power formed a consortium with several companies to produce and distribute H2OzBus, powered by hydrogen across Australia.
- The partners have signed a memorandum of understanding as a further step in evaluating and demonstrating the concept of hydrogen fuel cell electric buses for use in public bus transport in Australia.

Analyst Comment

- The consortium comprises Transit Systems, part of the SeaLink Travel Group Ballard Power Systems, BOC Limited, Palisade Investment Partners, and ITM Power.
- ITM Power and BOC will provide hydrogen production and refueling infrastructure. Whereas, Ballard Power Systems will supply the fuel cell system.
- ITM Power is already in collaboration with Shell for hydrogen refueling infrastructure. They formed a joint venture with Linde for larger scale hydrogen production.

01

COVID-19 recovery strategies taken by major economies

COVID-19 recovery strategies for Alternate fuels taken by: US, EU and Asian countries

SPOTLIGHT

Alternative Fuels
US implementing COVID–19 recovery plans in Alternate fuel sector

COVID-19 is badly hitting the oil and gas industry and thereby Alternate fuels. Policymakers are announcing future economic stimulus packages as part of a COVID-19 recovery plan, such as investments/grants and suspension of taxes. Associations such as the USDA and Diesel forum are executing the plan of action to recover from the impacts that Corona caused in the US. According to a report published by IEA renewable hydrogen and batteries could power an economic recovery from COVID-19 by spurring global GDP gains of almost $100tn (£80tn) between now and 2050.

USDA announces $100 million in competitive grants for American Biofuels Infrastructure

As a result of lockdowns, road transport has dropped between 50-75 per cent with the average global road transport activity falling to 50 per cent

Grant would help US bio crop farmers and fuel manufacturers to overcome the loss caused due to the Coronavirus pandemic

According to IEA, Global energy demand for the first quarter of this year fell by 3.8% compared to last year

Diesel Technology Forum is planning to suspend federal excise tax (FET) for new heavy-duty truck

US is going to suspend the federal excise tax (FET) through 2021 for new heavy-duty commercial truck purchases

The decision is to encourage truckers to invest in technologies that are commercially available and deliver economic and environmental benefits

Diesel engines are the workhorse of the trucking industry and power over 95 percent of the largest tractor trailer trucks

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SPOTLIGHT

Alternative Fuels
EU proposed COVID-19 recovery plan for energy sector

The European Commission (EC) has unveiled a "major recovery plan" to help Europe recover from the Covid-19 pandemic, with several long-term commitments to improving the continent's energy infrastructure. It has proposed a €750 billion package that looks to balance economic recovery with EU commitments for carbon neutrality by 2050.

"A green recovery is economically beneficial, but also the only option when the alternative means further carbon lock-in and fuelling the climate crisis for decades to come. Carbon-intensive companies that receive financial support should be required to implement climate change transition plans consistent with the Green Deal and Paris Agreement,".
–Stephanie Pfeifer, CEO, Institutional Investors Group on Climate Change (IIGCC)

Agreement for COVID recovery

EU countries committed to work together, forging a general agreement to align coronavirus economic recovery efforts with progress on climate change >>

Major recovery plan for COVID-19: announcement

European Union proposed Green energy economic recovery plan >>

Mar 2020 — **Apr 2020** — **May 2020** — **May 2020**

10 countries to urge for pandemic recovery plans

Sweden, Netherlands, Italy, Spain, Austria, Denmark, Finland, Portugal, Latvia and Luxembourg - urged the EU to adopt a "green" recovery plan >>

Demand for Natural gas to be included in recovery plan

Bulgaria, the Czech Republic, Greece, Hungary, Lithuania, Poland, Romania and Slovakia are demanding to include Natural gas projects in "Green Recovery Plans" >>

- The majority of the countries in the EU, along with the EU Commission, are pushing to commit to **net zero emissions by 2050**.
- With oil prices low, this is a ripe moment to eliminate fossil fuel subsidies in favor of renewables.
- A healthy and safe COVID-19 recovery requires that countries fully commit to investing and rebuilding for a **sustainable future**.
- **Just Transition Fund (JFT)**: Budgeted at €7.5 billion, basically helps regions and communities working in the fossil fuel sector transition to green energy jobs.
- The Commission has proposed €500 billion in grants and €250 billion in loans to the member states.

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COVID-19 impact on Biofuels: Recent developments

Governing bodies and related associations, across world are implementing new strategies to overcome the COVID-19 pandemic effects on Alternate fuel sector.

COVID impacts by region, Strategies taken by governing bodies to overcome the impact

US	▪ U.S. biofuel producers and farmers are facing continuous economic hardship as ethanol plants are forced to idle due to market conditions caused by the COVID-19 pandemic. ▪ Fuel demand has fallen by more than half. On an annual basis, that equates to as many as 7 or 8 billion gallons loss of ethanol demand, or the market for approximately 2.4 to 2.7 billion bushels of corn	Strategies ▪ USDA announces $100 million in competitive grants for American Biofuels Infrastructure ▪ The Higher Blends Infrastructure Incentive Program (HBIIP) intends to increase significantly the sale and use of higher blends of ethanol and biodiesel by expanding the infrastructure for renewable fuels derived from the U.S. agricultural products.
Europe	▪ French Biodiesel firm Avril has revealed it has temporarily closed some of its production as demand drops due to the pandemic and social distancing rules	Strategies ▪ European ethanol producers cooperating with Member States where needed to ensure the production and supply of ethyl alcohol for hand sanitizer. ▪ European Union proposed "Major recovery plan" for COVID-19 impact on energy sector.
Asia Malaysia	▪ Malaysia to delay start of B20 Biodiesel mandate(for biofuel with 20% palm oil component) due to COVID-19.	Strategies ▪ Malaysia's FGV Holdings, crude palm oil producer, aims to increase returns from its renewable energy projects. These include producing biogas fuels (gas, solid and liquid) to generate power
Indonesia	▪ Indonesian government has delayed the implementation of B20 and E10 mandates due to COVID-19. ▪ Indonesia looking at how it can continue with B30 despite of reduced fuel demand due to COVID-19.	Strategies ▪ Indonesia looking at new ways to subsidize biodiesel. Biodiesel prices are subsidized by the government fund that levies taxes on palm oil exports but with the low price of palm oil.

02

Startup of the month- Hyzon Motors: Fuel cells for commercial vehicles

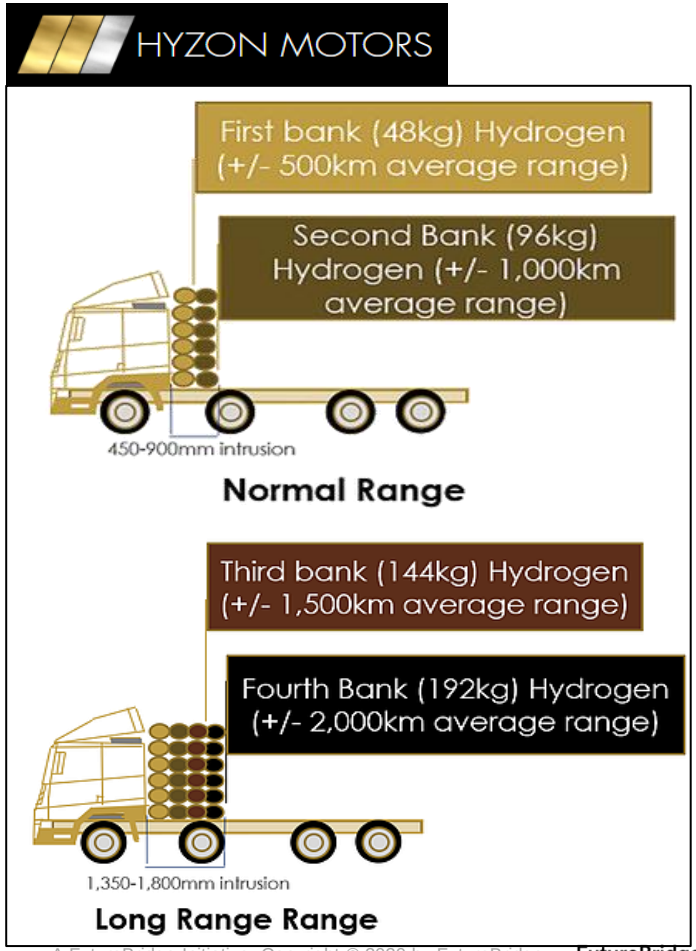
HYZON MOTORS

Startup highlight – Hyzon Motors

Hyzon Motors:

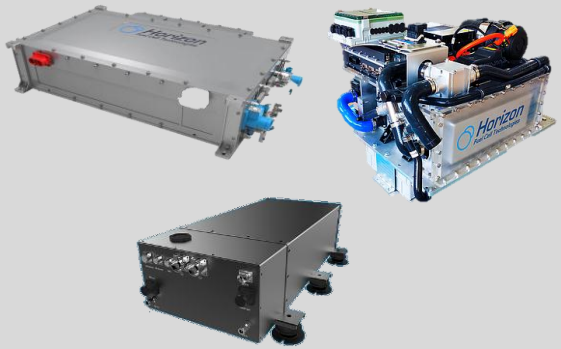
Hyzon Motors is a new fuel cell heavy-duty truck manufacturer founded on March 2020

Business strategies	• Hyzon Motors was launched by Horizon Fuel Cell Group, to develop heavy-duty FCEVs and fuel cell stacks exceeding 100kW. • Under the Hyzon brand, Horizon launched its first fuel-cell electric vehicles in January 2020, with semi-prototype trucks for Australian consumers. • The company has signaled its ambitions of providing fuel cells for a wide range of vehicles
Technology	➢ Hyzon motors develops world's first 150kw Fuel Cell Trucks. The vehicle line will include trucks from 15 tons to 40 tons, powered by fuel cell stacks between 100kW and 200kW. ➢ The company claims that fuel efficiency can vary between 3 and 12 km/kg, with its standard range of trucks expected to offer 500 km of range with 48 kg of hydrogen, up to 2000km with 192kg. ➢ Next year the company aims to add other light commercial vehicles[5] and types on the van platform. **Power Systems** • 150 kW Hydrogen Fuel Cell Hybrid Electric (40t) • 200 kW Hydrogen Fuel Cell Hybrid Electric (40-60t) • 370 kW Hydrogen Fuel Cell Hybrid Electric (80t)



Role of fuel cells in Commercial vehicles

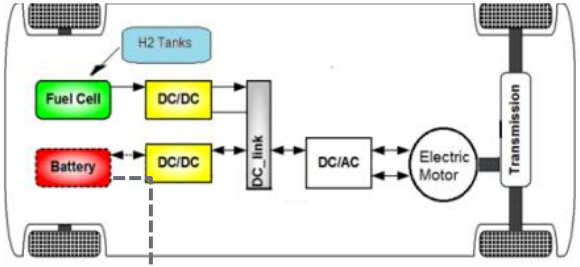
Hyzon Motors: Horizon fuel cell technology



- Hyzon Motors is using Horizon's fuel cell technology
- VL 30 to VL100 Fuel Cell from Horizon deliver high power density which can be readily used in cars, buses, passenger cars and logistics vehicles.
- PEM FUEL CELL SYSTEM
  - ➢ Compact 30-100kW module
  - ➢ System efficiency 42-46%
  - ➢ Liquid-Cooled
  - ➢ Simple operation

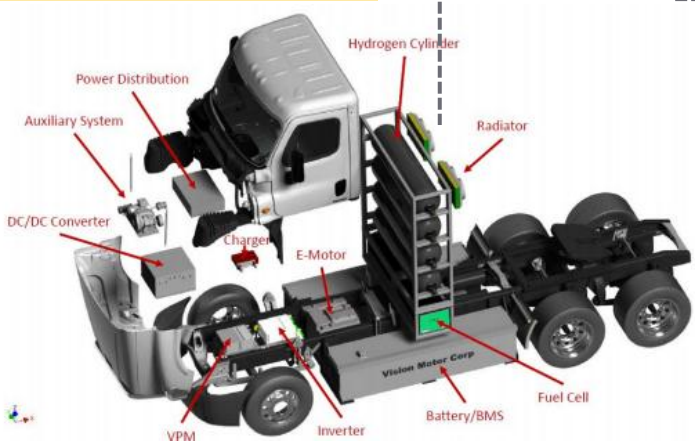
1. Fuel cell stack

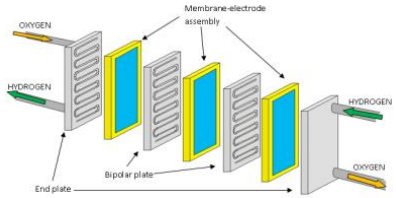
Fuel cells produce electricity through a chemical reaction, typically between hydrogen and oxygen, with water and heat as byproducts. In a fuel cell vehicle, the electricity is used to power an electric motor that drives the vehicle's wheels. Fuel cells convert roughly 50% of the hydrogen's energy into electricity. Recently Nikola has developed hydrogen-electric fuel cell truck that could surpass 1,000 miles between stops and top off in 15 minutes.



3. Battery

Energy density up to 1,100Wh/kg on a material level and 500 Wh/Kg on a production cell level including; casing, terminals and separator -- more than double current lithium-ion battery cells.





Fuel cell Commercial vehicles

Hydrogen fuel would be a perfect solution for commercial vehicle applications. It offers much higher specific energy than batteries. The lighter weight contributes to solving the range and payload issues inherent with a 100% battery-powered propulsion.

Existing models of FC powered commercial vehicles

Nikola Motors
Nikola provides heavy-duty trucks with estimated range of 500-750 miles (1,200+km) between fill ups.

Toyota
Toyota along with its partner Hino is developing hydrogen fuel cell heavy-duty truck.

Some key Players

NIKOLA, TOYOTA, HYUNDAI, KENWORTH

Some key suppliers of fuel cells for commercial vehicles:

BOSCH, BALLARD, Cummins, CeresPower

Concepts and new models revealed for FC powered commercial vehicles

Oct 30, 2019

***Cummins** unveiled hydrogen fuel cell truck concept >>*

Nov 01, 2019

***Hyundai** revealed fuel cell truck concept >>*

Jan 20, 2020

***Honda-Isuzu** collaboration for fuel cell truck >>*

Apr 20, 2020

***Daimler-Volvo** joint venture for fuel cell truck >>*

03

Appendix

Appendix

S.No	Development	Date	Type	URL
1	Arcola Energy and Optare launch Metrodecker H2 hydrogen fuel cell double-deck bus	1-May-20	Technology development	Link
2	Researchers develop new composite membrane for direct ethanol fuel cells	5-May-20	Technology development	Link
3	IEA touts hydrogen and batteries as key to COVID-19 recovery	4-May-20	Announcement	Link
4	USDA announces $100 million in competitive grants for American Biofuels Infrastructure	4-May-20	Investment	Link
5	BMW hydrogen fuel cell investment confirms commitment to EVs	7-May-20	Investment	Link
6	Hyundai Motor to jointly establish hydrogen refuelling station for fuel cell electric buses at Incheon Airport	12-May-20	Announcement	Link
7	Hyzon Motors compete in hydrogen heavy-duty vehicles	18-May-20	Product launch	Link
8	Rice University's artificial leaf creating breakthrough in hydrogen fuel production	15-May-20	Technology development	Link
9	Scientists discover new polymer glass to boost support for hydrogen fuel cells	18-May-20	Technology development	Link
10	Air Products and Topsoe sign global alliance agreement for collaboration on large-scale Ammonia, Methanol, DME projects	16-May-20	Technology development	Link

Latest deliverable to read

Special Pulse – Impact of COVID-19 on AF >>

What's new in Pulse ?

1. Market development in the midst of COVID & scenarios for 2020: China, USA and Europe
2. COVID-19: Positive and negative impact on Alternate fuel sector

Upcoming deliverable

Q2 2020 Pulse – AF

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