



Alternative Fuels

MARCH | 2020
BULLETIN



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- **European Union** new announcement on clean hydrogen alliance
- **Aiways** revealed first edition of methanol fuel cell supercar
- **Toyota-Hino** partnership for fuel cell heavy duty truck
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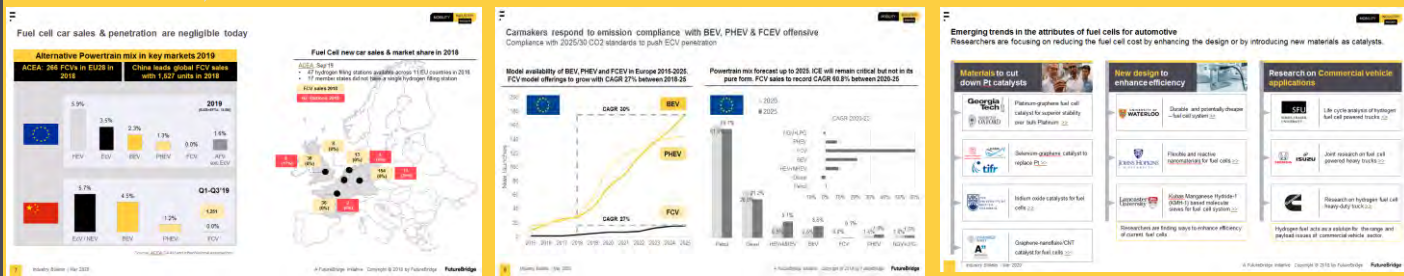
Toyota-Hino to develop heavy-duty fuel cell truck

Read our Spotlights to understand how European Union is supporting the development of hydrogen fuel cell technology.

- European **'Clean Hydrogen Alliance'** : Building a European green industry

Learn more about Alternate fuels : launches, startups, collaborations, competitor movement

Highlights



Common ethanol fuel mixtures

Code	E5	E10	E15	E25	E85	E100
Composition	max 5% anhydrous ethanol min 95% gasoline	max 10% anhydrous ethanol min 90% gasoline	max 15% anhydrous ethanol min 85% gasoline	max 25% anhydrous ethanol min 75% gasoline	max 85% anhydrous ethanol min 15% gasoline	100% Brazilian hydrous ethanol (contains on average 5.5 vol% water)
Countries	Western Europe today	USA today (Western Europe in near future)	USA EPA approval cars > 2000	Brazil	USA / Europe	Brazil

Gasoline blends for use in regular cars

Flex Fuel Vehicles

Image source: [Wikipedia](#)

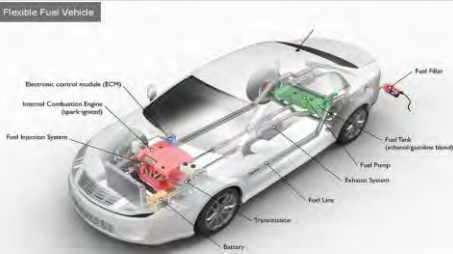


Image source: [afdc energy](#)

-Expert Says-

"Before electric cars become the norm we want to take advantage of reduced CO2 emissions today."

- Grant Shapps, the transport secretary, UK

03 Mar 2020

Nikola is becoming first public fuel cell truck company



Nikola is merging with a publicly listed acquisition company called VectoIQ.

- The joint venture is mainly focus on the development of next-generation smart transportation.
- The company will receive \$525 million in new investment as a result of this joint venture.

Analyst comment : Nikola lined several customers, such as [Anheuser-Busch](#) and [Iveco](#). They have also signed a deal with energy company [Nel](#) to develop the hydrogen filling stations, and automotive supplier [Bosch](#) to help design parts of its trucks.

Read this story →

04 Mar 2020

UK government introducing E10 fuel



UK government is set to introduce E10 ethanol as a new form of cleaner petrol.

- The fuel has a potential to reduce CO2 emissions by about 750,000 tonnes per year or the equivalent of 350,000 fewer cars on the road.
- The government was consulting on plans to make it the standard grade at British filling stations from 2021.

Analyst comment : The E10 blend is already used in countries including Germany, France, Belgium and Finland.

Read this story →

08 Mar 2020

H24US new patent for hydrogen purification membrane



H24US has filed a patent application with the USPTO for its advanced hydrogen separation membrane.

- The membrane can be used in a system with minimum capital expense, has a low or zero carbon footprint.
- The company is dedicated to reducing hydrogen cost and to provide an "accelerant" to realize the promise of clean hydrogen energy.

Analyst comment : The technology behind the patent for H24US will help solve the global energy transition challenge by bringing down the cost to produce hydrogen from low carbon energy sources.

Read this story →

Future of fuel cell vehicles : Players are massively using fuel cells for CV applications

HYUNDAI H2 XCIENT Fuel Cell heavy duty truck



NIKOLA
IVECO
FPT
Partnership for fuel cell truck



HYUNDAI HDC-6 NEPTUNE concept truck



Cummins Hydrogen fuel cell concept truck



PLUG POWER Class 6 trucks for logistics



BALLARD 8th generation fuel cell module for heavy duty sector



NIKOLA Fuel cell electric pick up



U.S. DEPARTMENT OF ENERGY
U.S. DEPARTMENT OF ENERGY H2Rescue fuel cell truck



*image credits: OEMs , Supplier and Start-ups

11 Mar 2020

European Commission is planning for 'clean hydrogen alliance'



European Union is all set for a new and wide partnership to develop clean hydrogen fuel technologies as a part of push towards carbon neutrality by 2050.

- The program is named as "Clean Hydrogen Alliance" which is expected to receive €3.2bn in public support.
- The new EU strategy points to the efforts of competitor markets, such as China and the US, here new technologies and trade policies have been developed.

Analyst comment : Germany, France, and the Netherlands are among those EU countries that have signaled their strong interest in hydrogen.

[Read this story](#)

19 Mar 2020

Gumpert Aiways has launched methanol fuel cell electric supercar



Gumpert Aiways unleashed the first edition of Nathalie powered by electric motors backed by a methanol fuel cell.

- It delivers a driving range of over 500 miles (805 km) refuel times of 3 min, and performance figures include a 2.5-second 0-62 mph (100 km/h).
- The chemical reaction in the fuel cells is charging the batteries and a negligible percentage of nitrogen oxide released as byproducts.

Analyst comment : [Methanol fuel cell](#) vehicle would produce 44% less CO₂ than a diesel one, and it would produce 37% less CO₂/kWh than a battery vehicle.

[Read this story](#)

24 Mar 2020

Toyota-Hino partnership to develop heavy-duty fuel cell truck



Toyota and Hino are going to develop a heavy-duty fuel cell truck jointly.

- The heavy-duty fuel cell truck in this joint development project is based on Hino Profia, and is being developed taking maximum advantage of the technologies both Toyota and Hino.
- The powertrain is equipped with two Toyota fuel cell stacks that have been newly developed for Toyota's next Mirai and includes vehicle driving control that applies heavy-duty hybrid vehicle technologies, developed by Hino..

Analyst comment : Toyota and Hino have positioned hydrogen as an important energy source for the future.

[Read this story](#)



-Expert Says-

"We welcome the proposal of a Clean Hydrogen Alliance, which can exploit all benefits that hydrogen can bring to the EU economy and jobs. This initiative is a clear evidence of the success of our public private partnership and we will actively support it."

— *Bart Biebuyck, FCH JU Executive Director, European Union.*

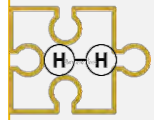
SPOTLIGHT



The European Commission has announced plans to set up an EU-wide “alliance” to promote the production of clean hydrogen in an effort to speed up the decarbonization of industry. The **Clean Hydrogen Alliance**, bringing investors together with governmental, institutional and industrial partners, will build on existing work to identify technology needs, investment opportunities, and regulatory barriers and enablers.

HYDROGEN TECHNOLOGIES AND SYSTEMS

- Potential to replace fossil-based energy with low-emission renewable hydrogen
- Could enable and optimize large-scale renewable electricity generation
- Could increase EU energy security and resilience

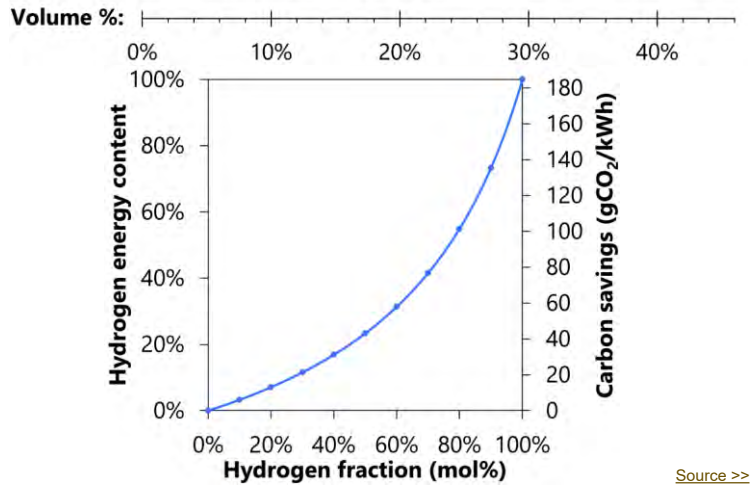
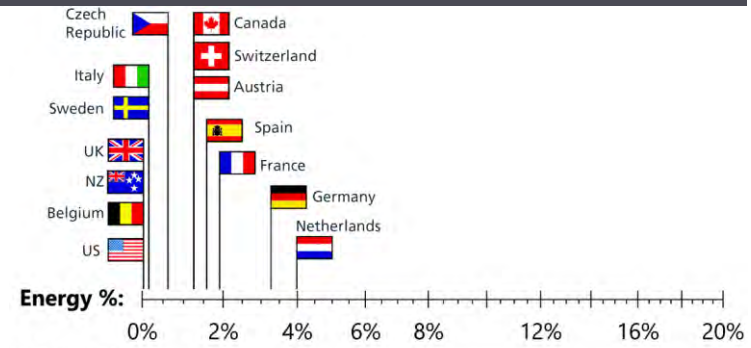


RECOMMENDATIONS:

- Develop a road map for a future European hydrogen economy.
- Build a supportive regulatory framework on renewable energy, develop common standards
- Support R&D investments and build an innovative industrial system through cross-border collaboration and partnerships in Horizon Europe
- Ensure safety and public acceptance through demonstrations and standardization

Alternative Fuels

European ‘Clean Hydrogen Alliance’: Building a European green industry

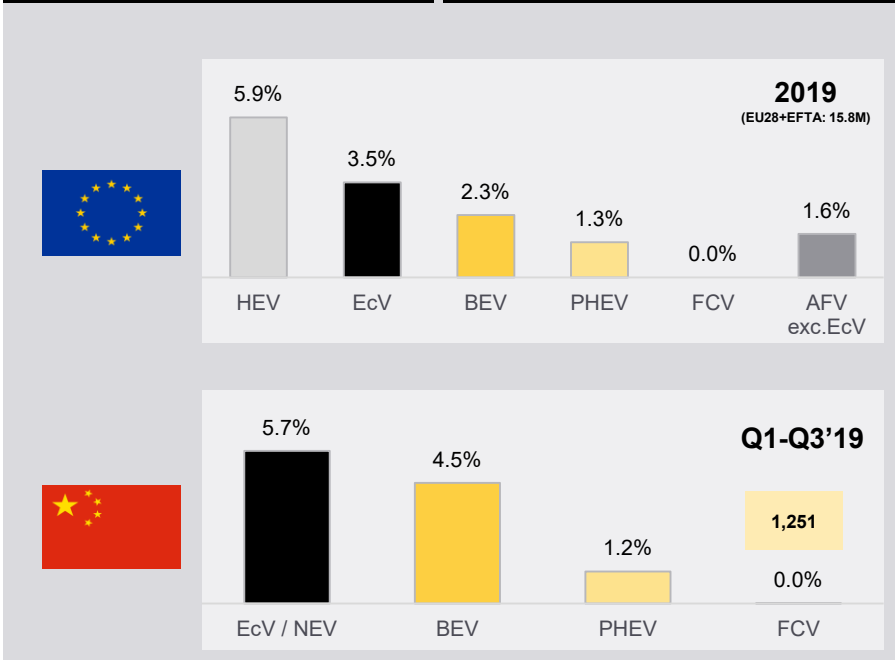


Source >>

Fuel cell car sales & penetration are negligible today

Alternative Powertrain mix in key markets 2019

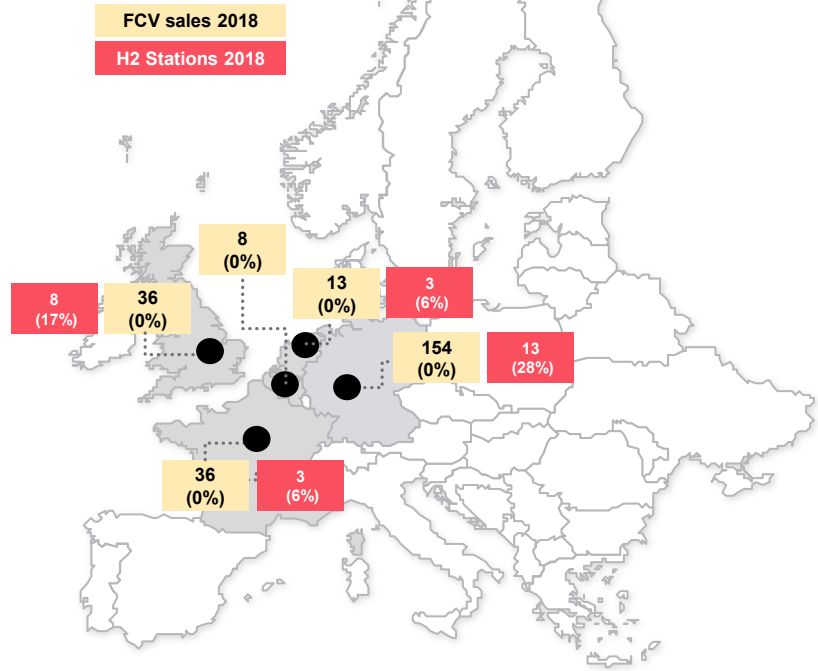
ACEA: 266 FCVs in EU28 in 2018 **China leads global FCV sales with 1,527 units in 2018**



Source: ACEA, CAAM and other National associations

Fuel Cell new car sales & market share in 2018

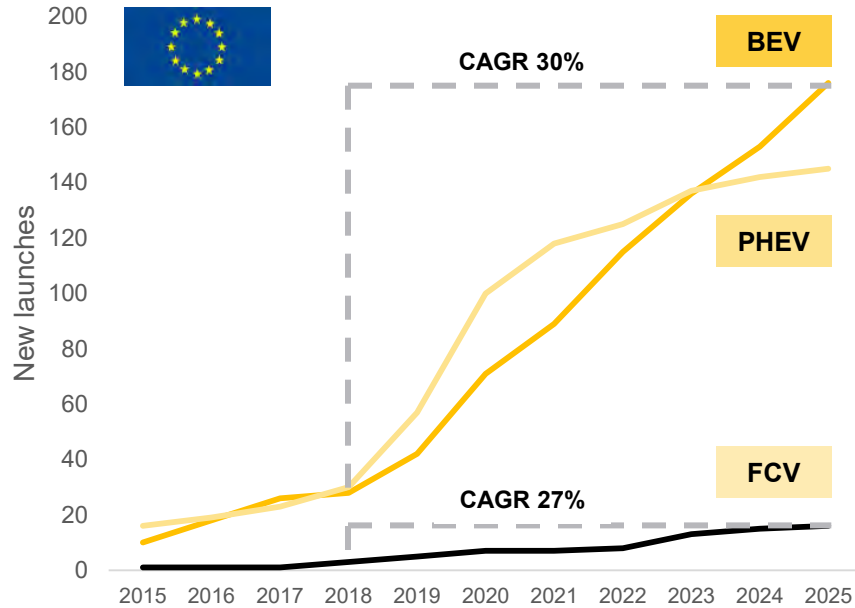
- ACEA, Sep'19
- 47 hydrogen filling stations available across 11 EU countries in 2018.
 - 17 member states did not have a single hydrogen filling station



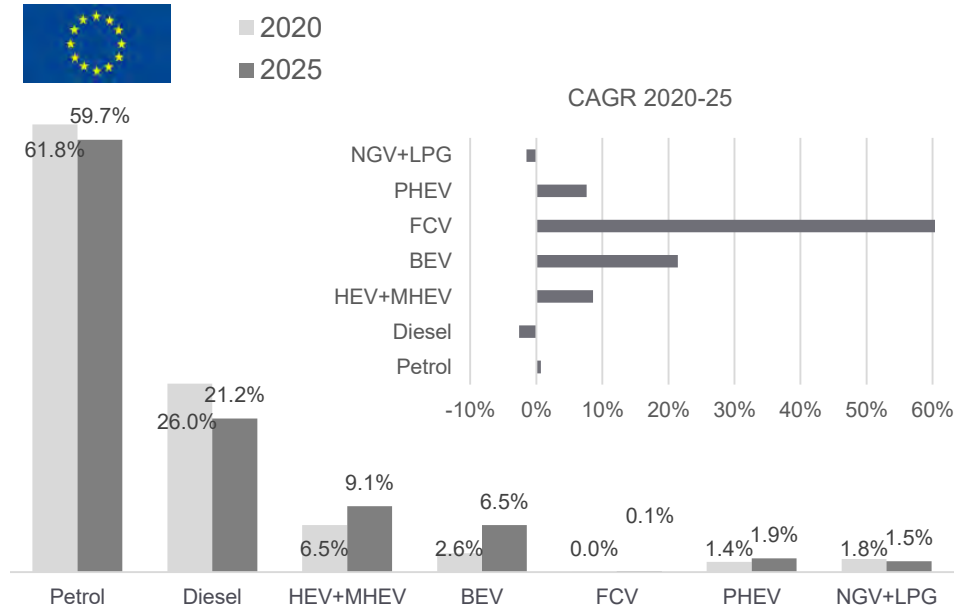
Carmakers respond to emission compliance with BEV, PHEV & FCEV offensive

Compliance with 2025/30 CO2 standards to push ECV penetration

Model availability of BEV, PHEV and FCEV in Europe 2015-2025.
FCV model offerings to grow with CAGR 27% between 2018-25



Powertrain mix forecast up to 2025. ICE will remain critical but not in its pure form. FCV sales to record CAGR 60.8% between 2020-25



Emerging trends in the attributes of fuel cells for automotive

Researchers are focusing on reducing the fuel cell cost by enhancing the design or by introducing new materials as catalysts.

Materials to cut down Pt catalysts



Platinum-graphene fuel cell catalyst for superior stability over bulk Platinum >>>



Selenium-graphene catalyst to replace Pt >>>



Iridium oxide catalysts for fuel cells >>>



Graphene-nanoflake/CNT catalyst for fuel cells >>>

New design to enhance efficiency



Durable and potentially cheaper – fuel cell system >>>



Flexible and reactive nanomaterials for fuel cells >>>



Kubas Manganese Hydride-1 (KMH-1) based molecular sieves for fuel cell system >>>

Researchers are finding ways to enhance efficiency of current fuel cells

Research on Commercial vehicle applications



Life cycle analysis of hydrogen fuel cell powered trucks >>>



Joint research on fuel cell powered heavy trucks >>>



Research on hydrogen fuel cell heavy-duty truck >>>


Hydrogen fuel acts as a solution for the range and payload issues of commercial vehicle sector.

Spotlights on focus: Research work for fuel cell development

SPOTLIGHT

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Research work to cut down platinum catalyst costs



Georgia Tech | University of Oxford

A team of researchers from Georgia Institute of Technology and University of Oxford have found that Platinum films on graphene could enhance the fuel cell catalytic activity and longevity.

TUM

Technical University of Munich research team revealed their findings on optimizing platinum clusters for fuel-cell catalysts.

Recent catalyst developments are key to the future of fuel cell technology, and the large-scale commercialization of clean electric power for transportation, as they:

- Reduce fuel cell costs, by reducing the use of precious metals
- Improve durability through innovative catalyst layer designs
- Increase robustness to a range of operating conditions

Limitation - Platinum is expensive which increases the initial cost of fuel cell production. Replacing it with another material which gives the same effectiveness for oxidation-reduction reaction that of Pt is difficult.

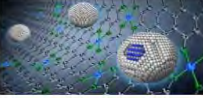
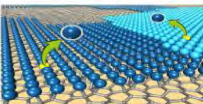
Solution - Research shows that new Pt films that are at least two atoms thick outperformed nanoparticle Pt in the electrocatalytic reaction. It suggests that the films could make potentially longer-lasting catalytic systems.

Solution - Research team measured ideal size for platinum stacks as one nanometer, containing some 40 platinum atoms. Catalysts of this order of size have a small volume but a large number of active spots, resulting in high mass activity.

Related information in Q2 2019 AC Pulse: "CEMs and Suppliers are cutting down the platinum catalyst in fuel cells"

In this configuration, the graphene is not acting as a separate entity from the platinum. They're working together as one. So we believe that if you're exposing the graphene side, you get the same catalytic activity and you could further protect the platinum, potentially further enhancing durability.

- Faisal Alamgir, Researcher Georgia Tech School of Materials





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SPOTLIGHT

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New advancements in fuel cell catalysts



Scientists are working to improve the performance of fuel cells by introducing new catalysts. Researchers from Brookhaven National Laboratory and the University of Arkansas have developed core-shell catalysts for ethanol fuel cell. A multi-institutional team from India (TIFR-H, IISER-Tvm) developed Selenium-graphene based catalysts for fuel cells.


Selenium-graphene catalyst

- Fuel cells using metal-based technologies performed excellently for initial few cycles, but then degraded in performance
- New inventions are made by scientists, either to completely replace Platinum or to reduce its quantity in the fuel cell.
- Graphene modified with selenium atoms in very low amounts can perform like platinum in a demonstrated reaction.
- Selenium enhances graphene's poor catalyzing power for oxygen reduction reaction in fuel cells.
- The composite catalyst has a high tolerance to 'poisoning effect' that happens in methanol fuel cells.

Aug@Pt core-shell catalyst

- Platinum and Iridium form 'mono-atomic islands' across the surface of the gold nanoparticles.
- Gold nanoparticle cores induce tensile strain in the Pt-ir mono-atomic islands, which increases those elements ability to cleave the carbon-carbon bonds, and then step away its hydrogen atoms.
- The new catalyst steers ethanol toward the 12-electron full oxidation pathway, releasing the fuel's full potential of stored energy, and ethanol fuel cell acts as a promising high-energy-density source of 'off-the-grid' electrical power.

Fuel cell unit (Stack)



Previous Metal Support Catalyst (Metal Treatment)

MEA (Membrane Electrolyte Assembly)

Electrode catalysts are important to the fuel cell's performance and its cost.


Image source: <https://www.greencarcongress.com/2019/06/20190620-001.html>

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SPOTLIGHT

Alternative Fuels

New Breakthroughs In Hydrogen Fuel Cell Technology



As the world looks towards a gradual move away from fossil fuel powered vehicles, greener alternative technologies are being explored, such as hydrogen power. Lancaster University researchers found a cheaper material with high energy density to store hydrogen. Researchers at Ontario's University of Waterloo have designed a new fuel cell which could potentially make the technology cheap.

Limitations of existing Fuel cell technology

- Expensive catalyst
- Energy density of storage material
- Requirement of larger cooling system
- Production and storing of Hydrogen
- Requirement of pure fuel
- Weight and size of entire fuel cell system
- Irreversible expansion damage caused by frozen water during colder climates

Recent advancements in fuel cells

New material for Hydrogen storage : Kubas Manganese Hydride-1 (KMnH-1)

- KMnH-1 enable the design of tanks be smaller and cheaper. Also, it makes existing hydrogen fuel to be more convenient and energy dense than Electric vehicles.
- It also absorbs and stores any excess energy so external heat and cooling is not needed and it can store four times as much hydrogen in the same volume as existing systems.
- Recent research works are revealing more materials for Hydrogen storage like Metal Hydrides and Metal Organic frame works (MOF's)

New fuel cell design approach to reduce the cost of Hydrogen fuel cell technology


- The design as three fuel-cell stacks that each work at a fixed power output, but are switched on and off to shorten the time each one is active. Thereby the durability of the cells increased.
- The new cells are economically practical to power vehicles than fossil fuels.
- The design makes the fuel cell to deliver constant amount of electricity.

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SPOTLIGHT

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Super Flexible nanomaterials pave the way for cheap hydrogen vehicles



Scientists from John Hopkins University and Purdue university have developed ultrathin electro catalyst for fuel cells. This breakthrough invention could produce cheaper and more efficient fuel cells which will enhance Hydrogen vehicles production.

Technology:

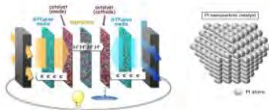

- Strain experienced by every material is due to the breakdown of the material's crystal symmetry at the atomic level
- The super flexible nanomaterial technology uses same principle: Changing material properties by manipulating the strain effect.
- Tuning of materials' thickness will create more strain and changes the material's properties, including molecular attraction.
- By decreasing the distance between atoms, material's reactivity can be increased.

Super flexible catalysts:

- The properties of thin metal electro catalyst sheets can be changed by applying force on them, thereby creating strain effect.
- Effective and flexible catalysts are created by this technology.

Advantages:

- More active catalyst in less cost
- Uses 90% less precious catalysts
- Increases catalyst activity by 10 to 20%

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Spotlights on focus: Demand of hydrogen mobility

SPOTLIGHT

Alternative Fuels – Dec'19 Bulletin

Europe and US play catch up with China for fuel cell technology


Europe



Activities:

- Rolls-Royce and Mercedes JV to develop hydrogen fuel cell vehicles for European market
- IVECO, FPT Industrial and Nikola partnership for battery and fuel cell EVs for Europe
- Plug Power expands hydrogen supply chain digital network in Europe.


China



Activities:

- Bosch will develop fuel cell for batteries in China
- Ballard Power Systems receives large order worth \$19.2M to supply FCEV in China
- Huawei breaks ground on automated fuel cell station in China

USA



Activities:

- US extends tax credits for fuel cell vehicles
- Toyota and Karworth are developing fuel cell buses for US market
- GM Defense is developing hydrogen fuel cell vehicles for US Army

As part of China's plan, the government has put a strong focus on fuel cell electric vehicles (FCEV) which can travel farther and are refueled in a similar way to diesel and petrol cars. Even though China is the global leader in fuel cell tech, Europe and US improving their competency by developing new FCEV's and hydrogen infrastructure. According to Symbio, demand for electro mobility will increase significantly with hydrogen-powered vehicles accounting for two million vehicles by 2030.


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Players are expanding hydrogen fuel cell partnerships



Hydrogen can help to achieve a clean, secure and affordable energy of future. But challenges like expensive fuel cell and lack of hydrogen infrastructure are limiting the use of hydrogen as a fuel. The partnerships and collaborations with global industry partners might help address technical barriers and enable progress in hydrogen and fuel cell technologies across applications and sectors.



faurecia

faurecia will provide an entire hydrogen storage system that comprises 10,000 hydrogen tanks for 1600 FC electric trucks of Hyundai Hydrogen Mobility

HYUNDAI

Hyundai will provide the DOE with five NEXO FCEV to help fuel cell R&D. Canoo will provide engineering services to develop Hyundai FCEV vehicles

POWERCELL

PowerCell and Inabata are joined for Japanese fuel cell market

INABATA

ANGEL Americas has engaged Williams Advanced Engineering (WAE) to develop world's largest hydrogen powered mine trucks

WILLIAMS

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SPOTLIGHT

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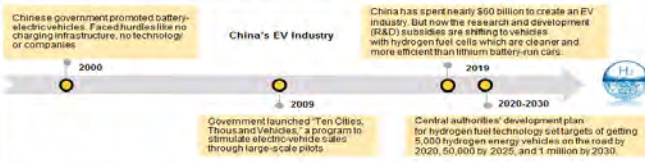
China is phasing out subsidies for electric vehicles and promotes cleaner mobility alternatives such as hydrogen

China to phase out subsidies for EVs and move towards hydrogen

The trend of fuel cells is to promote it step by step. It might start with certain areas first because fuel-cell development requires producing, storing, transporting, and fueling hydrogen, and operating this will expand in certain regions and [expand] like a net!

— Wan Gang, Former science and Technology minister, China (Architect behind EV boom in China)

China's EV Industry



Chinese government promoted battery-electric vehicles. Faced hurdles like no charging infrastructure, no technology or companies

2000


2009: Government launched 'Ten Cities, Thousand Vehicles', a program to stimulate electric-vehicle sales through large-scale pilots

2019: China has spent nearly \$90 billion to create an EV industry. But now the research and development (R&D) subsidies are shifting to vehicles with hydrogen fuel cells which are cleaner and more efficient than lithium battery-run cars.

2020-2030: Central authorities' development plan for hydrogen fuel technology set targets of getting 8,000 hydrogen energy vehicles on the road by 2020, 50,000 by 2025, and 1 million by 2030.

Developments for adapting Hydrogen Mobility

- China had sold almost 2,000 FCEVs by the end of 2019, and has around 15 fueling stations. Southern city of Foshan announced a plan to build at least 22 hydrogen refueling stations.
- SAIC Motors is going for the mass production of FCEV models for both passenger cars and commercial vehicles
- FAW Group has announced plans to mass-produce fuel cell versions of the Hongqi



Feb 2020 | Spotlight | Mobility Insider

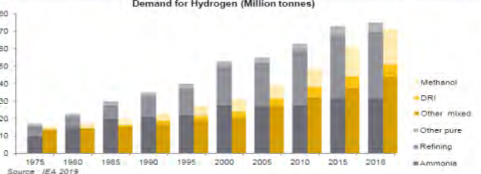
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SPOTLIGHT

Alternative Fuels

Demand for hydrogen on the rise: Investors are beginning to feel optimistic

Demand for Hydrogen (Million tonnes)



Source: IEA 2019

Investors are realizing the importance of Hydrogen and fuel cells in the energy transition, especially in heavy duty mobility and heavy industry. In this decade, it has been observed that, the shares of hydrogen producers and fuel cell manufacturers have soared to the highest level, which indirectly implicating the rise in demand for hydrogen as a fuel in automotive.

WHY?

- To meet emission reduction targets
- Number of countries adopting mandates and policy incentives that directly support investment in hydrogen is increasing

FCEV vs. BEV

- Hydrogen offers higher specific energy
- Less refueling time
- Lighter weight contributes to solving the range and issues with a battery powered propulsion

POWERCELL

Shares have risen to 28% >>

ITH POWER

Shares are up by more than 45% >>

BOSCH

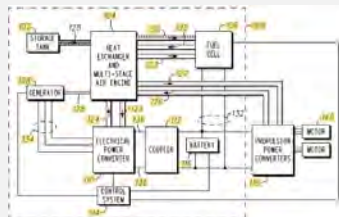
Increasing stake from 3.9% to 18% >>

Read more information in our April 19 and December 19 Bulletins

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IP excerpts

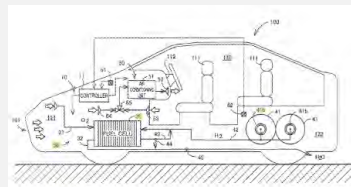


Apparatus and method using hydrogen pressure in fuel cell electric vehicle

- Patent explains a hydrogen fuel cell based EV which includes one tank for storing hydrogen under pressure.
- A combined heat exchanger and air engine expands the pressurized hydrogen and converts the expanding hydrogen into mechanical energy. Fuel cells receive the expanded hydrogen and charges battery. System also consists of a generator and an electrical power converter.

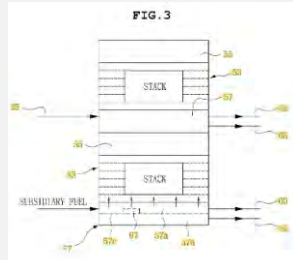


TOYOTA



Method of preventing fuel gas from entering cabin of mobile object including fuel cell and mobile object including fuel cell

- Patent includes a car comprised of a fuel cell, an air-condition cabin and a gas concentration detection unit .
- The controller switches an operation mode of the air conditioning device to an internal air circulation mode from another mode when the concentration of the gas is equal to or higher than a predetermined upper-limit threshold.



Device and method for heating fuel cell stack and fuel cell system having the device

- Patent relates to a device and method for heating fuel cell stack and fuel cell system.
- The fuel cell system includes a power generating unit having fuel cell stacks arranged with an interval defined between the stacks. The subsidiary fuel is burnt in the outlet manifold unit so as to heat both the outlet manifold unit and the stack coming into contact with the outlet manifold unit.



北汽新能源
BAIC BJEV

Energy control method, device and the fuel cell car of fuel cell car

- Patent explains a kind of energy control method of fuel cell car.
- The energy control method includes finding SOC value of a power cell which controls the working mode of fuel cell car in turn a fuel cell which generates power according to the working mode.



Questions raised during fuel cell webinar and our Answers

What about the Hydrogen storage? Actors, disruptors and new technologies?

We capture hydrogen storage solutions for mobility applications in our Mobility Insider program while FutureBridge's Energy Insider captures Industrial applications. Regarding new technologies,

- 1. Carbonaceous materials, such as CNTs and metal hydrides
- 2) Nanomaterials
- 3) porous manganese hydride
- 4) Nafion membranes enhanced with TiO₂/SnO₂

How do you see the position of suppliers like powercell, elringklinger, borit in automotive sector?

- Shares in some producers of hydrogen and manufacturers of fuel cells have increased to a higher level. According to the share prices, Powercell, is on the top of the list, followed by Ballard Power systems and ITM Power. Shares of Powercell have risen 28 per cent over the same period and 342 per cent over the past 12 months.
- ElringKlinger is not just a fuel cell manufacturer, it is an worldwide development partner and original equipment supplier to all of the world's vehicle and engine manufacturers.

What is the position of Nikola Hydrogen trucks?

- We would welcome the opportunity to showcase our profile for Nikola and our assessment of their strategy, portfolio and market position. We could schedule a demo so that you can experience what forms part of our offerings available exclusively to the subscribers of FutureBridge's Mobility Insider platform.
- Nikola is one of the leaders of hydrogen fuel cell trucks. They have secured \$480Mn funding from CNH Industrials, Bosch&Hanwa. They also become the first public hydrogen fuel cell truck company.

Following discussion I understand that there is no EU common policy about fuel cell. Is it correct?

- There are common policies and Programs within the EU. EU initiatives and funding opportunities have greatly contributed to the growing market for hydrogen across multiple sectors in the region. Here are the most important initiatives in the past 5 years.
- The Fuel Cells and Hydrogen Joint Undertaking (FCH JU) was established in 2008
- Linz Hydrogen Initiative , Sep 2019
- European Strategic Energy Technology (SET) climate policy with a time horizon of 2020 and beyond

with a lower energy density compared to batteries, why is FCV expected to be cleaner mobility as well as more efficient?

- Hydrogen offers much higher specific energy than batteries. The lighter weight could contribute to solving the range and payload issues inherent to a 100% battery-powered propulsion. They could be zero-emission electric vehicles since they emit only water vapor.

What are trends in biofuels policy Worldwide? This can influence push on ethanol/methanol fuel based fuel cell.

- Sixty-four countries around the world have targets and mandates for biofuels so far. Under our membership program you can gain access to all the latest activities from the front of policies and regulations in Biofuels.
- We are seeing an increase in blending of Biofuels such as Biodiesel, ethanol and methanol to conventional fuels. There are more incentives, subsidies and programs which promote biofuel production. This obviously will have an influence on ethanol/methanol fuel based fuel cell.

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