international association for hydrogen energy
Clean and Abundant Energy for Sustainability

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# THANK YOU

Since the first issue of the IAHE newsletter a decade ago in April 2009, we have watched the fields of hydrogen generation, storage, and usage continue to evolve. Today, fuel cell automobiles are on the road and in regular use, hydrogen infrastructures continue to grow, and the future remains bright. We have enjoyed bringing this newsletter to you, but all good things come to an end. IAHE leadership has announced that there will be a thrust to transform the IAHE webpage into a new dynamic template. Integral to that transformation will be the elimination of this newsletter and creation of an online magazine with feature stories written by trend setters. Inspired by Professor Carl-Jochen Winter's theme "HYtime" (hydrogen time), the new online magazine will be called HYtimes. Look for the changes online at http://iahe.org/.

Thank you for all the feedback over the years, I have enjoyed the time putting this newsletter together and watching the field evolve.

Best regards,

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# Table of Contents



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## IAHE Objective

The objective of the IAHE is to advance the day when hydrogen energy will become the principal means by which the world will achieve its long-sought goal of abundant clean energy for mankind. Toward this end, the IAHE stimulates the exchange of information in the hydrogen energy field through its publications and sponsorship of international workshops, short courses, symposia, and conferences. In addition, the IAHE endeavors to inform the general public of the important role of hydrogen energy in the planning of an inexhaustible and clean energy system.

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# Vehicle News

## Automakers to show off fuel-cell hybrids at this year's Vancouver car show

For the first time, three major auto makers will be showing off their fuel-cell electric vehicles at the Vancouver International Auto Show.

Jason Heard, executive director of the show, said the Hyundai Nexo, Honda Clarity and Toyota Mirai were the only fuel-cell electric hybrids on the market in North America and would all be on display this year.

"Cars can go up to almost 600 clicks on a full (fuel-cell) tank now and this is going to be something that's formidable in the future," said Heard. "We are fortunate to be on the leading edge of it."

This year's show at the Vancouver Convention Centre starts Tuesday, running until Sunday.

Heard said the auto show will also feature a booth from the Hydrogen Technology and Energy Corporation, a Vancouver company responsible for installing hydrogen fueling stations in B.C.

"We've never had a group like HTEC coming in and talking about the future of stations," he said. "The West Coast (of North America) is leading the charge and Vancouver is on that cusp. As the technology continues to develop we are going to see some major things over the next few years."

Vancouver has played a key role in developing fuel cells — in which compressed hydrogen and oxygen are mixed to create electric power, with water being the only exhaust — due to the creation of Ballard Research Inc. in 1979.

The Ballard group moved from battery research into fuel-cell research, and in 2008 created a spinoff company to look specifically at fuel cells for cars. This was eventually taken over by Ford and Daimler and the bulk of research and production moved away from Vancouver.

However, the West Coast of the U.S. and Canada remain integral to the future of fuel-cell cars that have gained traction since moving to the hybrid model with battery-electric power, similar to the more popular gas-electric hybrids.

The "Hydrogen Highway" promised in 2007 by former premier Gordon Campbell and then California governor Arnold Schwarzenegger never materialized — there was supposed to be dozens of hydrogen fueling stations built between the two regions. However, California now has 36 hydrogen stations and Vancouver has one, with another in Burnaby soon to open.

Over the next few years HTEC will open five more hydrogen stations in Vancouver and one on Vancouver Island. It takes a lot less time to refuel a cell with hydrogen than it does to recharge a battery for an electric vehicle, but electric vehicle recharging stations vastly outweigh hydrogen refueling stations. There are only about 11,000 fuel-cell vehicles on the road right now worldwide, compared to five million plug-in electric vehicles.

The recently released 2019 Hydrogen Fuel Cell Vehicle Market report stated the sector would grown considerably between 2019 and 2028, due in part to government initiatives and technology advancements, with North America dominating the industry.

Toyota last year revealed it would expand production of its Mirai to at least 30,000 by 2020, while Hyundai said it would produce 700,000 fuel cell systems a year by 2030, with most being for fuel-cell electric vehicles.

In B.C., the provincial government has promised to have 10 per cent of cars sold in the province be zero emission by 2025 and 100 per cent by 2040. Zero emission vehicles, which include fuel-cell cars, are eligible for subsidies.

According to a 2018 KPMG report on key automotive trends, fuel-cell electric vehicles were the No. 1 trend of the year.

Source: https://vancouversun.com/news/local-news/automakers-to-show-off-fuel-cell-hybrids-at-this-years-vancouver-car-show

## Japan looks past electric, bets on hydrogen powered cars

When it comes to electric cars, battery-powered vehicles dominate the roads. Sales of battery electric cars are set to take off.  Auto companies are making more models,

and countries are passing regulations to reduce carbon emissions. Even states like Pennsylvania have a plan to encourage more residents to buy battery electrics.

But Japan isn't sure that's the future — or, at least, the only future for electrified transportation. The country has ambitious goals to become the "hydrogen society," and right now, the focus is on its automakers.

At Toyota's LFA Works factory in Aichi prefecture, workers install the carbon-fiber hydrogen tanks on Toyota's new hydrogen-powered fuel cell car, known as the Mirai — which means "future" in Japanese.

This tiny factory, within Toyota's larger Motomachi plant, produces only about 10 cars each day. All are assembled by hand.

Plant manager Matsuo Yoshiyuki owns a Mirai and loves driving it.

"I believe in the future of hydrogen," he said. "It's very important for the [environment]."

But Yoshiyuki says owning a hydrogen car isn't very convenient.

"Sometimes I have problems [filling up] with hydrogen," he said. "There are not enough stations and the hours are very limited."

A hydrogen fuel cell doesn't burn anything — it uses a chemical reaction between the hydrogen and the oxygen from the air to produce electricity — and hydrogen-powered cars emit only water. So in a world striving to reduce its carbon emissions, it sounds like a great alternative to the internal combustion engine.

But the Mirai is expensive — even with generous Japanese government subsidies that bring it down from the equivalent of $70,000 to $50,000. The largest cost is the fuel cell, which Toyota says will drop as production ramps up.

### Hydrogen's chicken and egg problem

The lack of hydrogen fuel infrastructure challenges automakers. Only about 11,000 fuel cell vehicles are on the road worldwide, according to Juan Pontes with EV Volumes. About half are in California, where strict emission regulations and tax credits incentivize electric vehicles. It's hard to convince consumers to buy a car they can't easily fuel up. And it's just as difficult to get energy companies to build the infrastructure if there aren't enough vehicles to make it profitable.

Part of Japan's goal to be the first "hydrogen society" includes a target of building 900 hydrogen fueling stations by 2030. The country's roughly 100 stations were subsidized by the government with continued operational support from manufacturers like Toyota.

The energy ministry has ambitious goals in the lead-up to the 2020 Olympics. The city of Tokyo plans to deploy 100 hydrogen fuel cell buses for the games, with a longer-term goal of 200,000 such vehicles in the next six years.

### Hydrogen vs. battery electric

With about five million plug-in battery electric cars worldwide, fuel cell cars are in their infancy. Hydrogen's detractors say the fuel cell doesn't make sense given the greater energy efficiency of plug-in battery powered vehicles.

But in countries like Japan, where much of the population lives in dense urban areas, it's not easy to charge up a battery electric vehicle. It's here where companies like Toyota are banking on the convenience of hydrogen over plug-ins.

Matthew Klippenstein, co-author of online publication Fuel Cell Industry Review, says without a garage, or regular parking space that has access to an electrical outlet, hydrogen fuel cells make more sense.

"There's just no behavior change as long as you have [hydrogen] infrastructure in place," he said. "We go to the same gas station and fuel up in the same few minutes and just keep on tootling on. And I think that is ultimately the reason that Toyota and other carmakers now have more interest in fuel cells."

Klippenstein says he sees the divide between hydrogen fuel cells and battery electric plug-ins tracking the parallel path as the gasoline and diesel split familiar to American consumers.

"We will see a similar split where batteries will, for decades at least, dominate the light duty vehicle passenger

cars whereas fuel cells will ultimately win out in the heavier applications."

In South Korea, where the majority of residents also live in urban areas, automaker Hyundai just announced that it plans to produce 700,000 fuel cell cars a year by 2030.

### The Hydrogen Society

A new hydrogen fuel plant is rising several yards from Fukushima's Daiichi nuclear power plant, the site of the nuclear plant meltdown after the 2011 tsunami.

That accident forced Japan to shut down all of its nuclear reactors, which had provided about one-third of the country's electricity. Eight have since re-opened. Despite that energy source, Japan has always had to import all of its fossil fuels and is the world's No. 1 importer of liquefied natural gas, according to the U.S. Energy Information Administration.

But hydrogen is abundant, and the fuel could be produced anywhere.

Ken Koyama from the Institute of Energy Economics, a Japanese think tank, agrees that hydrogen is a good bet for Japan.

"We are always talking about the long run future," Koyama said. "It's not the next year or a five-year time horizon. It's a 20-year, 30-year, 40-year, 50 years because if we are really thinking about climate change it's a long-, very, very long-term strategy is critical."

Producing the hydrogen fuel is itself energy intensive. And critics point out that while the hydrogen fuel cell car emits only water, if fossil fuels are used to produce the hydrogen fuel, then the vehicles still contribute to global warming, just as battery electric vehicles charged with energy produced by coal plants can't be considered completely carbon-free.

"So it's not really clean if that is the case," says Kimiko Haraka of the Kiko Network, a Japanese environmental group.

Haraka is critical of a plan by a number of Japanese companies, including Kawasaki Heavy Industries, J-Power, Iwatani Corporation and Marubeni, to build a plant in Australia that would use lignite coal to produce hydrogen for fuel cell vehicles. She also worries that the many subsidies for hydrogen come at the expense of promoting renewable energy.

Still, Bertel Schmitt, a former car industry advertising executive who lives in Tokyo, says it makes sense for Japan and its automakers to include hydrogen vehicles in their long-game plan.

"They pretty much realize that the exhaust regulations will get tougher and tougher," he said. "What is being enacted right now, in 2020 in Europe, is nothing compared to what will come five years later, 10 years later."

For now, though, Schmitt says the internal combustion engine remains the cheapest and most convenient car on the market. Despite massive investment, he says Toyota knows hydrogen won't be taking over the roads anytime soon.

"They know that the guy sitting in the hydrogen fueling station will be very, very lonely for quite a while."

Source: https://whyy.org/articles/japan-looks-past-electric-bets-on-hydrogen-powered-cars/

## Fuel cell breakthrough brings hydrogen cars one step closer

The University of Science and Technology of China revealed that a new type of catalyst has been developed to prevent hydrogen fuel cells from failure, which could play a major role in boosting the hydrogen fuel cell automobile industry.

The result was published in Nature - the world's leading multidisciplinary science journal - at the end of last month.

It said the newly-developed catalyst can protect hydrogen fuel cells from being poisoned by carbon monoxide, extend the battery life and allow the battery to work in cold temperatures.

"This result may greatly accelerate the advent of hydrogen fuel cell vehicles," said Lu Junling, one of the professors at the School of Chemistry and Materials Science of USTC who initiated the research, according to Anhui Daily.

The goal for Lu and his team is to develop a cheap, active and selective catalyst for the oxidation of carbon monoxide, which can protect fuel cells and offer a means for plants to produce high-purity hydrogen, Anhui Daily reported.

With a high energy conversion efficiency and zero emissions, hydrogen fuel cells are regarded as one of the main development directions of the new energy automobile industry by some insiders and experts.

It takes only several minutes for hydrogen fuel cell vehicles to "refuel", allowing the car to run up to 350 to 600 kilometers.

Meanwhile, electric vehicles take several hours to fully charge and have ranges of 200 to 300 km, which could be shorter in cold temperatures, according to China Business News Daily.

"By 2025, fuel cell technology will be mature. The number of fuel cell vehicles may have hit 50,000 to 100,000 units," said Ouyang Minggao, an academician of the Chinese Academy of Sciences and a new energy vehicle expert, according to Economic Daily.

A raft of domestic and overseas automakers have dashed into the hydrogen fuel cell automobile industry.

South Korean and Japanese giants have taken the lead in developing and applying hydrogen energy, Economic Daily reported.

South Korean automaker Hyundai rolled out the world's first mass-produced hydrogen fuel cell car in February 2013. Japanese carmakers Honda and Toyota have produced hydrogen fuel cell models on a large scale. Hyundai signed an agreement with German auto giant Audi last June to develop hydrogen energy technology and set up an industry chain of hydrogen energy automobiles. Honda and Toyota have gone into partnership with General Motors and Mercedes-Benz respectively in terms of hydrogen energy applications.

According to Economic Daily, South Korea is scheduled to increase its production capability of hydrogen fuel cell passenger cars to 100,000 units by 2025.

Chinese independent auto brand Great Wall Motor acquired a 51 percent stake in Shanghai Fuel Cell Vehicle Powertrain, aiming to unveil its first hydrogen fuel cell model in 2022.

Zhengzhou Yutong Bus and Foton Motor have put hydrogen fuel cell commercial vehicles into use. And China National Heavy Duty Truck Group has developed three hydrogen fuel cell models.

Hong Kong's richest man Li Ka-shing invested in a hydrogen fuel cell vehicle plant in Foshan, Guangdong province in early 2018.

With a total investment of 12 billion yuan ($1.77 billion), the plant is expected to go into production at the end of this year and has an annual production target of 160,000 units, China Business News Daily reported.

However, the development of hydrogen fuel cell vehicles still faces difficulties, including the storage of hydrogen energy and establishing hydrogen refueling stations.

By the end of 2017, there were 328 hydrogen refueling stations worldwide, of which 12 were in China.

They are used to serve the research and testing of hydrogen fuel cell vehicles to a great extent, according to Economic Daily.

Source: http://www.ecns.cn/news/2019-02-18/detail-ifzeratr8870405.shtml

## More flexible nanomaterials can make fuel cell cars cheaper

A new method of increasing the reactivity of ultrathin nanosheets, just a few atoms thick, can someday make fuel cells for hydrogen cars cheaper, finds a new Johns Hopkins study.

A report of the findings, to be published Feb. 22 in Science, offers promise towards faster, cheaper production of electrical power using fuel cells, but also of bulk chemicals and materials such as hydrogen.

"Every material experiences surface strain due to the breakdown of the material's crystal symmetry at the atomic level. We discovered a way to make these crystals ultrathin, thereby decreasing the distance between

atoms and increasing the material's reactivity," says Chao Wang, an assistant professor of chemical and biomolecular engineering at The Johns Hopkins University, and one of the study's corresponding authors.

Strain is, in short, the deformation of any material. For example, when a piece of paper is bent, it is effectively disrupted at the smallest, atomic level; the intricate lattices that hold the paper together are forever changed.

In this study, Wang and colleagues manipulated the strain effect, or distance between atoms, causing the material to change dramatically. By making those lattices incredibly thin, roughly a million times thinner than a strand of human hair, the material becomes much easier to manipulate just like how one piece of paper is easier to bend than a thicker stack of paper.

"We're essentially using force to tune the properties of thin metal sheets that make up electrocatalysts, which are part of the electrodes of fuel cells," says Jeffrey Greeley, professor of chemical engineering at Purdue and another one of the paper's corresponding authors. "The ultimate goal is to test this method on a variety of metals."

"By tuning the materials' thinness, we were able to create more strain, which changes the material's properties, including how molecules are held together. This means you have more freedom to accelerate the reaction you want on the material's surface," explains Wang.

One example of how optimizing reactions can be useful in application is increasing the activity of catalysts used for fuel cell cars. While fuel cells represent a promising technology toward emission-free electrical vehicles, the challenge lies in the expense associated with the precious metal catalysts such as platinum and palladium, limiting its viability to the vast majority of consumers. A more active catalyst for the fuel cells can reduce cost and clear the way for widespread adoption of green, renewable energy.

Wang and colleagues estimate that their new method can increase catalyst activity by 10 to 20 times, using 90 percent less of precious metals than what is currently required to power a fuel cell.

"We hope that our findings can someday aid in the production of cheaper, more efficient fuel cells to make environmentally-friendly cars more accessible for everybody," says Wang.

Read more at: https://phys.org/news/2019-02-flexible-nanomaterials-fuel-cell-cars.html#jCp.

Source: https://phys.org/news/2019-02-flexible-nanomaterials-fuel-cell-cars.html

## Hexagon and Audi team up for hydrogen deal

German automobile manufacturer Audi has selected Hexagon Composites' new subsidiary Hexagon Purus for a hydrogen development project.

The dedicated business division for Hexagon's group-wide hydrogen activities, which was launched earlier this week, will supply high-pressure tanks for a multi-year hydrogen tank development and small-serial production project.

Audi said at its annual press conference last year that it wants to launch a small series of hydrogen fuel cell cars in 2020.

Rick Rashilla, Senior Vice-President of Hexagon Purus, enthused, "Winning this project is yet another milestone for Hexagon and the rapidly growing fuel cell electric vehicle industry. Our common environmental commitment now results in this collaboration project to realize the great potential of hydrogen fuel."

The strong momentum towards global zero-emission economies is stimulating demand for Hexagons clean mobility and storage solutions.

To focus the company's pursuit of the growing market opportunities for renewable fuel solutions, Hexagon launched Hexagon Purus through which it will continue to develop cutting-edge solutions working closely with supporting car, bus and truck manufacturers, fleet, rail and marine operators, gas distributors and refueling station operators.

The business division includes manufacturing, sales & marketing, R&D locations and personnel in Norway, Germany and the US.

"We strongly believe in the future of clean energy - and Hexagon Purus is our response to support this transition," said Michael Kleschinski, President of Hexagon Purus.

"For us, Purus represents something new, pure and unique. We are clarifying and sharpening our clean energy focus. Hexagon Purus gives us the opportunity to do something different!"

Source: https://www.gasworld.com/hexagon-and-audi-team-up-/2016713.article

## Toyota reveals 'Self-Driving Electric Moon Car' as Japan prepares to land astronauts on the moon


Japan is planning a moon landing for 2029 and wants its astronauts to explore the lunar surface in a vehicle built by Japanese automaker Toyota.

The Japan Aerospace Exploration Agency (JAXA) and Toyota announced Tuesday that it will collaborate on international space exploration, specifically on developing a manned, pressurized rover that uses Toyota's fuel cell vehicle (FCV) technologies.

"Manned, pressurized rovers will be an important element supporting human lunar exploration, which we envision will take place in the 2030s, " said Koichi Wakata, JAXA Vice President. "We aim at launching such a rover into space in 2029."

JAXA, which earlier this month landed its Hayabusa2 probe on the asteroid Ryugu, is hoping the collaboration with Toyota will "give rise to intellectual properties" needed for international space exploration.

Although the amount of fuel that could be taken to the moon would be limited, said JAXA and Toyota, the pressurized rover would have a total lunar-surface cruising range of more than 10,000 km.

however, Toyota's 'space mobility' concept for the pressurized rover being studied by JAXA and Toyota is pretty small. It envisions a 6 meter by 5.3-meter vehicle standing 3.8 meters tall. That's enough room for two people, say JAXA and Toyota, or four in an emergency. Toyota and JAXA also revealed that they have been jointly studying the concept of a manned, pressurized rover since May 2018.

The moon presents some special challenges for any vehicle. Gravity is one-sixth of Earth's, and the lunar surface is pocked by craters, cliffs, and hills. "It is exposed to radiation and temperature conditions that are much harsher than those on Earth, as well as an ultra-high vacuum environment," said Wakata. "For a wide-ranging human exploration of the moon, a pressurized rover that can travel more than 10,000 km in such environments is a necessity." Wakata also stressed the need for a 'Team Japan' approach to space exploration.

That's a message that appears to be finding favor. Japan Airlines-backed startup ispace last month announced that its HAKUTO-R mission will orbit the moon in 2020 ahead of a mission to land on the surface in 2021. An finalist in the ill-fated Google Lunar XPRIZE, ispace plans to map, and eventually recover, water ice on the moon and learn how to use it as a resource. If it can separate lunar water into hydrogen and oxygen, it could provide fuel for Toyota's moon buggy, as well as for a self-sufficient moon base, and even rockets.

Aside from Japan Airlines, HAKUTO-R's corporate partners include Japanese national daily newspaper Asahi Shimbun and Japan NGK Spark Plug, which wants to test solid-state battery technology on the moon in 2021. Another is Mitsui Sumitomo Insurance, which last month announced a new lunar insurance service. "The availability of lunar exploration insurance will encourage new players to participate in the lunar industry by reducing the risk of entry," said ispace founder Takeshi Hakamada last month. "With the ability to insure our landers and rovers, ispace and its customers will be able to concentrate on realizing our vision without hesitation."
Source:
https://www.forbes.com/sites/jamiecartereurope/2019/03/12/toyota-reveals-self-driving-moon-car-as-japan-prepares-to-land-astronauts-on-the-moon/#6ede0cea6dc8

## Hydrogen powered trucks seen as the future for zero-emission trucking

Batteries may be the future for carbon-free cars but this might not be the case for trucks.

Hydrogen powered trucks could be the future of the trucking industry, according to Maarten Wetselaar, Integrated Gas and New Energies Director, Royal Dutch Shell.

Wetselaar said at the 2019 edition of CERAWeek that hydrogen is essential for the decarbonization of heavy transport.

"For the decarbonization of heavy transport, there really is no alternative to hydrogen," Wetselaar said at one of the opening sessions of the 2019 edition of CERAWeek, reports Freight Waves.

CERAWeek, which was held in Houston, is a gathering that brings together several thousand leading energy decision-makers from both government and private industry. It is considered to be the world's leading energy conference.

It wasn't only Wetselaar who voiced this opinion about hydrogen trucking. Other sessions during the event that were hosted by various CERA officials also discussed the future of hydrogen powered trucks and how it was going to be this alternative fuel that would power heavy vehicles of the future and not battery electrics.

Hydrogen powered trucks have more advantages over battery powered trucks.

There are a number of reasons why several of the world's leading energy decision-makers believe that hydrogen will have advantages over batteries in the future, in regard to heavy duty trucks.

For instance, hydrogen doesn't exist as a stand-alone molecule in nature. It is always attached to something and energy needs to be applied to separate the hydrogen molecule from whatever it might be attached to. Therefore, a low carbon source, such as solar power, can be utilized as the energy source to generate hydrogen. Although most of today's hydrogen is produced from thermal processes by reforming natural gas, cleaner production methods, including solar and water electrolysis are being researched and are improving all the time.

One of the issues with batteries is that they are heavy. While this isn't a problem for cars, the battery capacity that would be needed to power a truck would add a significant amount of weight to the vehicle. This weight would be far more than hydrogen, where the conversion of an internal combustion engine hydrogen-driven fuel cell adds minimal weight to the vehicle.

Hydrogen is also seen as versatile. Beyond just being used in heavy vehicles, hydrogen has advantages over batteries as it can be used as a transport fuel, a power-generating fuel, stored for lengthy periods of time, etc.

All that said, at the moment, much needs to change in the industry for there to be a viable future for hydrogen powered trucks. According to several speakers at the event, a governmental role in the transition will be necessary for any transition to occur at all.

Source: https://www.hydrogenfuelnews.com/hydrogen-powered-trucks-seen-as-the-future-for-zero-emission-trucking/8537130/

## Skoda Electric & Proton to work on fuel cell electric buses

Proton Power Systems has signed a letter of intent with Skoda Electric a.s. in the Czech Republic, as the partners aim to jointly develop, sell and service fuel cell electric buses using Proton's modular 'HyRange' systems.

Note that Skoda Electric is not part of the Volkswagen Group unlike the Skoda brand for cars but runs under the roof of Skoda Transportation. The Czech outlet specializes in making electric motors for transport, so for vehicles such as buses, tramways, suburban trains and the like as Skoda Electric.

On the cooperation at hand, Proton announced the prototype fuel cell electric buses built with Skoda Electric would be brought to European bus operators by the first

quarter of 2020. The initial target is to produce and sell at least ten such hydrogen vehicles per year.

Proton Power Systems chief executive officer Faiz Nahab said he was “pleased” to have scored this agreement with the Czech manufacturer. Their market value rose 11 per cent after the announcement.

The company has been looking for cooperation for some time now with another example being Proton’s planned joint venture with e.Go Mobile to develop a fuel cell range extender for their minibus reportedly. Although this is unconnected, it is remarkable that the Munich-based start-up e.Go has also become a Volkswagen partner most recently. In this case, they plan on sharing the upcoming MEB platform for electric vehicles.

Source: https://www.electrive.com/2019/03/17/skoda-electric-proton-to-work-on-fuel-cell-electric-buses/

## Hyundai Canada launches NEXO, becomes first manufacturer to make fuel cell technology accessible to Canadian drivers

Hyundai Auto Canada Corp. announced today the national launch of the first-ever NEXO, Canada's only fuel cell-powered SUV and the first vehicle of its kind to be made easily accessible to consumers. By collaborating with Modo, the first Vancouver-based carsharing co-operative of its kind, the NEXO will bring fuel cell technology to a much wider audience than ever before.

NEXO is powered by hydrogen, a fully sustainable energy source, which allows the vehicle to emit clean water vapor and purify the air as it is being driven. This technology also provides the vehicle with superior range conservation in cold climates compared to other battery electric powertrains, making them particularly resilient for Canadian winters. What's more – a five minute refill will carry you for up to 570 KM.

Modo will make two NEXO vehicles available for consumer use in the coming weeks through its carsharing services. This collaboration will provide Vancouverites with unparalleled access to fuel cell vehicles, allowing more Canadians than ever to learn about and experience this technology firsthand. Hyundai will also be the first to make fuel cell vehicles available for retail sale through select local dealerships.

"Hydrogen vehicles are the most promising type of alternative powertrain transportation in existence today. It's important for us to make innovative green technologies like NEXO readily available for Canadians to ensure a sustainable future," says Don Romano, President and CEO of Hyundai Auto Canada Corp. "We're thrilled to launch NEXO in B.C, as the province is a leader in implementing important sustainability initiatives and is aligned with our vision of introducing new means of clean mobility."

Hyundai has always been a leader in sustainable transportation, remaining the only automaker in Canada to offer vehicles with four electrified powertrains including hybrid, plug-in hybrid, battery electric and hydrogen fuel cell. With the launch of NEXO, Hyundai becomes the only automotive manufacturer in Canada to offer a second generation fuel cell vehicle – the first being the Tucson Fuel Cell which launched in 2015.

"We are excited to be the first carshare to offer consumers the opportunity to experience a hydrogen fuel cell vehicle for themselves," says Patrick Nangle, CEO of Modo. "Supporting a cleaner BC aligns with Modo's social and environmental purpose as a member-owned co-operative. We are grateful to Hyundai Canada and the Canadian Hydrogen and Fuel Cell Association for their financial contribution in making this possible."

While hydrogen fueling infrastructure is still in the early stages of development, Vancouver is home to one of Canada's only public refueling stations located in the city's Marpole neighborhood. Members of the public who are interested in test-driving NEXO are able to do so at the Vancouver International Auto Show, which runs from March 19 through 24.

Source: https://www.newswire.ca/news-releases/hyundai-canada-launches-nexo-becomes-first-manufacturer-to-make-fuel-cell-technology-accessible-to-canadian-drivers-831459118.html

## Bentley eyes up hydrogen fuel cell technology


Bentley will have electrified version of all its cars by 2025, but the British company is also looking at fuel cell tech

Bentley bosses have revealed to Auto Express that firm is looking into the development of hydrogen fuel cell technology.

The British company has previously announced plans to offer an electrified powertrain on every one of its models by 2025, but Bentley's head of engineering Werner Tietz has said that plug-in hybrid and fully electric vehicles are only two of the solutions the brand is working on.

"We have a lot of opportunities - we will have electrified versions of all our names plates by 2025, this is a clear strategy," Tietz told us. "We are discussing fully electric solutions but we have to think about different technologies away from battery technology, things like fuel cell technology - this is something we have to look at. If you want to tow 3.5 tons you cannot do that with a battery electric vehicle."

However, this technology is unlikely to arrive before 2025. Bentley's immediate focus is on developing longer-range plug-in hybrid models. Tietz added: "An important next step is a longer range for plug-in hybrid; if we have a development in battery technology maybe 100km is possible."

Tietz added that being part of the VW Group offers up a lot of opportunities of which they can take advantage of, although no decision on what path to take has been made. "We are looking at several concepts, the cooperation with the Group means we have lots of technologies available," Tietz said.

The news follows comments made by Bentley's design director Stefan Sielaff at last year's Geneva show, who favors a four-door coupe as the firms first EV. "The next step for us is an electric, unique Bentley," Sielaff told us. "We are still in the phase of trying to define what it could be but I think it should be a vehicle that contains certain coupe-style and elegance. I don't think it should be something raised, like an SUV."

Source:
https://www.autoexpress.co.uk/bentley/106215/bentley-eyes-up-hydrogen-fuel-cell-technology

## Researchers develop sensor systems to safeguard hydrogen fueling

A research team is working to develop a sensor system that can provide continuous in situ monitoring of hydrogen quality at hydrogen fueling stations. The infrared measuring cell will be installed inside the hydrogen filling station and will have to operate under very challenging conditions.

The sensor system has to work reliably, despite extremely high pressures and short refueling times. The new sensor system will be undergoing operational trials this autumn. The research team from Saarbrücken will be at this year's Hannover Messe, where they will be showcasing their high-pressure test rig at the Saarland Research and Innovation Stand.

Cars don't like it if they are forced to run on low-quality or low-purity fuels. And the same is true of vehicles powered by fuel cell technology. The driver of a fuel cell vehicle fills up with hydrogen rather than a fossil-based fuel, but even hydrogen can be contaminated. Impurities such as sulfur-containing compounds, ammonia or hydrocarbons can all contaminate the hydrogen during the production process, during transportation to the hydrogen station or during the refilling process. And that can make driving a lot less pleasurable.

"Contaminants can actually poison the fuel cell," explains sensor expert Professor Andreas Schütze from Saarland

University. Even low levels of impurities can damage the fuel cell membranes. As a result, the fuel cell produces less electricity, power output is reduced and the vehicle travels shorter distances. In the worst case, the fuel cell will be irreversibly damaged and the car will simply stop running.

To stop things ever getting that far, Schütze and his team have been working with research partners to develop technology that ensures that the fuel cell is only fed with high purity hydrogen, thereby extending the service life of the fuel cell. Project partners include the Fraunhofer Institute for Solar Energy Systems ISE and Hydac Electronic GmbH.

Up until now, the purity of the hydrogen was determined by analyzing samples in a laboratory. At Saarland University and at Zema—Center for Mechatronics and Automation Technology in Saarbrücken, researchers are working on a sensor system that continuously monitors the quality of the hydrogen during the refueling process. "The challenge is twofold: measuring at the required level of precision and coping with the conditions under which the sensor system needs to operate," said Schütze. The refueling process uses hydrogen pressures of 700 to 900 bar and lasts less than three minutes.

The research team is therefore developing an infrared measuring cell that can measure reliably and accurately under these extreme conditions. The very high pressures to which their sensors are exposed are used by the team to further improve the sensitivity of their process.

Schütze and his research team have already produced marketable measuring cells for monitoring the quality of oils and other liquids. But the pressures that the researchers are now having to deal with mean that they are in uncharted territory.

"Up until now, no one has made measurements of this type at pressures this high. Normally, these sorts of measurements are done at pressures of no more than 40 or 50 bar," said Schütze. The measuring cell for the odorless gas H2 is installed inside the hydrogen fueling station and the hydrogen fuel flows through a small tube. "We illuminate the gas passing through the tube with light from an infrared source and we collect the light passing out on the opposite side of the tube. If there has been a change in the chemical composition of the gas, the infrared spectrum will change accordingly. This allows us to detect the presence of unwanted additives or contaminants," explains Schütze.

Members of his research team are currently conducting experiments and are assigning particular infrared absorption signals to the various contaminants. They are also determining which wavelengths of the infrared spectrum are most suitable for the measurements and are calibrating the system. These important preparatory stages need to be completed before this autumn, when the sensor system will be installed in a hydrogen refueling station for operational trials.

"One of the questions we're studying at the moment is whether and how the intensity of the infrared spectrum we measure changes with pressure. The sensor system has to be able to reliably detect a range of contaminants at concentration levels significantly below what we find in oils," explains Marco Schott, a doctoral student working on the hydrogen measuring cell.

Source: https://pacetoday.com.au/researchers-develop-sensor-system-safeguard-hydrogen-fuelling/

## Toyota to help encourage Australians to drive hydrogen fuel cell vehicles

Australians will have the opportunity to drive fuel cell vehicles first hand.

Hydrogen fuel cell vehicles are not a common site on Australian roads, as is the case with most nations. The main reason for this is due to the fact that there is very little infrastructure available to support the use of these vehicles. That being said, Toyota will be loaning its Mirai vehicles to give some Australian's a better understanding of what it's actually like to drive a hydrogen car.

Toyota will be loaning two examples of its Mirai sedan to be trailed locally.

The hydrogen fuel cell vehicles on short-term loans from the Japanese automaker, will be shared between energy delivery provider AusNet Service and sister company Mondo and peak body, Hydrogen Mobility Australia.

The short-term loans of the Mirais (approximately one to three month-long loans) will provide members of these organizations with the opportunity to sample what its like to drive fuel cell vehicles in the real world.

"There is a common misconception that hydrogen-electric vehicles, like the Mirai FCEV, drive differently," Matt MacLeod, Toyota Australia's manager of advance technology vehicles said, reports Drive.

MacLeod explained that due to these misconceptions it is important to provide people with a first-hand experience of the car to better understand it.

The hydrogen fuel cell vehicles loan program is considered to be an important step in encouraging hydrogen fuel adoption.

MacLeod knows that the fact that there is very little hydrogen infrastructure in Australia is an "obviously large hurdle" that needs to be overcome in order for car makers to logically introduce this eco-friendly technology, particularly ahead of impending carbon emission regulations.

What those who test out the Mirai fuel cell electric vehicles (FCEV) will discover is that hydrogen fuel cars drive very similar to a traditional gas-powered car. The major difference, of course, is that is uses a different fuel source, which emits nothing but water vapor from the tailpipe. Furthermore, the car makes very little noise.

MacLeod feels that the loan program is the beginning of getting people interested in the technology.

"That's where the Mirai FCEV loan program is a step in the right direction because these zero-emission vehicles are being used by real people in real world situations," he said.

In addition to Toyota's loan program, another brand that is pushing its hydrogen fuel cell vehicles is Hyundai, which reportedly plans to supply 20 examples of its NEXO to the A.C.T. Government this year.

Source: https://www.hydrogenfuelnews.com/toyota-to-help-encourage-australians-to-drive-hydrogen-fuel-cell-vehicles/8536982/

## Hydrogen railway train under development in South Korea

The Korea Railroad Research Institute is developing a hydrogen train as part of a project.

The railway technology research project for which the hydrogen railway vehicle is being developed is part of a bigger objective to gradually replace the country's diesel railway trains. The project comes from the Ministry of Land, Infrastructure and Transport.

The hybrid train that is being developed is based on a hydrogen fuel cell.

The hydrogen railway train will be a hybrid vehicle that is powered by hydrogen fuel cells. It will be capable of travelling at a maximum speed of 110 km (68.4 miles) per hour and travel more than 600 km (372.8 miles) on a single refueling.

The plan is to finish the development of the hydrogen fuel cell hybrid power system, power conversion system for railway cars, hydrogen refueling station construction plans and railway technology technical standard by the end of this year, reports FuelCellsWorks.

What's more, Korea Railroad Research Institute plans to finish the verification of the stability and efficiency of the railway test line by 2022. The total investment in the project is 25 billion Won ($22.2 million).

Hydrogen railway trains could help combat South Korea's diesel train pollution.

Hydrogen trains are environmentally friendly. Unlike diesel trains, they do not produce pollutants. Furthermore,

their carbon emissions are lower than electric cars. Additionally, it is possible to lower the cost of maintaining and constructing the electric power infrastructure in the country by eliminating electric cable lines, substations and other power supply facilities required to maintain electric power infrastructure.

Diesel trains are seen as one of the major pollutants producing carbon and fine dust in South Korea's railway sector. Back in May of last year (2018), the nation introduced new air pollutant emission standards with which all new introduced diesel rail vehicles must comply.

The goal of the project is to replace current diesel railway vehicles in the nation, efficiently and over time.

South Korea isn't the only nation looking into replacing diesel trains with hydrogen railway vehicles. As Hydrogen Fuel News reported back in January, the UK is also considering adding hydrogen trains to some of its rail lines.

Source: https://www.hydrogenfuelnews.com/hydrogen-railway-train-under-development-in-south-korea/8536972/

## Germany installs the most public H2 fuel stations in 2018, worldwide

The European country now has 60 publicly accessible hydrogen refueling stations.

Last year, a total of 48 publicly accessible H2 fuel stations were launched into operation around the globe. Seventeen (17) of these stations were launched in Germany, making it the country to see the largest growth in regard to this type of hydrogen infrastructure, in 2018.

Japan continues to lead the world in terms of having the most hydrogen (H2) fuel stations.

Germany currently has 60 public H2 fuel stations, making it the second country in the world with the most hydrogen stations. However, the leader of these alternative refueling stations is Japan, which presently has a total of 96 publicly accessible H2 stations, after nine (9) more locations were added in 2018. These facts are according to the results of the 11th annual evaluation of H2stations.org, a website of the German Ludwig-Bölkow-Systemtechnik and TÜV Süd, reports Electrive.com

Ludwig-Bölkow-Systemtechnik also notes that the US saw 10 new hydrogen refueling stations become operational last year, including six (6) in California, alone. This brings the total number of publicly accessible H2 stations in the US to 42, placing it third behind Germany.

Germany has plans for 38 more H2 fuel stations.

At present there are a total of 152 hydrogen refueling stations in Europe, 136 in Asia and 78 in North America. However, not all of these stations are publicly accessible. Only 223 of the world's total 369 refueling stations are public, while the rest are reserved for closed user groups.

Germany reportedly has plans for an additional 38 stations, 34 of which will be developed under the auspices of the H2 Mobility Germany industrial initiative. According to the initiative's website, four of these future stations have entered the planning phase, 10 are in the approval phase, 11 are in the execution phase, while the remaining nine (9) stations are in the commissioning and trial phase, reports Electrive.com

Beyond government initiatives, which are helping to support the growth of hydrogen infrastructure in many countries around the world, businesses are also getting involved and are helping to drive hydrogen evolution and the building of more H2 fuel stations. Among these businesses include Hyundai, Toyota and Nikola Motor.

Source: https://www.hydrogenfuelnews.com/germany-installs-the-most-public-h2-fuel-stations-in-2018-worldwide/8536954/

## New clean hydrogen production method developed by Belgian bioscience experts

Hydrogen gas can be produced using a new type of solar panel.

A new solar panel has been developed by bioscience experts in Belgium that can produce clean hydrogen from moisture in the air. Even more impressive, the renewable method can generate significant quantities of hydrogen gas, up to 250 liters per day.

The new technology is suitable for localized, on-site generation.

This clean hydrogen production method is not the first time hydrogen has been produced from a renewable power source or solar energy. However, the innovative solar panel's compact size (measuring 1.6m2), combined with its operational efficiency, makes it ideal for localized on-site generation.

This technology has taken over a decade to develop, according to the bioscience experts from the Katholieke Universiteit Leuven in Belgium, who invented the device. The sustainable technology the scientists developed involves the use of an electrolysis system that has been paired with an efficient atmospheric water absorption system, which produces hydrogen from moisture in the air.

A significant amount of solar energy is needed to split the water molecules to produce hydrogen gas. When this project was first attempted years ago, the yield was only slightly over 0.1%, but with refinements of the technology, this has increased to 15%.

This clean hydrogen technology could benefit fuel cell vehicles as well as fuel national gas grids.

For this particular hydrogen production method to work, an assembly of standard photovoltaic (PV) cells and a piece of apparatus with two compartments is required. To maintain a satisfactory level of hydration, a well-designed temperature and hydration management system is utilized.

Throughout the day, solar cells deliver the required voltage to cause the water molecules to react and split. The energy required to operate a heat absorber/collector that is directly connected to a reversible water sorption material is provided by light transmitted through the PV cells.

Water releases from the material before it is diffused through an ion exchange material. Throughout operation, water is oxidized at the anode and oxygen is released in air. At the same time, hydrogen is produced and collected at the cathode. During the night, cool, humid air circulates through the device and the reversible water sorption material is able to replenish.

This green hydrogen technology is still in its early stages and field trials will be the next step to test to see how it performs in the real world. That being said, the researchers are hopeful that it could help to accelerate a clean hydrogen economy.

One of the reasons is that due to the inventions compact design and efficiency, it can be easily transported and used onsite, helping to overcome one of the major hydrogen fuel vehicle barriers of expensive refueling infrastructure. Additionally, this clean hydrogen energy also shows potential for being used to provide clean and renewable power to fuel national gas grids.

Source: https://www.hydrogenfuelnews.com/new-clean-hydrogen-production-method-developed-by-belgian-bioscience-experts/8537096/

## Taranaki unveils hydrogen roadmap

A region in New Zealand has unveiled a roadmap to become a global leader in hydrogen production and utilization.

The country is moving into a low-emissions future that will substantially alter its current energy ecosystem.

The New Zealand Government has set national targets of a 30% reduction in greenhouse gas emissions by 2030 compared with 2005 levels, 100% renewable electricity by 2035 and net zero emissions by 2050.

In order to achieve these targets, Taranaki has released a roadmap which positions hydrogen as the fuel of the future and looks at the potential for the region to leverage its existing skills and infrastructure.

According to the 'H2 Taranaki Roadmap', released on Friday, the region has a unique collection of strengths that position it as the major player in the New Zealand hydrogen opportunity.

Some of these strengths include: significant water, wind and solar resources; supporting service industry including pipeline integrity and very high pressure test facilities; already home to large producers and users of hydrogen; hydrogen infrastructure design and engineering expertise; and local and regional government support.

Developed by Hiringa Energy with support from Venture Taranaki, New Plymouth District Council and the New Zealand Government's provincial growth fund, the roadmap outlines a series of projects that together with leveraging the existing heavy energy industry skills and infrastructure in the region, will help seed the establishment of a low-emissions hydrogen sector.

The opportunities have the potential to become multi-billion-dollar development projects, create significant employment opportunities, and generate billions of dollars in domestic and export revenue, the roadmap explains.

At its heart and to start the journey, a critical mass of near-term public and private sector projects are proposed to create the ecosystem and establish a hydrogen industry in New Zealand, including:

- Establishment of a New Plymouth refueling station and out-of-region connecting hubs, to service buses, trucks, light commercial, waste and contractor specialized vehicles
- Development of a green ammonia project at Kapuni, establishing hydrogen production to support the growth of hydrogen transport and provide the foundation for transition to a low-emissions chemical industry
- Implementation of hydrogen into a stationary energy application within regional infrastructure such as one of the region's aquatic centers, council buildings or district health facilities, providing combined heat and power, energy storage and resilience
- Deployment of near-term projects with Japanese and other international partners that enhance business and regional relationships and create the basis for future export developments
- Studies and trials for hydrogen injection into the gas grid, including 100% hydrogen scenarios
- Investigation of carbon capture and storage using the Taranaki gas fields together with carbon capture utilization options, including synthesis of fuels and industrial chemicals
- Exploration of opportunities to use hydrogen-based fuels in peaker electricity generation plants

The report's author, Andrew Clennett of Taranaki-based Hiringa Energy, is enthusiastic about the potential hydrogen could have in transitioning the regional economy.

"Taranaki is very fortunate with its natural resources, infrastructure, and the forward thinking and the leadership shown by our regional officials and industry," he says.

"Hiringa is enjoying working with progressive partners to develop a number of exciting projects that will help future-proof jobs in the region while contributing to New Zealand's future energy needs."

"We are facing many challenges with the energy transition ahead, requiring the community, businesses, regions and government to continue to work together. It is important that we act now to create and capture the opportunities this transition offers, ensuring we leave a positive legacy for our children."

Source: https://www.gasworld.com/taranaki-unveils-hydrogen-roadmap/2016837.article

## U.S. Gulf Coast refiners increasingly buying hydrogen

United States Gulf Coast refiners have increased hydrogen purchases for their hydrocrackers to reduce levels of the highly pollutant sulfur and are likely to continue to buy more as the need for cleaner fuel rises.

"As global demand for distillate fuel oil has increased and sulfur content regulations have become more stringent, refineries have needed to use more hydrogen," the Energy Information Administration (EIA) said in a report issued

last month.

Sulfur comes in varying proportions with all types of crude oil, with grades that have a high proportion called 'sour,' as opposed to those with less sulfur called 'sweet.' Unless refineries process the sulfur, once burned, it becomes sulfur dioxide, a precursor to acid rain, according to the EIA.

Hydrogen demand will rise very soon because shippers will now need to conform to new sulfur contents in marine fuels that will take effect at the start of next year, the EIA said.

Fuel used in shipping currently has to have no more than 3.5 percent sulfur, but starting next year the sulfur emissions need to be capped at 0.5 percent. Ships conventionally run on fuel oil and diesel.

Pollution legislation at sea is catching up with that on land, as regulations against emissions near cities and in inland areas has limited sulfur content in fuels for over a decade. Unlike pollution near cities, emissions by ships in high seas occurs in areas outside of national jurisdictions.

Hydrogen is used to process sour crude, which often commands lower prices precisely because of the need to process the sulfur with hydrogen, or mix it with a "sweeter" crude so that the resulting blend is not as sour.

Refineries can produce hydrogen "through steam reforming of natural gas or by purchasing it" from third parties.

The trend for most of this decade has been for increases both in demand of hydrogen as well as in purchases from third parties, the EIA said.

The delivery is made through a 600-mile network of hydrogen pipelines running from Louisiana to Houston, with connections to refineries.

In addition to the U.S. Gulf Coast, other areas of the U.S., such as the Midwest, have increased capacity to use hydrogen to treat sour crude oil and products, with use rising 13 percent from 2012 to 2017, the EIA said. The U.S. Midwest is home to refineries that process sour Canadian crude oil.

Source:
https://www.upi.com/Top_News/US/2019/03/18/US-Gulf-Coast-refiners-increasingly-buying-hydrogen/7701552911373/

## New fuel cell could help fix the renewable energy storage problem

If we want a shot at transitioning to renewable energy, we'll need one crucial thing: technologies that can convert electricity from wind and sun into a chemical fuel for storage and vice versa. Commercial devices that do this exist, but most are costly and perform only half of the equation. Now, researchers have created lab-scale gadgets that do both jobs. If larger versions work as well, they would help make it possible—or at least more affordable—to run the world on renewables.

The market for such technologies has grown along with renewables: In 2007, solar and wind provided just 0.8% of all power in the United States; in 2017, that number was 8%, according to the U.S. Energy Information Administration. But the demand for electricity often doesn't match the supply from solar and wind. In sunny California, for example, solar panels regularly produce more power than needed in the middle of the day, but none at night, after most workers and students return home.

Some utilities are beginning to install massive banks of batteries in hopes of storing excess energy and evening out the balance sheet. But batteries are costly and store

only enough energy to back up the grid for a few hours at most. Another option is to store the energy by converting it into hydrogen fuel. Devices called electrolyzers do this by using electricity—ideally from solar and wind power—to split water into oxygen and hydrogen gas, a carbon-free fuel. A second set of devices called fuel cells can then convert that hydrogen back to electricity to power cars, trucks, and buses, or to feed it to the grid.

But commercial electrolyzers and fuel cells use different catalysts to speed up the two reactions, meaning a single device can't do both jobs. To get around this, researchers have been experimenting with a newer type of fuel cell, called a proton conducting fuel cell (PCFC), which can make fuel or convert it back into electricity using just one set of catalysts.

PCFCs consist of two electrodes separated by a membrane that allows protons across. At the first electrode, known as the air electrode, steam and electricity are fed into a ceramic catalyst, which splits the steam's water molecules into positively charged hydrogen ions (protons), electrons, and oxygen molecules. The electrons travel through an external wire to the second electrode—the fuel electrode—where they meet up with the protons that crossed through the membrane. There, a nickel-based catalyst stitches them together to make hydrogen gas ($H_2$). In previous PCFCs, the nickel catalysts performed well, but the ceramic catalysts were inefficient, using less than 70% of the electricity to split the water molecules. Much of the energy was lost as heat.

Now, two research teams have made key strides in improving this efficiency. They both focused on making improvements to the air electrode, because the nickel-based fuel electrode did a good enough job. In January, researchers led by chemist Sossina Haile at Northwestern University in Evanston, Illinois, reported in Energy & Environmental Science that they came up with a fuel electrode made from a ceramic alloy containing six elements that harnessed 76% of its electricity to split water molecules. And in today's issue of Nature Energy, Ryan O'Hayre, a chemist at the Colorado School of Mines in Golden, reports that his team has done one better. Their ceramic alloy electrode, made up of five elements, harnesses as much as 98% of the energy it's fed to split water.

When both teams run their setups in reverse, the fuel electrode splits $H_2$ molecules into protons and electrons. The electrons travel through an external wire to the air electrode—providing electricity to power devices. When they reach the electrode, they combine with oxygen from the air and protons that crossed back over the membrane to produce water.

The O'Hayre group's latest work is "impressive," Haile says. "The electricity you are putting in is making $H_2$ and not heating up your system. They did a really good job with that." Still, she cautions, both her new device and the one from the O'Hayre lab are small laboratory demonstrations. For the technology to have a societal impact, researchers will need to scale up the button-size devices, a process that typically reduces performance. If engineers can make that happen, the cost of storing renewable energy could drop precipitously, helping utilities do away with their dependence on fossil fuels.

Source: https://www.sciencemag.org/news/2019/03/new-fuel-cell-could-help-fix-renewable-energy-storage-problem

## HyperSolar reports breakthrough with its first-gen renewable hydrogen generator

The California-based renewable hydrogen production company has confirmed stable production from its generator.

HyperSolar has announced in a company press release that its stability test of its first-generation renewable hydrogen generator has reached 566 hours of continuous stable hydrogen production, breaking the company's own record for wireless self-contained solar hydrogen device.

**The breakthrough technology produces green hydrogen using sunlight and any water source.**

The company's proprietary, fully-integrated hydrogen production device uses improved coating and catalyst technology with no solar cell degradation. Its design will reportedly serve as the foundation of HyperSolar's first generation commercial renewable hydrogen generator.

Prior to this most recent announcement, HyperSolar previously reported a continual production of hydrogen sur-

passing 500 hours on February 5, 2019. The same device from this previous report was further tested by the research team at the University of Iowa and revealed a stable production of hydrogen for 566 hours, breaking its own record, which is also believed to be the new international record for a wireless self-contained solar hydrogen device.

After 566 hours, the device began to show a notable reduction of the produced hydrogen. However, in spite of this degradation, the solar cell itself was not degraded. It was protected by the adjustments made to the coatings in the lab.

**HyperSolar is now working on a process to improve the renewable hydrogen generator's lifetime.**

"Our team has identified the cause for performance degradation this time to be the manual coating and catalyst integration step performed in the lab. The company is working with contract manufacturers to employ an automated process to overcome this limitation and improve device lifetime," said Tim Young, HyperSolar CEO, in the PR.

The company has been working hard to fine tune its process to ensure the solar cell of their device is well protected from the corrosion under water. Employing commercial manufacturing processes for better and advanced coating and integration technology will further prolong the lifetime of the renewable hydrogen generator, putting HyperSolar one step closer to reaching its 1000-hour goal of stable operation. Reaching this goal would bring the device closer to one year of stable operation, making the cost of the hydrogen more economical and competitive.

Source: http://www.hydrogenfuelnews.com/hypersolar-reports-breakthrough-with-its-first-gen-renewable-hydrogen-generator/8537007/

## Solar panel splits water to produce hydrogen

A research team in Belgium says its prototype panel can produce 250 liters of hydrogen gas per day

Solar panels are multiplying on rooftops and in gardens worldwide as communities clamor for renewable electricity. But engineers in Belgium say the panels could do more than keep the lights on—they could also produce hydrogen gas on site, allowing families to heat their homes without expanding their carbon footprints.

A team at Katholieke Universiteit Leuven, or KU Leuven, says it has developed a solar panel that converts sunlight directly into hydrogen using moisture in the air. The prototype takes the water vapor and splits it into hydrogen and oxygen molecules. If it scales successfully, the technology could help address a major challenge facing the hydrogen economy.

Hydrogen, unlike fossil fuels, doesn't produce greenhouse gas emissions or air pollution when used in fuel-cell-powered vehicles or buildings. Yet nearly all hydrogen produced today is made using an industrial process that involves natural gas, and this ultimately pumps more emissions into the atmosphere.

A small but growing number of facilities are producing "green" hydrogen using electrolysis, which splits water molecules using electricity—ideally from renewable sources such as wind and solar. Other researchers, including the team in Belgium, are developing what's called direct solar water-splitting technologies. These use chemical and biological components to split water directly on the solar panel, forgoing the need for large, expensive electrolysis plants.

"Finding a way to create hydrogen in some easier or more efficient way is maybe a Holy Grail quest," says Jim Fenton, who directs the Florida Solar Energy Center at the University of Central Florida.

KU Leuven sits on a grassy campus in Flanders, the Dutch-speaking northern region of Belgium. Earlier this month, professor Johan Martens and his team at the Centre for Surface Chemistry and Catalysis announced their prototype could produce 250 liters of hydrogen per day on average over a full year, which they claim is a world record. A family living in a well-insulated Belgian house could use about 20 of these panels to meet their power and heating needs during an entire year, they predict.

The solar panel measures 1.65 meters long—roughly the height of a kitchen refrigerator, or this reporter—and has a rated power output of about 210 watts. The system can convert 15 percent of the solar energy it receives into hydrogen, the team says. That's a significant leap from 0.1 percent efficiency they first achieved 10 years ago.

(Separately, international researchers last year said they achieved 19 percent efficiency in producing hydrogen from direct solar water splitting.)

However, Martens's lab was tight-lipped about its technology. Tom Bosserez, a post-doctoral researcher, declined to disclose any specifics, citing intellectual property concerns. He says only that the lab specializes in "catalysts, membranes, and adsorbents."

"Using our expertise in this area, we were able to develop a system that is very efficient in taking water from the air and splitting it into hydrogen by using solar energy," Bosserez wrote in an email. Asked about some of the engineering challenges they faced during a decade of development, he says, "The most difficult part is getting the water out of the air."

Academic papers offer scattered clues about the technology, though Bosserez says their research "goes beyond what we publish." In recent years, the engineers have studied the efficacy of a variety of materials, including porous, multi-junction silicon solar cells with "micrometer-scale pore dimensions"; thin-film catalysts made from manganese (III) oxide; and a poly (vinyl alcohol) anion exchange membrane involving a potassium hydroxide solution and nickel-based catalysts.

Martens says generally that his team is using "cheap raw materials" in lieu of precious metals and other expensive components. "We wanted to design something sustainable that is affordable and can be used practically anywhere," he told VRT, a public broadcasting network in Belgium.

Researchers plan to field test their prototype at a house in the rural town of Oud-Heverlee. Hydrogen would be stored in a small, underground pressure vessel during the summer months, then pumped throughout the house during the winter. If all goes according to plan, Martens says the team could install 20 panels at the house, or build a larger neighborhood system to allow other families to use the "green" hydrogen.

Fenton, of the Florida Solar Energy Center, says it's far too early to determine whether or when hydrogen-producing solar panels could become economically viable. The technology is still in the very early development stage, and—particularly in the United States—existing heating fuels such as natural gas are relatively cheap. However, as countries work to address climate change, and as more communities install local renewable energy infrastructure like rooftop solar, he sees a potential role for these hydrogen systems.

"If the application works out, it might lend itself very nicely to generating hydrogen that I could store and use for the heating of my house, for cooking, maybe run it in my fuel-cell car," Fenton says. "It's these futuristic kinds of opportunities. But it's still something we need to prepare for."

Source: https://spectrum.ieee.org/energywise/green-tech/fuel-cells/solar-panel-prototype-splits-water-to-produce-hydrogen

## New Brunswick Power, Florida developer partner to build first hydrogen-powered electric grid

Hydrogen fuel has been an elusive source of electric generation in the power sector.

While the generation itself is emissions-free, environmentalists have noted the amount of power needed to separate hydrogen from water can take up more energy than the power actually supplied by the product. Cost has also traditionally been an issue, often limiting hydrogen power to "niche" sectors such as heat generation, according to Kennedy.

But the potential advantages of the technology are vast, and the technology will operate on the grid as long duration energy storage to be available during peak periods, according to Kennedy.

A new report from Nature Energy predicts that hydrogen-fueled power will soon be cost competitive in the U.S. and German power markets, and recommends policy incentives such as investment tax credits, which have been effective in cutting down the prices of other clean energy resources, such as wind and solar.

That may become a reality if technologies such as Joi Scientific's are able to keep customer costs down. NB Power and the developer "believe there is commercial via-

bility that could be a plus" for ratepayers, though it's "impossible to say at this point" how customer bills will be impacted by the change, NB Power spokesperson Marc Belliveau told Utility Dive.

The utility, which is the primary electricity provider for Canada's eastern province New Brunswick, has a goal of generating 40% of its electric power from renewable resources by 2020, and Kennedy says the ultimate objective is to make NB Power an "emissions-free utility."

Its current generation portfolio includes wind, hydro, oil, diesel and coal-fired generation, and Kennedy said he envisions the partnership as a way to eliminate the utility's oil peakers and coal while keeping rates the same.

Patents on the technology are still being written so Kennedy did not want to address the ratio of energy consumed versus produced by the technology, but noted the two companies were "satisfied" with the technology and the issue of conversion loss was something that had been addressed in their research and development.

The announcement follows a 2016 agreement between the utility and the developer, giving NB Power authority to develop and sell "hydrogen-fueled generation" to other utilities.

"Our goal is to help New Brunswick have all the tools they need" to go zero-emissions, said Kennedy, adding that the partnership will allow them to deliver the technology to other utilities across Atlantic Canada and eventually across other parts of North America, Asia and Europe.

NB Power "understands the space and utilities and the markets," said Kennedy and are an ideal partner "to go out into the wider world hand in hand" with.

"The goal for all utilities is to generate power with less carbon or no carbon and we are working on the products and tools to transition to more reliable systems and systems that are not contributing to climate change," he said.

Canada intends to reduce its country's emissions 56% below 2003 levels by 2030.

Source: https://www.utilitydive.com/news/new-brunswick-power-florida-developer-partner-to-build-first-hydrogen-powe/549382/

## 2020 Olympic Games to use hydrogen fuel to light cauldrons, torch during relay

The organizing committee of the 2020 Tokyo Olympic and Paralympic Games is planning to use the next-generation energy of hydrogen fuel to light the flames of the cauldrons and torch relay. If realized, the 2020 Games would be the first Olympics to use the alternative energy source for this purpose.

Hydrogen produced at a state-of-the-art plant under construction in Fukushima Prefecture, which was devastated by the 2011 Great East Japan Earthquake and tsunami, will be used, the sources said. The Athletes' Village also will use hydrogen fuel as a power source.

The organizing committee intends to showcase Japan's advanced technology with hydrogen and reconstruction as themes during the event.

According to sources connected to the organizing committee, the committee is discussing using the hydrogen fuel for the torch at the start of the relay in Fukushima Prefecture.

Hydrogen fuel will also be used as the final torchbearer lights the cauldron at the new national stadium in Tokyo, another cauldron in the Daiba area of Tokyo and to light the Olympic flame during the Games after the opening ceremony.

The Tokyo organizing committee is also considering hydrogen fuel for the ceremonial torch lighting in Greece.

As hydrogen fuel does not emit carbon dioxide at the time of combustion and is a seemingly inexhaustible energy source on Earth, it is called the "ultimate clean energy." Easier to transport and store compared to electricity, it is expected to be a new energy source for Japan,.

The flame from burning hydrogen fuel is colorless, but with additive agents, various hues can be created, such as red, purple and green.

A senior official of the organizing committee said that a torch displaying various colors "would expand the theatrical effect for the opening ceremony and torch relay."

By using hydrogen fuel from Fukushima Prefecture, the committee intends to spread the news to the global community about the region's recovery since the 2011 disaster.

Additionally, the Tokyo metropolitan government plans to use hydrogen fuel cells to cover part of the electricity needs for accommodations in the Athletes' Village in Chuo Ward, Tokyo, the sources said.

A senior official of the Tokyo government said, "We want to make the Athletes' Village a showcase for a next-generation 'hydrogen town.'"

Source:
https://www.staradvertiser.com/2019/02/28/news/2020-olympic-games-to-use-hydrogen-fuel-to-light-cauldrons-torch-during-relay/

## Shell plans to become world's largest power firm

Shell is set to become one of the largest power companies in the world, its Director of New Energies has said, as its emissions target forces the company to evolve away from oil and gas.

Speaking to Bloomberg on the sidelines of an energy conference in the US last week, Maarten Wetselaar, Shell's Integrated Gas and New Energies Director, said: "We believe we can be the largest electricity power company in the world in the early 2030s." And to Financial Times he said that for Shell to achieve the goal it set in December to cut emissions by 20% by 2035 "the amount of power – of clean power – we will need to be selling…will make us by far the biggest power company in the world."

Asked how shareholders might respond to the lower returns from power compared to oil and gas, he said: "We are not interested in the power sector because of what we saw in the last 20 years, we are interested because we think we like what we see in the next 20 years…where we believe by optimizing and trading we can make better returns than the industry has done so far."

As well as power trading, Wetselaar said the company will invest in generation from renewable sources, including solar and wind at industrial- and domestic-scale; hydrogen fuels; electric vehicle charging; and home battery storage. It has no plans to enter the transmission portion of the supply chain or generation from coal or nuclear. It will also consider building gas plants to help balance intermittent supplies from its renewables.

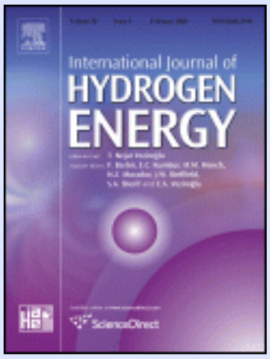
To help meet these ambitions, he said the company plans to spend US$1bn–2bn/y on its new energy technologies. While this is dwarfed by the group's total US$25bn/y budget for capital expenditure, he said that the plan will be to prove it can make between 8–12% returns in power before scaling up investment.

"Electrification is the biggest trend in energy in the coming 10–15 years because it is by far the easiest way to decarbonize energy usage. So, we think the power market will grow a lot, faster than any of the other energy markets," he told Bloomberg.

Shell's new energies business has invested in projects throughout the power supply chain. Last year it took stakes in wind farms being developed off the US and Netherlands, and last week it opened a 27 MW solar project to provide power for its Moerdijk chemical plant in the Netherlands. On transport, it is part of joint venture that is installing hydrogen fueling pumps at 100 locations across Germany; and in January entered the US electric vehicle charging market with its purchase of Greenlots. On the domestic front it purchased UK household energy provider First Utility in February 2018; and last month bought German home energy storage battery technology firm sonnen.

Source:
https://www.thechemicalengineer.com/news/shell-plans-to-becomes-world-s-largest-power-firm/

# International Journal of Hydrogen Energy Highlights




The *International Journal of Hydrogen Energy* aims to provide a central vehicle for the exchange and dissemination of new ideas, technology developments and research results in the field of Hydrogen Energy between scientists and engineers throughout the world. The emphasis is placed on original research, both analytical and experimental, covering all aspects of Hydrogen Energy, including production, storage, transmission, utilization, enabling technologies, environmental impact, economic and international aspects of hydrogen and hydrogen carriers such as $NH_3$, $CH_4$, alcohols, etc.

The utilization includes thermochemical (combustion), photochemical, electrochemical (fuel cells) and nuclear conversion of hydrogen, hydrogen isotopes and/or hydrogen carriers to thermal, mechanical and electrical energies, and their applications in transportation (including aerospace), industrial, commercial and residential sectors. When outstanding new advances are made, or when new areas have been developed to a definitive stage, special review articles will be considered. Shorter communications are also welcome.

## Most Cited IJHE Articles (in 2019)

1. **Ni supported on CaO-MgO-A203 as a highly selective and stable catalyst for H2 production via the glycerol steam reforming reaction**
   Charisiou N, Papageridis K, Tzounis L, Sebastian V, Hinder S, Baker M, Alketbi M, Polychronopoulou K, Goula M. Int J Hydrogen Energy 2019;():256-273
2. **Facile synthesis of carbon encapsulated RuO2 nanorods for supercapacitor and electrocatalytic hydrogen evolution reaction**
   Edison T, Atchudan R, Lee Y. Int J Hydrogen Energy 2019;44(4):2323-2329
3. **The hydrogen storage properties and catalytic mechanism of the CuFe2 04 -doped MgH2 composite system**
   Jebakumar Immanuel Ediston T, Atchudan R, Lee Y, Int J Hydrogen Energy 2019; ():2323-2329
4. **Syngas production from dry methane reforming over yttrium-promoted nickel-KIT -6 catalysts**
   Swirk K, Galvez M, Motak M, Grzybek T, Ronning M, Costa P. Int J Hydrogen Energy 2019;():274-286
5. **Experimental studies on the explosion indices in turbulent stoichiometric H2/CH4/ air mixtures**
   Sun Z. Int J Hydrogen Energy 2019;():469-476
6. **A decade of ceria based solar thermochemical H20/CO2 splitting cycle**
   Bhosale R, Takalkar G, Sutar P, Kumar A, AlMomani F, Khraisheh M. Int J Hydrogen Energy 2019;():34-60

## Most Downloaded IJHE Articles (February-April 2019)

1. **Future cost and performance of water electrolysis: An expert elicitation study**
   Schmidt O, Gambhir A, Staffell I, Hawkes A, Nelson J, Few S. Int J Hydrogen Energy 2017;42(52):30470-30492
2. **Kinetics study and modelling of steam methane reforming process over a NiO/ $Al_2O_3$ catalyst in an adiabatic packed bed reactor**
   Abbas S, Dupont V, Mahmud T. Int J Hydrogen Energy 2017;42(5):2889-2903
3. **A comprehensive review on PEM water electrolysis**
   Carmo M, Fritz D, Mergel J, Stolten D. Int J Hydrogen Energy 2013;38(12):4901-4934
4. **Hydrogen and fuel cell technologies for heating: A review**
   Dodds P, Staffell I, Hawkes A, Li F, Grunewald P, McDowall W, Ekins P. Int J Hydrogen Energy 2015;40(5):2065-2083
5. **Developments of electric cars and fuel cell hydrogen electric cars**
   Wilberforce T, El-Hassan Z, Khatib F, Makky A, Baroutaji A, Carton J, Olabi A. Int J Hydrogen Energy 2017;42(40):25695-25734
6. **Systematic analysis of biomass derived for fuel cells**
   Archer, S., Steinberger-Wilckens R. Int J Hydrogen Energy 2018; 43(52)23178-23192
7. **Nanomaterials for photoelectorchemical water splitting-review**
   Josny J, Mathew J, George S. Int J Hydrogen Energy 2018;43(10);4804-4817

## Systematic Analysis of biomass derived fuels for fuel cells

S. A. Archer, R. Steinberger-Wilkens. J Hydrogen Energy 2018: 43(52): 23178-23192.

With increasing demand worldwide for use and proliferation of fuels that are non fossil-based, alternatives are in demand with the purpose of minimizing environmental impact. The focus of this paper is renewable energy from biological feedstock and wastes. This paper presents an analysis of the current methods of biomass conversion, to extract biofuels and biologically produced gases to then be used in fuel cells.

This study focuses on various biomass (waste) streams and investigates the sustainable potential of these biomass pathways for production of fuel gases for fuel cells. It assesses production efficiencies, upgrading/reforming, and added value products. Agriculture can provide sources for biogas production from energy crops or wastes, using anaerobic digesters.

The growing interest in biomass use for energy supply has resulted in the development of many conversion techniques to produce biofuels: biological (fermentation, anaerobic digestion, and metabolic processing), thermo-chemical (gasification and supercritical water gasification (SCWG) for gas production, and pyrolysis and subsequent liquefaction for liquid fuels), and extraction of carbohydrates, lipids, and hydrocarbons, e.g. for alcohol and biodiesel production.

This study compares the different biomass conversion systems and the fuels they produce and combines them with different fuel cell applications. Key findings of this study include the insight that even pathways with low efficiency and high fuel gas demands have the potential to be more sustainable. This is due to higher yielding biomass feedstock, compared to pathways with higher efficiency, low fuel gas demands, and higher feedstock demands. SOFCs proved to be a more favorable technology than PEFCs, due to their wide range of fuel choices and higher efficiency.

https://www.sciencedirect.com/science/article/pii/S0360319918333949

*-By Michael Daugherty*

## The development of a through-plane reactive excitation technique for detection of pinholes in membrane-containing MEA sub-assemblies

Ulsh, M., A. DeBari, J. M. Berliner, I. V. Zenyuk, P. Rupnowski, L. Matvichuk, A. Z. Weber and G. Bender. Int J Hydrogen Energy 2109 44(16): 8533-8547

The global fuel cell market was valued at USD 3.21 billion in 2016 and is still growing. As the markets for polymer-electrolyte-membrane fuel cells expand, there continues to be a need for the development of in-line quality inspection techniques for high-volume manufacturing methods for components. Such techniques introduce real-time identification of process-induced irregularities during manufacturing, thereby mitigating the impact of poor quality of various components like membrane-electrode assemblies (MEAs). A particular type of irregularity known to impact MEA lifetime is loss of membrane integrity, due to formation of pinholes.

In the recent article by Ulsh, M. et al, (Ulsh, DeBari et al. 2019), they focus on the development of such a technique to detect pinholes in MEA sub-assemblies using a reactive excitation strategy coupled with infrared thermography. A specialized device was introduced and, using various MEA sub-assemblies, validate the detection of pinholes in stationary samples. A Multi-physics model was also utilized to understand and predict the impact of various design and operational parameters of this technique. Both their simulation and in-situ experimental results demonstrate the feasibility of the technique.

Given the breadth of different MEA fabrication approaches that are being pursued across the industry, a technique that can detect the loss of membrane integrity but is agnostic to the particular order or manner of construction of the MEA is of great importance. Put into context, the technique developed by the team, was able to detect (≥1 °C) thermal response for a membrane pinhole of approximately 90 μm in diameter is measured in a fraction of a second. This is proves the immense potential this technique holds in reducing manufacturing costs for mass scale production in the fuel cell industry.

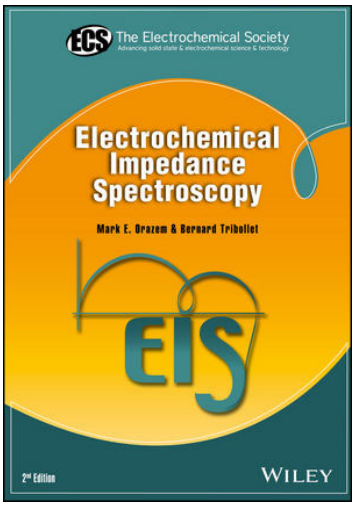
https://www.sciencedirect.com/science/article/pii/S0360319918341855?via%3Dihub

*-By Anirban Roy*

# From the Bookshelf

## Electrochemical Impedance Spectroscopy, Second Edition

### Authors: Mark E. Orazem and Bernard Tribollet




This book by Orazem and Tribollet, part of Wiley's Electrochemical Society Series, emphasizes generally applicable fundamentals rather than providing a detailed treatment of applications. As a reader one can expect to find discussions of specific applications among the references at the end of the book. It is intended as both a reference source and a textbook for training new scientists and engineers.

The authors present the subject in a manner that facilitates the sequential development of understanding and expertise, either in a formal course or in self-study. Throughout the book, illustrative examples in the form of questions followed by answers demonstrate how the principles that have been described can be applied to problems. In this way the audience can try to solve the problems before reading the answers. Important equations and relationships are identified and collected in easily accessible tables.

Most notably, an easily recognized icon—an elephant—appears frequently at the bottom of a page where a critical concept is first mentioned, to emphasis its importance. The elephant also serves to remind the reader of the parable of the blind wise men and the elephant, which is quoted in the introductory section to emphasize the philosophy that impedance spectroscopy cannot be used as a stand-alone technique.

Finally, the closing chapter of the book, gives a philosophy for EIS that integrates experimental observation, model development, and error analysis. The authors' approach differs from the usual sequential approach to developing models for given impedance spectra by emphasizing the advantages of obtaining supporting observations to guide model selection, the use of error analysis to guide regression strategies and experimental design, and the use of models to guide selection of new experiments. They illustrate this approach by citing examples from the scientific literature. This final chapter of the book illustrates that selection of models, even those based on physical principles, requires both error analysis and additional experimental verification.

https://onlinelibrary.wiley.com/doi/book/10.1002/9781119363682

# Become a Member of IAHE

The International Association for Hydrogen Energy (IAHE) has four categories of membership:

- **H-Members:** Scientists, engineers, and laypersons who are interested in fields relating to Hydrogen Energy. They receive IAHE e-newsletter, hard copies of the International Journal of Hydrogen Energy (IJHE), and reduced registration for IAHE conferences.
- **E-Members:** Scientists, engineers and laypersons who are interested in fields relating to Hydrogen Energy. They receive IAHE e-newsletter, access to electronic copies of the International Journal of Hydrogen Energy (IJHE), and reduced registration for IAHE conferences.
- **Student Members:** They are students who are interested in hydrogen energy. They receive the IAHE e-newsletter. The student membership is free and led by Dr. John Sheffield. Please email him at john.sheffield@dnvkema.com for more information.
- **IAHE Fellows:** Long-time IAHE members who have significantly impacted society by promotion of Hydrogen Economy through research, education and/or service.

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These part-time courses run for 12 weeks each and are delivered fully online (face-to-face block-release may be possible for a group of more than 12, subject to demand). Principles of Hydrogen Safety runs in semester one and Hydrogen Safety Technology runs in semester two.

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## Get in touch

Prof Vladimir Molkov, E: v.molkov@ulster.ac.uk
Dr Volodymyr Shentsov, E: v.shentsov@ulster.ac.uk
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Correct at time of print (June 2018). Visit ulster.ac.uk for up-to-date information on courses, fees and facilities.

# The 17th International Conference on Clean Energy

# (ICCE-2019)

Dear Colleagues,

On behalf of the organizing committee of the 17th International Conference on Clean Energy (ICCE-2019), we are happy to announce the ICCE-2019 to be held in Shenyang Jianzhu University (SJZU), China, from 9 to 12 August 2019.

The conference theme, "Clean energy, Clean world", means that clean energy will reward us a blue sky and change our world. The cleaner production will make a better use of energy resources and reduce the production and emission of contaminant so that it is an important procedure to realize sustainable development.

**Important Dates**

**Abstract Submission Deadline: 15 May 2019**

**Conference Date: 9-12 August 2019**

Mark your calendar, and present your results and experiences via poster or oral presentation to this international conference. We hope by this conference you will gain new knowledge, make new friends, and enjoy splendid summer days in the beautiful city of Northeast China. ***High quality papers presented at this conference will be recommended for publication in the International Journal of Hydrogen Energy (IJHE) after further review.***

Papers are solicited from all relevant areas, from new concepts, theories, modeling and simulation to experiments. Topics of interest include, but are not limited to:

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(3). Nuclear energy (4). Wind energy
(5). Hydropower, ocean energy and geothermal energy
(6). Fuel cell (7). Energy storage
(8). Energy conversion (9). Biomass and biofuels
(10). Clean fossil fuels (11). Waste-to-energy
(12). Intelligent grids (13). Energy economy, management and policy
(14). Buildings energy efficiency (15). Energy engineering and environmental protection
(16). Green manufacturing and machine saving energy

For more information, pleases visit http://2019icce.csp.escience.cn We are looking forward to welcoming you in August 2019 in Shenyang.
In case of any questions, please feel free to contact us.

Best Regards,

Prof. Dr. Yuhou Wu
Conference Chair

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# 9th International Seminar on Fire and Explosion Hazards

St. Petersburg, Russia, 21-26 April 2019

The 9th International Seminar on Fire and Explosion Hazards ISFEH9 (www.isfeh9.org) will be held in St.-Petersburg, Russia, on 21-26 April 2019. This conference continues past successful events organized in Moscow, Russia (1995, 1997), Lake Windermere, UK (2000), Londonderry, UK (2003), Edinburgh, UK (2007), Leeds, UK (2010), Providence, USA (2013), and Hefei, China (2016).

During its more than 20-year history, the Seminar has become one of the important international events in fire and explosion science and engineering. The Seminar program will include broad areas of fire and explosion studies, mitigation, and prevention. The following conference tracks (with the variety of topics therein) are available for paper submission:

- Combustion fundamentals of fires
- Deflagration, DDT, detonation
- Fire dynamics
- Material behavior in fires
- Fire safety engineering
- Fire suppression
- Hydrogen safety
- Wildland fires
- Toxicity
- Evacuation and human behavior

Papers will be peer-reviewed and, if accepted, will be included in the book of the Seminar Proceedings. Authors of selected papers will be invited to submit extended versions for publication in special issues of *Fire Safety Journal*, *Combustion Explosion and Shock Waves*, and *International Journal of Hydrogen Energy*. These journals are indexed by Scopus and Web of Science.

Abstract submission deadline is July 1st, 2018. Please do your best to submit the one- or two-page abstract via the conference website http://www.isfeh9.org/submission by this date, and do not hesitate to contact ISFEH9 Organizing Committee at info@isfeh9.org if you have any inquiries. Notification with the decision on the abstract will be sent off as indicated in the Key Dates section of the conference website www.isfeh9.org.

The city of St.Petersburg is an exciting place to visit and has much to offer for participants and accompanying persons, for whom an extensive social program is being developed.

Welcome to submit your research to ISFEH9 and to visit St.Petersburg!

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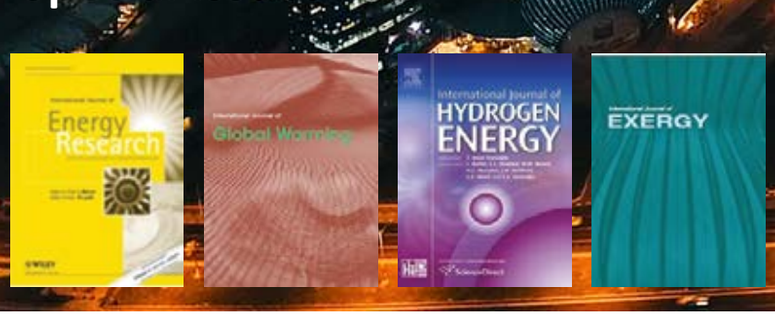


## Important Dates

| | |
|---|---|
| **Abstract Submission** | December 15, 2018 |
| **Abstract Acceptance** | December 30, 2018 |
| **Short-Paper Due** | January 30 2019 |
| **Short-Paper Acceptance** | February 20, 2019 |

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# CALL FOR PAPERS

# INTERNATIONAL JOURNAL OF HYDROGEN ENERGY

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The supply of increasing energy demands a massive exploration of research to develop new and renewable sources. Nowadays, micro/nano scale materials are needed for solving the environmental and energy problems. Materials for energy and environment produce clean and efficient sources of energy to address our present energy related concerns and steer society to a more sustainable future. Smart and functional nanomaterials, due to their unique characteristics and excellent performances, are demanded in the area of green energy and renewable energy sources. The multi-dimensional nanostructured materials exhibit a high specific surface area and more exposed active surface sites which effectively pose several innovative physico-chemical properties that considerably facilitate their chemical and electrochemical activities. The main aim of special issue is to highlight the recent advances in research and to provide a platform for the designing, synthesis, characterizations and the applications of novel multifunctional nanomaterials in hydrogen energy and related energy. Area of interest includes the Reviews/Research Articles/Communications/Letters to Editors on the following topics but is not limited to:

1. Hydrogen Energy
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3. Electrocatalysts
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Before submission authors should carefully read over the journal's Author Guidelines, which are located at https://www.elsevier.com/journals/international-journal-of-hydrogen-energy/0360-3199/guide-for-authors. Prospective authors should submit an electronic copy of their complete manuscript through the journal Manuscript Tracking System at https://ees.elsevier.com/he/default.asp according to the following timetable:

Last Date of Manuscript Submission: 15 August, 2019
Due Date of Completion of Review: 30 October, 2019
Expected Date of Publication: --------2019

**Guest Editors:**

**1. Prof. Sadia Ameen**
Advanced Materials and Devices Laboratory,
Jeongeup Industry-Academic Cooperation Support Centre, Jeongeup Campus,
Chonbuk National University, 56212, Republic of Korea

**2. Prof. M. Shaheer Akhtar**
New & Renewable Energy Material Development Center (NewREC),
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**Plenary I: Prof. Denis Fichou**
*(Nanyang Technological University, Singapore & Sorbonne Université, Paris, France)*

Title: Organic single crystal semiconductors for emerging electronic devices

**Plenary II: Prof. Chulhee Kim**
*(Dept Polymer Science & Engineering, Inha University, South Korea)*

Title: Tunable Multifunctional Supramolecular Platforms with Stimuli-responsive Surfaces

**Plenary III: Prof. Chris Matyjaszewski**
*(Carnegie Mellon University, Pittsburgh, USA)*

Title: Advanced Materials by ATRP

**Plenary IV: Prof. Paras Prasad**
*(State University of Buffalo, New York, USA)*

Title: Development and applications of a new class of 2-D and quantum materials

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## Important Dates:

| | |
|---|---|
| **Abstract submission** | 17th February 2019 |
| **Early bird registration** | 17th May 2019 |
| **Acceptance notification** | 17th March 2019 |
| **Conference date** | 17th June ~ 21st June 2019 |

## Publications:

1. Molecular Crystals Liquid Crystals journal ***(Impact factor = 0.633)***
2. Pigment & Resin Technology ***(Impact factor = 0.486)***
3. International Journal of Hydrogen Energy ***(Impact factor = 4.229)***

**Secretariat**
Centre for Ionics University of Malaya,
Department of Physics, Faculty of Science, University of Malaya,
50603 Kuala Lumpur, MALAYSIA

E-mail: icfpam2019@um.edu.my

Contact number: (603) 7967 4095/7143

# 10th International Conference
# Photosynthesis and Hydrogen Energy Research for Sustainability
# 23-28 June 2019
# St. Petersburg, Russia

**Dear Colleagues, Dear Friends:**

We are pleased to cordially invite you to participate in the 10th International Conference "*Photosynthesis and Hydrogen Energy Research for Sustainability - 2019*" ***in honor of Kimiyuki Satoh (Japan), Tingyun Kuang (China), Cesare Marchetti (Italy) and Anthony Larkum (Australia).***

Your participation is important for the success of the Meeting, and will be very much appreciated. This Meeting will be a great occasion for discussions of previous, present, and future research on photosynthesis and hydrogen energy, from molecular to global, and will provide an exciting scientific program, which will cover the breadth and depth of photosynthesis and hydrogen energy, and to meet researchers of photosynthesis and hydrogen energy from around the world. This meeting will provide a forum for students, postdoctoral fellows and scientists from different countries to deepen their knowledge and understanding, widen professional contact, to create new opportunities and establish new collaborations.

Please save the date, spread the information among colleagues, and link the website at **https://icprs.ru/**

The website will be supplemented step-by-step with relevant information on the meeting.
Sincerely yours,

Suleyman Allakhverdiev
Conference Chair

*P.S. From late May to early July nights are bright in St-Petersburg, but the real White Nights normally last from June 11 to July 2.*

NATIONAL HYDROGEN ASSOCIATION TURKEY

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

WSSET World Society of Sustainable Energy Technologies

International Association for Hydrogen Energy

Bridging Continents by $H_2$

# WHEC2020

## 23rd World Hydrogen Energy Conference

## July 5-9, 2020

Istanbul, Turkey

www.whec2020.org

info@whec2020.org

# The 11th International Exergy, Energy and Environment Symposium (IEEES-11)

**Date: 14 - 18 July 2019**

**Venue: SRM Institute of Science & Technology, Chennai, India**

## Founding Chair

**I. Dincer**
University of Ontario Institute of Technology, Canada

## Symposium Chair

**M. Leenus Jesu Martin**, SRM IST, Chennai, India
**V. Edwin Geo**, SRM IST, Chennai, India

## Symposium Co-Chair

**F. Aloui**

Polytechnic University of Hauts-de-France, Valenciennes, France

## Contact

**The Symposium Chair**
Department of Automobile Engineering
School of Mechanical Engineering
SRM IST, Kattankulathur, Tamil Nadu, INDIA
Mobile: 00-91-9840498667

**Email ID:** convenor.ieees11@srmuniv.ac.in
ieees11.2019@srmuniv.ac.in (For paper submission)
**Website: http://www.srmuniv.ac.in/ieees-11**

The 11th International Exergy, Energy and Environment Symposium (IEEES-11) is an initiative aimed at bringing together the academicians, researchers, scientists, technocrats and practicing engineers in the field. As a confluence of many disciplines, this International Symposium/Conference serves as a forum that promulgates ideas, experience, and knowledge of the fellow researchers and engineers working on sustainable energy systems across the globe. It is worthy to note that IEEES-11 covers a diverse assortment of cutting-edge topics, including Clean Coal Technologies, Renewable Energy Technologies, Smart Energy Systems, Alternative Fuels, Hydrogen and Fuel Cell Technologies, Nuclear Energy, Desalination Technologies, and Environmental Technologies.

The IEEES-11 increases the visibility and advancement in futuristic and cleaner technologies like Green Energy, Renewable Energy, Environmental Science and e-mobility. Other highlights are Smart Cities, Green Building, Energy Management Systems, and Desalination Technologies. It also addresses the societal and environmental threats, unveiling the challenges in the Life Cycle Assessment, $CO_2$ Reduction Technologies, Bio-Waste Utilization, Nuclear Energy and Fuels for Transportation that includes Synthetic and Third Generation fuels. During this symposium, more emphasis will be given to the "Green Transportation and Sustainable mobility", beneficial for the new development of sustainable technology for thermal comforts and green transportation vehicle. A special session will be hosted on the importance of Hydrogen Production and Utilization/Storage Technologies, Fuel Cell Technologies and the challenges involved in its implementation in the mobility sector.

This is the eleventh symposium, which is to be held in SRM IST, Chennai, India. Previous successful editions were held at Izmir, Turkey (2003); Kos, Greece (2005); Evora, Portugal (2007); Sharjah, United Arab Emirates (2009); Luxor, Egypt (2011); Eurasia, Turkey (2013); Valenciennes, France (2015); Antalya, Turkey (2016); Split, Croatia (2017) and Katowice, Poland (2018). Topics and new trends will be introduced through several keynote lectures that will be presented by internationally recognized experts.

- ★ Algae Fuels
- ★ Bio-Waste Utilization
- ★ Cogeneration and Micro Generation
- ★ Combustion, Pyrolysis, and Gasification Technologies
- ★ Desalination Technologies
- ★ Electro-Chemical Devices (Fuel Cells, Capacitors, Batteries, etc.)
- ★ Energetic System Optimization
- ★ Energy Systems and Applications
- ★ Environmental Engineering Technologies
- ★ Environmental Impact Assessment
- ★ Exergy Analysis and Modeling
- ★ Fossil Fuels
- ★ Green Buildings
- ★ Green Energy Technologies
- ★ Green Transportation Vehicles
- ★ Heat and Mass Transfer
- ★ Hydrogen Production and Utilization Technologies
- ★ Life Cycle Assessment
- ★ New Materials for Energy Applications
- ★ Nuclear Energy
- ★ Refrigeration and Heat Pump Systems
- ★ Renewable Energy Systems
- ★ Sectoral Energy Management
- ★ Smart Grids
- ★ Sustainable Communities
- ★ Sustainable Development
- ★ Sustainable Mobility
- ★ Synthetic Fuels
- ★ Thermal comfort and Green Transportation Vehicles
- ★ Thermal Systems and Applications
- ★ Thermodynamic Optimization
- ★ Tri-generation Systems

## International Advisory Committee

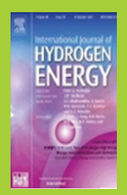


## Important Dates

**Abstract submission:** 15 January 2019
**Notification of abstract acceptance:** 30 January 2019
**Full manuscript due:** 15 March 2019
**Notification of manuscript acceptance:** 10 May 2019

IF: 3.009

IF: 0.913



IF: 4.229

IF: 0.66

IF: 1.09

SPRINGER NATURE

# AEM 2019 ADVANCED ENERGY MATERIALS

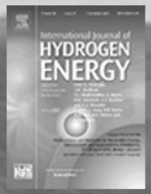
September 11-13, 2019
University of Surrey, Guildford, England
LONDON is the hub to reach the University of Surrey.

www.advanced-energymaterials-conference.com

## International conferences on:

- Advanced Energy Materials
- Advanced Nano Materials
- Hydrogen Energy
- Solar Energy Materials
- Polymer Energy Materials
- Crystalline Porous Materials
- Catalysis and Energy Materials
- Advanced Graphene Materials
- All the above international conferences will be hosted simultaneously as parallel sessions in the same venue.

## Special Issues






UNIVERSITY OF SURREY

# XXIV$^{th}$ International Symposium on Combustion

## 23-25$^{th}$ of September 2019, Wrocław, Poland

Wrocław University of Science and Technology

The conference will cover:

- Stationary Combustion Systems in Mega & Nano Scale and their Emissions generation, reduction problems
- Advanced Combustion Technologies and Renewable Energy Sources
- Diagnostics in combustion systems
- Fire and Detonations, Explosions, and Supersonic Combustion
- Generation, storage and utilization of Hydrogen
- Engines and Gas turbines
- Modelling of combustion processes including kinetics and industrial applications
- Other Concepts including assisted combustion (plasmas, electric and magnetic fields), catalysis, fuel synthesis
- Use of by-products of combustion processes
- Thermal valorisation of solid fuels
- Zero-emission combustion technologies
- Industry Perspectives

energies

an Open Access Journal by MDPI

Boiler, Combustion and Energy Processes Department
Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland, +48 71 3203942; iscp2019@pwr.wroc.pl; iscp2019.pwr.edu.pl

# ICENES 2019

## 19th International Conference on Emerging Nuclear Energy Systems
## 6 - 9 October 2019, Bali, Indonesia

**The 19th International Conference on Emerging Nuclear Energy Systems (ICENES 2019) is recognized as one of the major international conference on scientific, engineering, and other technical aspects of innovative nuclear reactor design, advanced nuclear technology, etc. In the conference, we are looking at "bold" and "unthinkable" ideas on a sound scientific-technical basis. Papers on strategy, concept, technique and method related to innovative nuclear system are welcome.**

**ICENES has been held in 14 countries as a venue for sharing ideas and research results on emerging nuclear energy technologies and applications. The ICENES 2019 will be held by The Technical University of Bandung in Holiday Inn, Bali, Indonesia (6-9 October 2019). The conference will cover keynote, invited and contributed oral talks and poster presentations.**

**Host organizations**
**Technical University Bandung**
**Bahçeşehir University**

***President of ICENES***
**Prof. Dr. Sümer ŞAHİN**
***Conference Chairmen***
**Prof. Dr. Abdul WARIS**
**Prof. Dr. Zaki SUUD**
**Technical Program Chairman**
**Prof. Dr. Sidik PERMANA**
**Scientific Secretaries**
**Dr. Syeilendra Pramuditya**
**Dr. Eng. Dwi Irwanto**

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**Yonghee Kim** **Hiroshi Sekimoto**
**Jose Manuel Perlado** **Kazuo Tanaka**
**Waclaw Gudowski** **Şenay Yalçın**
**Mohamed Sawan** **Andrey Gulevich**
**V. Jagannathan** **Minghuang Wang**
**Chen Zhibin** **Ruzhu Wang**
**Xiaojing Liu**

## Technical Topics

1. **Innovative Nuclear Energy Development Strategy**
1. **Advanced Fission Systems**
   - **Space Nuclear Reactors**
   - **Generation IV Reactors**
   - **Small Modular Reactor**
2. **Fusion Energy Systems**
   - **Magnetic Confinement Fusion System**
   - **Inertial Confinement Fusion System**
4. **Hybrid Nuclear Energy Systems**
   - **Fusion Driven Subcritical System**
   - **Accelerator Driven Subcritical System**
5. **Advanced Technology and Other Issues**
   - **Modeling, Database and Simulations**
   - **Advanced Fuels & Materials**
   - **Facility and Component Development**
   - **Radiation Protection & Shielding**
   - **Safety and Environment**
   - **Operation and Maintenance**
   - **Reprocessing**
6. **Nuclear Energy Expanded Applications**
   - **Solar and Wind Power**
   - **Hydrogen Energy**
   - **Nuclear Hydrogen Production**
   - **Others**
7. **Knowledge, Management**
8. **Human Resources and Social Issues**

## Key Dates

- **April 30, 2019**
  **Abstract Submission Deadline**
- **May 30, 2019**
  **Abstract Acceptance Notification**
- **June 15, 2019**
  **Early Registration Deadline**
- **October 6-9, 2019**
  **Conference Convened**
- **September 30, 2019**
  **Manuscripts Submission Deadline**

## Contact Information

**Tel: +62 813 22 19 66 44**
**E-mail: awaris@fi.itb.ac.id**
**Website:**
**http://portal.fmipa.itb.ac.id/icenes2019**

# Upcoming Meetings & Activities

## April 2019

**9th International Seminar on Fire and Explosion Hazards**
April 21-26, 2019
St. Petersburg, Russia
http://www.isfeh9.org/

**8th Global Conference on Global Warming**
April 22-25, 2019
Doha, Qatar
https//www.gcgw.org

**14th Hydrogen Power Theoretical and Engineering Solutions International Symposium**
April 24-26, 2019
Foz do Iguacu, Brazil
https://www.hypothesis.ws

## May 2019

**10th International Conference on Hydrogen Production**
May 15-17, 2019
Cluj-Napoca, Romania
https://www.ich2p.org

**The Impulse Summit for Hydrogen and Fuel Cells**
May 22-23, 2019
Vancouver, Canada
https://www.f-cell.de/en/program/f-cell-hfc.html

## June 2019

**WHTC 2019**
June 2-7, 2019
Tokyo, Japan
http://whtc2019.jp/index.html

**15th International Conference on Frontiers of Polymers and Advanced Materials 2019**
June 17-21, 2019
Penang, Malaysia
https://umconference.um.edu.my/ICFPAM-2019

**10th International Conference Photosynthesis and Hydrogen Energy Research for Sustainability**
June 23-28, 2019
St. Petersburg, Russia
https://icprs.ru/

## July 2019

**Energy Security and Chemical Engineering Congress 2019**
July 17-19, 2019
Penang, Malaysia
http://esche.ump.edu.my/index.php/en/

**11th International Exergy, Energy, and Environment Symposium (IEEES-11)**
July 14-18, 2019
Chennai, India
http://www.srmuniv.ac.in/ieees-11/

## August 2019

**17th International Conference on Clean Energy**
August 9-12, 2019
Shenyang, China
http://2019icce.csp.escience.cn/dct/page/1

## September 2019

**Advanced Energy Materials**
September 11-13, 2019
Guildford, England
https://www.advanced-energymaterials-conference.com/

**XXIVth International Symposium on Combustion**
September 23-25, 2019
Wrocaw, Poland
http://iscp2019.pwr.edu.pl/

## October 2019

**19th International Conference on Emerging Nuclear Energy Systems**
October 6-9, 2019
Bali, Indonesia
http://portal.fmipa.itb.ac.id/icenes2019

## July 2020

**WHEC 2010**
July 5-9, 2020
Istanbul, Turkey
http://www.whec2020.org

# Get Connected—Internet Groups of Interest

## LinkedIn Connections

*Hydrogen Group*
Hydrogen Group is a global specialist recruitment business, placing exceptional, hard to find candidates in over 70 countries.

*Global Hydrogen Ambassadors Network*
Their goal is to exchange opinions on a topic, which may look easy at first glance, but is rather complex. All questions are allowed. A wealth of answers can be expected.

*World EcoEnergy Forum: Driving Innovation in the Energy Storage and Smart Grid Industry*
The aim of this group is to bring together executives responsible for R&D to discuss about new product development and sustainable development in the energy storage and smart-grid industry.

*Hydrogen Pathway*
This is a very active group-page within LinkedIn that includes discussions and latest news regarding hydrogen energy.

*Renewable Energy Solutions*
I.R.E.S. platform to create bridges between international based investors, manufactures and wholesale companies in the Renewable Business Industry. Solar power, wind energy, tidal power, geothermal power, air power, hydrogen, waste management.

*Global Renewable Energy Network*
Global Renewable Energy Network (GReEN) is the premier business network for professionals and companies involved in the development, commercialization, and utilization of renewable energies (e.g. bioenergy, geothermal, hydro, hydrogen, ocean, solar, and wind), worldwide.

*Fuel Cell & Hydrogen Network*
Bringing together professionals and enthusiasts alike, the Fuel Cell & Hydrogen Network serves to connect those advocating fuel cell and hydrogen technologies. The group welcomes people who are interested in all types of fuel cell technologies as well as the wide variety of hydrogen technologies, and is not exclusive of hydrogen fuel cells.

*Fuel Cells*
Welcomes those who are interested in clean energy fuel cell applications and technologies. Encourages members to start discussions that are relevant to fuel cells, to post promotions and jobs, and to use this group to develop their professional network.

*Fuel Cell Energy*
The Fuel Cell Energy Group advocates the use of Fuel Cell Energy & the promotion of its Technology and for those interested in learning more about Fuel Cell Technology. Fuel Cell Professionals, Renewable Energy, Clean Technology, and Environmental Advocates are welcome. Solar, Wind, Biomass, Biofuel, Tidal Power & Wave Professionals also welcome to learn about this emerging technology.

## Facebook Connections

*Hydrogen + Fuel Cells*

Hydrogen was underestimated for a long time, but for seasonal energy storage H2 can be produced environmentally friendly by electrolysis from water and renewable energies. Therefore the H2 technology offers great potential. And fuel cells are the ideal energy converters for this. Here in this group - the former Global Hydrogen Ambassadors Group - you will find all the important information about it. .

*International Association for Hydrogen Energy*
Facebook community for sharing the information regarding advances in hydrogen energy.

## Blogs

*H2-International*
Offers a blog and newsletter that contains articles which are published in the German magazine HZwei. Offers detailed information on hydrogen and fuel cells, and is a respectful attempt at continuing the work of Peter Hoffman, the author of *Hydrogen & Fuel Cell Letter*.

http://www.h2-international.com/