



## **Anheuser-Busch continues leadership in clean energy, places order for 800 hydrogen-electric powered semi-trucks with Nikola Motor Company**



*Brewer announces plan to convert entire dedicated fleet to renewable power by 2025*

In May, Anheuser-Busch and Nikola Motor Company announced that America's leading brewer has placed an order for up to 800 hydrogen-electric powered semi-trucks from the pioneer in hydrogen-electric renewable technology. The zero-emission trucks—which will be able to travel between 500 and 1,200 miles and be refilled within 20 minutes, reducing idle time—are expected to be integrated into Anheuser-Busch's dedicated fleet beginning in 2020.

Through this agreement Anheuser-Busch aims to convert its entire long-haul dedicated fleet to renewable powered trucks by 2025. Nikola's cutting-edge technology will enable the brewer to achieve this milestone across its long-haul loads, while also helping to improve road safety through the trucks' advanced surround viewing system.

"At Anheuser-Busch we're continuously searching for ways to improve sustainability across our entire value chain and drive our industry forward," said Michel Doukeris, CEO of Anheuser-Busch. "The transport industry is one that is ripe for innovative solutions and Nikola

is leading the way with hydrogen-electric, zero-emission capabilities. We are very excited by the possibilities our partnership with them can offer."

"Hydrogen-electric technology is the future of logistics and we're proud to be leading the way," added Trevor Milton, CEO of Nikola Motor Company. "Anheuser-Busch has a long history of investing in progressive, sustainable technology and we are excited to partner with them to bring the largest hydrogen network in the world to the USA. By 2028, we anticipate having over 700 hydrogen stations across the USA and Canada. With nearly 9 billion dollars in pre-order reservations, we are building to order, not speculation, and are very excited for what's to come."

The partnership with Nikola will contribute to Anheuser-Busch's recently announced 2025 Sustainability Goals, which include reducing CO<sub>2</sub> emissions by 25% across its value chain [i]. Once fully implemented, the carbon reductions gained from these 800 trucks will reduce the brewer's carbon emissions from logistics by more than 18%—equivalent to taking more than 13 thousand passenger vehicles off the road annually.

Emission reduction has, and continues to be, a long-term focus for Anheuser-Busch. In 2006, the brewer joined the U.S. Environmental Protection Agency's SmartWay Transport program; and since 2008, has reduced its total energy use in U.S. breweries by more than 30%. Anheuser-Busch has proudly brewed America's most loved beers for the past 165 years and through its commitment to a sustainable future, hopes to continue doing so for the next 165 years and beyond.

[i] 25% carbon reduction per beverage is in line with science-based methodology and has been verified and approved by the Science Based Targets Initiative.

Source: <http://www.anheuser-busch.com/newsroom/20071/05/anheuser-busch-continues-leadership-in-clean-energy---places-ord.html>

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## Newsletter Production

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## IAHE Objective

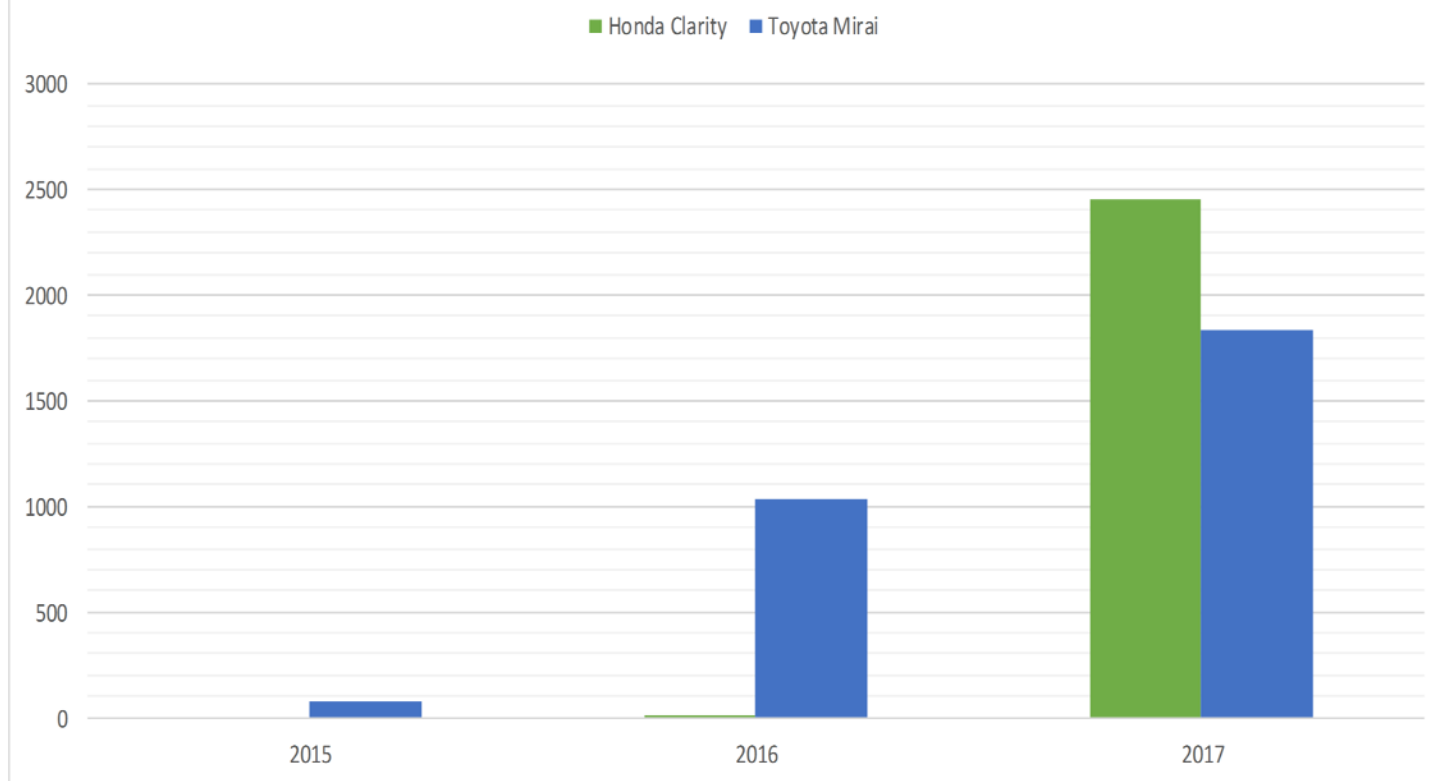
The objective of the IAHE is to advance the day when hydrogen energy will become the principal means by which the world will achieve its long-sought goal of abundant clean energy for mankind. Toward this end, the IAHE stimulates the exchange of information in the hydrogen energy field through its publications 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.

## Get Connected with IAHE



# Car Sales Data for the U.S.

## U.S. Fuel Cell Car Sales Comparison



### Honda Clarity

YEAR	SALES
2015	
2016	8
2017	2,455

### Toyota Mirai

YEAR	SALES
2015	72
2016	1,034
2017	1,838

## China is shifting its focus toward fuel cell vehicles

### China is beginning to show more interest in hydrogen fuel

China may begin showing more support for fuel cell vehicles in the near future. The country has become a strong advocate for clean transportation and has invested heavily in promoting vehicles powered by batteries. China's focus on clean transportation has helped accelerate the adoption of renewable energy as well. Now, the country is beginning to shift its focus toward hydrogen fuel and vehicles equipped with fuel cell technology.

### More than 1 million fuel cell vehicles may be on Chinese roads by 2030

The Chinese government recently announced plans to significantly increase the country's hydrogen infrastructure. The government aims to support the development of new hydrogen stations that will help support some 50,000 fuel cell vehicles by 2025. By 2030, China aims to have more than 1 million hydrogen-powered vehicles in operation. China's New Energy Vehicle strategy will see some 1,000 new hydrogen fuel stations built throughout the country by 2030. Many of the fuel cell vehicles coming to China will likely be buses, but consumers are beginning to show strong interest in such cars.

### China is strongly committed to the Paris Agreement

There are many reasons why China is beginning to show more support for hydrogen fuel. Among these reasons is the country's commitment to the Paris Agreement. China is working to make significant cuts to its emissions in the coming years in order to comply with international expectations. The country is also poising itself to become the world's leading renewable energy entity. Already China has established itself as the world's largest clean transportation market, which has created new and promising economic opportunities.

### Subsidies are helping encourage consumers to purchase clean cars

The Chinese government currently offers subsidies for those interested in purchasing clean vehicles. These subsidies have helped encourage consumers to purchase new cars, but some still shy away from those powered by fuel

cells. These particular vehicles are more expensive than their battery-powered counterparts and have less infrastructure support. As China begins expanding its hydrogen network, however, more consumers are likely to embrace fuel cell cars.

Source: <http://www.hydrogenfuelnews.com/china-is-shifting-its-focus-toward-fuel-cell-vehicles/8534519/>

## Plug Power, Workhorse, and FedEx team up on fuel-cell delivery vehicle

Three companies have teamed up to put a hydrogen fuel-cell delivery vehicle into regular service. The vehicle is an EGEN van built by Workhorse, a company best known for its battery-electric vehicles, with a hydrogen powertrain and fueling station supplied by Plug Power. It operates at a FedEx facility in Menands, New York, near the state capital of Albany.

The single Class 5 van operates on a standard FedEx delivery route, according to Plug Power. It has already racked up more than 3,000 miles in initial on-road tests, and the company expects it to accumulate 27,000 more miles in service over the next six months. That will go a long way (no pun intended) toward promoting the use of hydrogen fuel-cell vehicles in commercial applications.

So will Plug Power's range claims. The company estimates a range of more than 160 miles per delivery cycle, and claims this is 166 percent better than what an equivalent battery-powered delivery van could achieve.

As is always the case with hydrogen fuel cells, fueling infrastructure will likely be the limiting factor. The FedEx delivery van refuels at a station built by Plug Power in Latham, New York. It's one of just a handful of public hydrogen stations on the East Coast. That should be adequate for a single vehicle, but for hydrogen to displace diesel or gasoline, more stations will be needed.

FedEx previously worked with Plug Power to provide fueling infrastructure for hydrogen fuel-cell airport tractors at its air-cargo hub in Memphis, Tennessee. The logistics giant has also tested delivery vans that use both fuel cells and battery packs together. Toyota is currently testing its "Project Portal" fuel-cell semi truck in California, and Nikola Motors hopes to start production of its own fuel-cell semi in 2020.

Because they operate on predictable routes that never take them far from a central terminal, delivery vehicles may be a better application for hydrogen fuel-cell power-trains than passenger cars, which have struggled due to a lack of available fueling stations. But producing enough hydrogen for a large fleet of vehicles may still be difficult, and fuel cells still face stiff competition from batteries in the race to lower emissions.

Source: <http://www.thedrive.com/tech/20515/plug-power-workhorse-and-fedex-team-up-on-fuel-cell-delivery-vehicle>

## Toyota begins selling its new hydrogen-powered bus in Japan



Japanese automaker Toyota has begun the production and sale of its new hydrogen-powered bus, called Sora. The bus has only been launched in Japan and there are just over 100 units currently available. Sora buses are expected to operate primarily within Tokyo and may even see significant use during the 2020 Olympic Games, which will be held in the city. The Toyota Sora uses the same fuel cell technology that is currently being used to power the automaker's Mirai model.

### Bus is equipped with an external energy system that can supply electricity in an emergency

The Toyota Sora has been equipped with an external power device that can supply some 235 kilowatt-hours of electrical power. This energy device could be useful in emergency situations when access to electricity is needed but disrupted in some way. This has become somewhat popular with Toyota's clean vehicles, partly due to the im-

pact of the 2011 Fukushima earthquake. During that time, hydrogen fuel cells were used to provide emergency power to those that had no access to electricity.

### Toyota Sora aims to offer a comfortable ride for passengers

The bus is designed with comfort and efficiency in mind, and its use of fuel cell technology allows it to accomplish this. The fuel cell system makes no noise, allowing the bus to operate in relative silence. The bus' seats are also programmed to store themselves while not in use, creating more room for standing passengers. No gear shifting significantly reduces the lurching that is associated with more conventional buses. The Toyota Sora is also equipped with acceleration control, which allows for smooth acceleration to make for an easier ride.

### Japan is focusing more heavily on clean vehicles

The bus is part of Toyota's ongoing effort to make transportation more environmentally friendly. It also showcases where Japan's transportation sector is heading into the future. The Japanese government is eager to embrace clean vehicles, particularly those powered by fuel cells, in order to establish a hydrogen society. The country intends to show off a vast array of hydrogen-powered vehicles and fuel cell systems during the 2020 Olympics.

Source: <https://www.hydrogenfuelnews.com/toyota-sora-is-now-being-sold-in-japan/8534944/>

## Rasa's hydrogen car to take on Tesla

Nasdaq-listed electric car maker Tesla Inc. is all set to face some stiff competition.

While automakers are focusing on electric vehicles (EV) that are powered by high capacity batteries, UK-based Riversimple is betting big on hydrogen as a clean and efficient fuel for future cars, whose efficiency and range is claimed to surpass that of EVs.

If all goes as per plan, the Riversimple Rasa hydrogen-powered car is expected to emerge as a practical alternative to electric vehicles.

### Meet the Rasa Car

Rasa is a two seater car that is powered by a hydrogen fuel cell. Its prototype, which is currently being tested on the busy roads of London and on the county lanes of Powsy, Wales, UK, has successfully managed to achieve driving speeds of above 60 miles per hour and has been swiftly maneuvering and negotiating the traffic on the busy roads of the capital of England.

The major components of the car, like the chassis, are built using extremely strong and yet very lightweight carbon fiber composites, which neatly integrates with the vehicle body. In the monocoque structure model, where the chassis is integral with the car's body structure, the Rasa chassis weighs less than 40 kilograms. The overall car weighs around 580 kilograms, which is almost half the weight of a present-day conventional car. Lower weight allows the vehicle to run for longer range.

The car consists of four electric motors, each one integrated into one of the car wheels allowing for a four wheel drive. The motors are used as brakes which helps to preserve more than 50 percent of the kinetic energy when the brakes are applied. The car is fitted with super capacitors that store this energy and make it available during car's acceleration. In conventional cars, this energy is not recoverable.

Unlike batteries, these superconductors cannot store a large amount of energy but are capable of storing smaller amounts very quickly, which makes them ideal for quickly storing the energy available during braking, and for instantly providing it when the car accelerates.

The primary fuel source of the Rasa car is a hydrogen fuel cell. While many experiments have been performed on fitting the conventional vehicles with fuel cells, they have remained inefficient due to the large weight of the conventional vehicles. Rasa's unique synthesis of various technologies - to keep the vehicle lightweight and to reuse braking energy for acceleration - helps to achieve high efficiency and longer driving range.

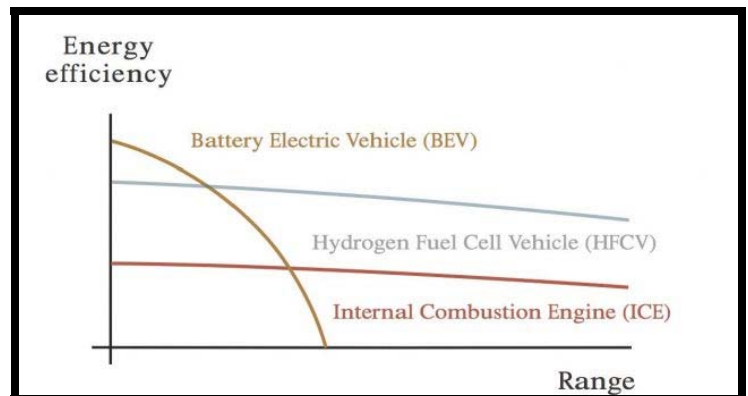
Riversimple call Rasa a "network electric car," as it has been designed to network the available energy all around the car. Available energy can move in any direction on any path, in addition to the standard route of back into the fuel cell.

Due to this mechanism, the Rasa efficiently runs on an 8.5kW hydrogen fuel cell. It can go 300 miles on 1.5 kilograms of hydrogen. The fuel efficiency is enhanced by its aerodynamic design, which also keeps the car stable despite its low weight.

## Can Rasa Hit Tesla?

Tesla's electric vehicles have gained traction on two major points – first is the use of clean fuel, and secondly, their low cost of use. However, these EVs need regular charging which means driving to charging stations and waiting for the vehicles to be fully charged. Hydrogen can be generated by the process of electrolysis that can be performed at the point of distribution.

Riversimple provides a comparative chart for the energy efficiency of vehicles operated by various sources, indicating a clear advantage for hydrogen fuel cell vehicles (HFCV) over those with fossil fuel-based internal combustion engines. Though battery powered electric vehicles have higher efficiency, their range is much lower than HFCV.



## Rasa's USP

Riversimple calls itself a sustainable car company, not a hydrogen car company. Rasa was conceptualized, designed and created based on the features of simplicity, efficiency, lightness, strength, affordability, safety and sustainability. The name "Rasa" was derived from the Latin term "Tabula Rasa" which means a "Clean slate", and fits perfectly for the basis and the purpose for which it was created. Riversimple claims to have designed the Rasa from scratch to deliver a significant change in fuel efficiency of the automobile and to keep the minimal impact on the environment.

The pricing model of the Rasa is different. The customers don't purchase the car outright, rather they will pay a fixed monthly fee to own the car, and the fee will also cover all maintenance and insurance costs as well as the necessary fuel to run it. Riversimple calls it "product as a service," or more specifically, "mobility as a service," as a single monthly payment covers everything for the customer allowing them to use the car as a medium of mobility. A customer can return the car to Riversimple at the end of contract term, after which the company will offer it to the next customer.

Riversimple's approach is to build cars at low prices at several local factories, then lease them and build fueling stations nearby. The company was founded in 2013 former motorsport engineer and racing driver Hugo Spowers. It is based in Powsy, United Kingdom.

Source: <https://www.investopedia.com/investing/rasas-hydrogen-car-take-tesla-tsla/>

## Hyundai favors fuel cell vehicles over battery electrics

### Hyundai continues to praise the capabilities of fuel cells

South Korean automaker Hyundai has become a leading supporter of hydrogen fuel within the auto industry. The company was among the first to bring a hydrogen-powered SUV to the market and recently released its latest fuel cell car in its native country. Hyundai has invested heavily in fuel cell technology and believes that these energy systems are the future for transportation. Hyundai Canada CEO Don Romano even believes that fuel cell vehicles will overtake their battery-powered counterparts in the near future.

Hydrogen could become more plentiful as excess electricity is used to produce the fuel

According to Romano, fuel cell vehicles could be significantly more convenient to operate than battery electrics. This is partly due to the fact that they can be refueled in a matter of moments whereas battery vehicles require several hours to fully charge. Notably, excess electricity can also be converted into hydrogen fuel with relative ease. This would make the fuel significantly more accessible to consumers with fuel cell vehicles. Romano suggests that

conventional storage methods can only contain so much energy, which adds further value to hydrogen as a way to chemically store electrical power.

### Other companies are being urged to invest in fuel cell vehicles and their future

Like other automakers, Hyundai has been investing in the development of new fuel cell technology and the establishment of a comprehensive hydrogen infrastructure. Hyundai has been urging other companies to follow suit, suggesting that they will see major returns on their investments as fuel cell vehicles gain popularity. In Canada, government policies are beginning to show more support for these vehicles in an effort to make transportation cleaner and encourage consumers to embrace hydrogen-powered cars.

### Fuel cell cars may be able to overcome challenges with better technology

Currently, the major challenges facing fuel cell vehicles are their high cost and lacking infrastructure support. Comparatively, battery electrics are less expensive and have access to a wide range of charging stations. Hyundai believes these issues are only temporary, however, as fuel cell technology is still relatively new to the transportation space. As technology develops, the company believes fuel cell vehicles will become more affordable and will have abundant access to the hydrogen they need to operate.

Source: <http://www.hydrogenfuelnews.com/hyundai-favors-fuel-cell-vehicles-over-battery-electrics/8534698/>

## Toyota to ramp up hydrogen fuel cell vehicle sales around 2020

Toyota Motor Corp on May 24 said it plans to set up a facility to mass manufacture hydrogen fuel cell stacks, a key component of fuel cell vehicles, as it seeks to ramp up production of hydrogen-powered cars and expand their usage as a zero-emission alternative to gasoline vehicles.



The new unit will come up on the grounds of its Honsha plant in Toyota City near the automaker's global headquarters, the company said in a statement. It is also constructing a dedicated line at the nearby Shimoyama plant to produce tanks for storing high-pressure hydrogen gas inside vehicles.

Toyota declined to give details about their latest investment in this technology, but said mass production of components will begin around 2020, enabling the company to meet its target for global annual fuel cell vehicle sales of more than 30,000 units, including passenger cars and buses.

"As a technology, fuel cells are mature and ready to scale up," Toyota said in a statement. "In order to encourage more widespread use of hydrogen-powered zero-emission vehicles, popularization needs to start by the 2020s."

Toyota already sells the Mirai sedan, the world's first mass-market fuel cell electric vehicle (FCEV), in Japan, in the United States and also some European countries. The model starts at about 7.2 million yen (\$65,807.51) in the Japanese market.

Due to its high cost and complexity of building its components, the Mirai is produced in small lots. Only around 5,300 units have been sold since its 2014 launch, a fraction of regular production models.

Mass manufacturing of the two components - hydrogen fuel cell stacks and hydrogen tanks - will enable Toyota to lower the price of FCEVs, and expand its fuel cell technology.

Honda Motor Co and Hyundai Motor Co also manufacture fuel cell vehicles, while other automakers are also developing the technology. However, many automakers, including Nissan Motor Co and Tesla Inc, are focusing on all-battery electric cars as a solution to reduce vehicle emissions.

Toyota, which developed the Prius, the world's first gasoline hybrid vehicle, sees hydrogen FCEVs as a zero-emission alternative, which requires less time to refuel compared with the time it takes recharge electric vehicle batteries.

Source:

<http://kfgo.com/news/articles/2018/may/24/toyota-to-build-fuel-cell-stack-plant-ramp-up-fuel-cell-vehicle-sales-from-2020/>

## U.S. Hybrid Powers world's first fuel cell street sweeper



The world's first hydrogen fuel cell-powered street sweeper, and clean truck and bus deals with two of China's biggest vehicle makers, underscore U.S. Hybrid's growing role in the green vehicles arena.

U.S. Hybrid provided a briefing on the deals and outlined its business strategy at ACT Expo, a green transportation conference in Long Beach, this week.

The sweeper, built by San Bernardino, Calif.-based Global Environmental Products, is powered by a hydrogen fuel cell system from U.S. Hybrid. It will be used by California's transportation agency, Caltrans, as part of its freeway sweeping fleet.

Additionally, U.S. Hybrid unveiled a fuel cell shuttle bus project with a unit of China's BYD and said it plans to team with China's Dongfeng Motor Corp. to provide fuel-cell and battery-electric powertrains for a variety of Dongfeng trucks to be sold in the U.S. and globally.

The shuttle will start making rounds between Honolulu airport and a nearby rental car center in September. The first of the Dongfeng-U.S. Hybrid trucks, a Class 6 delivery truck, will go on sale in the U.S. later this year.

The deals are part of a growth spurt that 19-year-old U.S. Hybrid hopes will make it a key global player in the low-and zero-emissions commercial vehicle industry, Abbas Goodarzi, the company's chief executive, told Trucks.com



For many of the projects, the company is using fuel cells that it builds at a facility in Connecticut. The electronic controls are developed at the company headquarters in Torrance, Calif.

Making hydrogen gas produces a substantial amount of the major greenhouse gas carbon dioxide, but electric motors are so efficient that studies by scientists at Argonne National Laboratory in Illinois have found it to be cleaner than gasoline or diesel when used as a vehicle fuel.

## Clean sweeper

For the sweeper, it also provides power for the brushes, blowers and vacuum.

The sweeper's 20-kilogram hydrogen supply enables it to operate nonstop for 10 hours and can be refilled at any of the nearly two dozen hydrogen stations in the Los Angeles Basin, typically in under 10 minutes, Goodarzi said.

A kilogram of hydrogen contains the energy equivalent of a gallon of gasoline.

The powertrain was designed to propel the 11-ton sweeper through three duty cycles, each consisting of 25 miles of 55 mph highway driving to get to and from the work site and an additional 25 miles of sweeping at 10 mph.

U.S. Hybrid and Global already build a diesel-electric hybrid sweeper used by the New York City sanitation department, but this is the first fuel cell sweeper, Goodarzi said.

The hybrid sweeper delivers a 55 percent fuel savings and a 58 percent reduction in greenhouse gas emissions and the fuel cell model is expected to nearly double that fuel efficiency with zero tailpipe emissions, "to support California's mission to significantly reduce greenhouse gas emission," he said.

## Hawaii shuttle

The rental car center at Honolulu's Daniel K. Inouye International Airport soon will be shuttling travelers in a 27-passenger, 35-foot hydrogen fuel cell electric bus built by U.S. Hybrid and electric bus and truck manufacturer BYD's North American unit.

BYD will convert one of its battery-electric shuttles for the project, while U.S. Hybrid is supplying the hydrogen fuel cell powertrain and related components, Goodarzi said.

BYD is based in China but has a large U.S. subsidiary that builds electric buses and trucks in Lancaster, Calif., about 60 miles north of Los Angeles.

The U.S. Hybrid fuel cell system will enable the shuttle to operate 16 hours a day, while a battery-electric bus would be limited to a single shift before needing to be recharged, Goodarzi said.

Teaming with BYD—the world's largest electric bus maker—not only opens the California clean bus and truck market to U.S. Hybrid's fuel cell powertrains, it gives the company a foot in the door to the huge Chinese market, he said.

The fuel cell shuttle is slated to go into service Sept. 1, he said.

The Honolulu rental car shuttle will carry about 30 kilograms of hydrogen and will be able to cover about 300 miles between refills, Goodarzi said.

There is no retail hydrogen station in Honolulu, but the airport shuttle will be able to refill at the hydrogen station at Hickam Air Force Base, adjacent to Inouye International. Hickam, which makes its own hydrogen fuel at a plant running on renewable solar energy, has long been a fuel cell vehicle test center for the military.

## Electrified trucks

In a second venture with a major Chinese vehicle builder, U.S. Hybrid is teaming with Dongfeng Motor to provide powertrains for multiple classes of Dongfeng's commercial trucks.

Buyers interested in zero emissions models will be able to specify the type of U.S. Hybrid powertrain—battery-electric or fuel cell. Pricing and other details have not yet been announced.

The initial Dongfeng-branded Class 6 truck for the U.S. market will have up to 300 miles of range with U.S. Hybrid's 80 kilowatt hydrogen fuel cell system, Goodarzi said.

The battery-electric version will deliver “more than 150 miles” of range and will use a U.S. Hybrid electric drive system with a rechargeable battery pack rated at “more than 100 kilowatt-hours,” he said.

Dongfeng is one of China’s major passenger and commercial vehicle companies. Its Special Vehicles division is one of the world’s largest builders of battery and fuel cell trucks, with more than 64,000 of its battery-electric trucks operating in China today, Goodarzi said.

Source: <https://www.trucks.com/2018/05/02/us-hybrid-first-fuel-cell-street-sweeper/>

## Big trucks go electric

While some might say the trucking industry is experiencing a watershed (where the direction of an industry changes), others would describe it



more like a dam break, where suddenly we see a flood. In this case, the flood is medium- and heavy-duty big trucks moving to zero-emission technology. As late as early 2017, conventional wisdom held that, while some trucks at the lower end of the medium-duty segment might be electrified, big over-the-road rigs would power on with diesel for the foreseeable future.

Then things changed. The longtime producer of diesel engines (and some natural gas ones), Cummins, rolled out an electric Class 7 truck and announced that they would supply any powertrain their customers wanted, including those producing zero emissions.

Then Elon Musk unveiled his electric semi with his trademark high production, rivaling something from an auto show or CES. And the orders began coming in, topping 400 as of January 2018. First deliveries are due by the end of 2019, though most in the industry note that Tesla has yet to hit any of its announced delivery dates and hasn’t even released complete details on the truck or indicated where it might be produced. What Musk has promised is a \$150,000, 330-mile range truck and a \$180,000, 500-mile range model.

## Another Path to Zero

*[For more information on Toyota’s fuel cell powered Class 8 truck, find a full article on page 14]*

Then another path was forged when Toyota drove into a press event with its fuel cell Class 8 truck hauling a full-length trailer. The truck featured two fuel cell stacks from a Mirai passenger car stuffed into a modified Kenworth truck (since Toyota doesn’t make heavy-duty trucks—currently). The truck puts out 670 horsepower, more than enough for typical heavy-duty operations, such as towing around 80,000 pounds of freight for more than 200 miles between fill-ups.

This truck fulfilled the dream of the state of California (where almost all of these new vehicle events took place). California’s stated goals are to see the transition of all transportation to zero emissions over the next few decades. Sooner rather than later, of course.

The public-private California Fuel Cell Partnership even drew up an action plan to spur this move.

Toyota has since been joined by Kenworth, with its own hydrogen fuel cell truck, which made an appearance at CES. It was preceded by a one-off fuel cell delivery van for UPS and a fuel cell truck built by technology company US Fuel Cell. There has also been a wave of publicity about a range-extender fuel big trucks from another startup, Nikola Motor Company. It has some wild claims (a 1,200-mile range), but has yet to be tested or driven by any third party.

Infrastructure remains the Achilles heel for hydrogen fuel cells. While hydrogen is the most abundant element in the world, capturing it and turning it into transportation fuel is still an expensive process and is only being done in a limited way. California was hoping to have 100 public hydrogen stations by 2020, but lately has indicated that goal may not be met.

## The Electric Slide

The electric truck scene has gone from zero-to-100 faster than a Tesla in Ludicrous Mode. What was an eco-dream a year ago is now a full-fledged movement. In addition to the Cummins and Tesla announcements mentioned above, two of the big boys in the big truck industry have

made it clear they are not leaving this segment to upstarts or component makers.

Daimler led the way, putting its Class 5 eCanter model on sale in Europe, Japan, and the U.S. in late 2017. It packs a 115 kW electric motor and an 82.8 kWh battery pack (for comparison, a Tesla Model X 100D has two motors that equal about 386 kW and uses a 100 kWh battery) and a 62-mile range. Fuso also showed the E-Fuso Vision One Class 8 concept truck. Daimler has made it clear that the real big rig is planned for production as well.

Volvo Group's Volvo Big Trucks followed up in January with a statement that it would have a medium-duty all-electric truck on the market in 2019, although the first models were due to be delivered to early customers this year. The company also said the trucks would be coming to the U.S. at some point, with more details likely coming soon.

The significance of the two major OEMs—Daimler and Volvo—entering this electric parade is huge. Unlike Tesla, Nikola, and other smaller startups, these major players know truck customers. They know a medium or heavy-duty truck is not a fashion statement, but a bottom-line purchase. While some big companies buy one or a dozen for their PR value, most of the sales will need to pay their own way.

Batteries are still the key and a reliable charging network is equally critical for the heavy-duty market. Since an agreed-upon charging format for these trucks is still up in the air (two systems are currently competing with companies like Tesla, adding a third proprietary network), it will not be surprising to see the OEMs initial forays to be limited.

Batteries have advanced greatly in the past decade, dropping costs while increasing power density, but they're still pretty heavy. The issue in the commercial market remains: given a choice between hauling freight or batteries, you can be sure most customers will opt for the former. The almost 24-hour duty cycle for many trucks also doesn't allow much time to recharge batteries. But the gauntlet has been thrown down by Tesla and others. You can rest assured that your future Amazon Prime delivery may not involve internal combustion engines.

Get ready for the new fleet of big trucks being electric and

alternative fuel source trucks, triggered by Cummins' zero-emission plans and Elon Musk's electric semi design. (Top to bottom) Toyota, Nikola, Tesla, Volvo, and Cummins are major drivers of trucking's new electric approach.

Source: <https://innotechtoday.com/big-trucks-go-electric/>

## New truck uses hydrogen fuel without fuel cells



### Company develops the world's first hydrogen combustion engine for commercial trucks

ULEMCo, a company based in the United Kingdom, has developed a new combustion engine that makes use of hydrogen fuel. The company is using the new engine to power a commercial truck—a Volvo FH16. ULEMCo plans to begin testing the truck later this year in order to demonstrate the capabilities of hydrogen fuel. The truck will be the first of its kind to use hydrogen without also making use of a fuel cell system.

### Truck requires no fuel cell system

The new truck is expected to be able to travel some 189 miles using approximately 17 kilograms of hydrogen fuel. The vehicle's combustion engine will operate in a manner similar to conventional engines. The primary difference, of course, is that it will be using hydrogen instead of diesel. Because the truck does not need a fuel cell system, its costs align with that of other commercial vehicles. ULEMCo has, however, had to install additional storage equipment in order for the truck to make effective use of its hydrogen supply.

### Hydrogen is gaining more attention in the commercial transportation space

Hydrogen fuel has been gaining momentum throughout the transportation sector for some time. Recently, companies that develop commercial trucks have begun making use of fuel cell technology. These companies hope that fuel cells will make their trucks more environmentally friendly by eliminating their emissions. Fuel cells are notoriously expensive, however, which has slowed their adoption in the commercial field. ULEMCo believes that new trucks do not need fuel cells to cut down on their emissions.

## **Demonstration may highlight the value of using hydrogen fuel without fuel cells**

The new truck is meant to serve as a demonstration of how hydrogen fuel can be used even without fuel cells. If successful, more hydrogen combustion engines may be seen on the roads in the coming years. There are safety concerns, of course, as hydrogen is infamously volatile. ULEMCo has, of course, taken steps to ensure that its new commercial truck is safe to operate in all conditions.

Source: <http://www.hydrogenfuelnews.com/new-truck-uses-hydrogen-fuel-without-fuel-cells/8534695/>

## **Clean mobility is making a tremendous impact in Michigan**

### **Clean cars are contributing \$18 billion to the state's economy**

Michigan's clean mobility sector contributes some \$18 billion to the state's economy and generates more than \$700 million in tax revenue every year, according to a new report from Clean Fuels Michigan. The report highlights the numerous economic benefits that are associated with clean vehicles. Investments in the research, development, and commercialization of clean cars have been increasing in recent years, which has created new opportunities within the state, making Michigan much more attractive to automakers.

### **Report shows that the clean transportation sector is creating tens of thousands of new jobs**

The report shows that clean mobility has helped bring more than 69,000 jobs to the state. The majority of these jobs have to do with building out the infrastructure need-

ed to support clean vehicles. The report also suggests that clean vehicles could have a significant impact on the health of those living within Michigan. Because these vehicles produce no harmful emissions, they could help decrease healthcare costs by improving the state's air quality.

## **Companies are working to promote innovation in clean technology for vehicles**

Michigan's automakers and utilities have become strong supporters of clean vehicles. Several companies are looking to reduce the overall cost of clean vehicles by investing in innovative technology. This technology can make these vehicles more efficient and attractive to consumers, thereby accelerating the adoption of clean mobility. DTE Energy, in particular, is currently working to ensure that electric and natural gas vehicles are quickly integrated into the state's transportation sector.

State continues to expand its clean transportation infrastructure

Michigan has been increasing its support for clean vehicles in order to make progress toward its environmental goals. In doing so, the state has committed itself to tackling several challenges. The most significant of these challenges has to do with establishing an infrastructure that will support the widespread adoption of clean cars. Not only in Michigan working to build new charging stations for electric vehicles, the state is also working to expand its hydrogen infrastructure in order to support cars powered by hydrogen fuel.

Source: <https://www.hydrogenfuelnews.com/clean-mobility-is-making-a-tremendous-impact-in-michigan/8535013/>

## **Hydrogen trains from Alstom are coming to the UK**

### **Alstom teams with Eversholt Rail to bring new trains to the UK**

Alstom, a leading railway company, has announced that it will be working with Eversholt Rail. The two companies will be converting Class 321 electric trains to run off hydrogen. These hydrogen trains would then be put to service in the United Kingdom, where the demand for fuel cell-



powered trains is growing quickly. According to Nick Crossfield, managing director for Alstom UK & Ireland, "the potential for H<sub>2</sub> trains is enormous."

## Government continues its efforts to make transportation more environmentally friendly

The UK government has already been showing support for hydrogen trains for some time. Officials are eager to see more environmentally friendly vehicles come to the country in order to combat climate change and reduce emissions by a significant level. By 2040, the government intends to have no diesel vehicles as part of the country's railway system. These trains will be replaced by those powered either by battery or fuel cell technology.

## Hydrogen trains have already been tested in Germany

Alstom has become the first company in its industry to introduce a regional hydrogen train. Called the Coradia iLint, the train is currently being tested in Germany. Tests have proven fruitful, of course, providing Alstom with valuable information concerning how fuel cells operate and how they can be used to power passenger trains and other vehicles. Hydrogen trains are particularly promising because the fuel they need to operate can be produced using renewable energy systems, such as wind and solar farms.

The UK has become a major supporter of clean transportation in recent years. Not only is the country working to renovate its railway system, it is also looking to promote clean vehicles among residents. The government hopes to become a major market for automakers looking to sell their clean vehicles to consumers and subsidies are being offered to those interested in making purchases. Fuel cells have begun to establish some presence in the country

and new hydrogen stations are beginning to be opened in metropolitan areas in order to support vehicles that are equipped with these energy systems.

Source: <https://www.hydrogenfuelnews.com/hydrogen-trains-from-alstom-are-coming-to-the-uk/8534962/>

## ZEFER Project introduces fleet of 180 fuel cell vehicles in Europe

Hydrogen fuel cell vehicles (FCEVs) haven't gained the popularity many had hoped for. The Zero Emission Fleet Vehicles for European Rollout (ZEFER) intends to sway public opinion by deploying fleets of FCEVs in London, Paris and Brussels.

### ZEFER deploys fuel cell fleet

The ZEFER FCEVs will be put to work in large fleets of 60 vehicles each. Altogether, 170 of these machines will provide service to taxis and private-hires, while 10 will be for police units. The roll out will happen quickly, with most of the vehicles deployed by 2018. Already, 25 are being introduced in London by a company called Green Tomato cars.

FCEVs use a fuel cell to turn hydrogen gas into electricity. The only bi-products of the FCEV process are water and excessive heat, which means the ZEFER fleet can easily help clean up polluted cities. A burgeoning network of hydrogen stations will refuel the vehicles.

ZEFER predicts the FCEVs will cover a lot of ground. In Paris, the estimate is 90,000 km/year and in London, 40,000 km/year. Data will be collected on the vehicles as they make their rounds. The retrieved information will then be presented as a petition for greater FCEV use.

### A collaborative effort

All together, the ZEFER initiative will cost €26-million (\$32-million US) pan-European. So, who's backing the effort? The coordinator is Element Energy Limited of the United Kingdom. Other participating organizations include hydrogen suppliers, vehicle end users, observing partners and supporting partners. The backing network spans the United Kingdom, France, Belgium and Germany. ZEFER also received €5 million from the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), a public-private partnership devoted to the advancement of FCEVs in Europe.

Hopefully, with so much support and enthusiasm, they will begin to get the recognition they deserve.

Source: <http://www.futurecar.com/2253/ZEFER-Project-Introduces-Fleet-of-180-Fuel-Cell-Vehicles-in-Europe->

## Toyota explores the potential of a hydrogen fuel cell powered class 8 truck



Toyota has built a prototype hydrogen fuel cell truck using most of the hydrogen fuel cell components from two of its Mirai passenger vehicles. What sounds like a project from a scene in a *Transformers* movie turns out to be almost as entertaining as a Hollywood blockbuster.

### A Compelling Need

Toyota Logistics Services (TLS) operates a facility in the Port of Los Angeles which sits in very close proximity to the Port of Long Beach. The heavy concentration of container ships hauling cargo in and out of the ports combined with the heavy trucks used to move individual containers in and out of the port at the highest volumes in the United States have resulted in some of the worst air quality in the nation.

To put this in perspective, 10,000–12,000 trucks move in and out of the Ports of Los Angeles and the Port of Long Beach every day. Every single day. Cramping that much heavy vehicle traffic into a small area comes at a cost. The air quality in the region has driven the cancer risk up in neighborhoods adjacent to the Port of Los Angeles to 1.7 times that of the greater Los Angeles region.

### A Prototype is Born

Toyota took up the challenge of driving a meaningful re-

duction in its emissions from the port region and, after some brainstorming, decided to build a hydrogen fuel truck prototype to explore the potential use cases for a hydrogen fuel cell electric truck in its TLS facility.

Toyota's project was initiated prior to the announcement of the Nikola Motors hydrogen fuel cell truck, before Tesla's fully electric Semi was unveiled, and even before Cummins' electric powertrain offering. Today, BYD is already delivering its fully electric, class 8 heavy trucks to customers, with a slew of offerings and most of the other players already taking reservations for offerings that will enter the market over the next few years.

To get started, Toyota bought a glider—or rolling chassis—and threw it into a warehouse with two of its Mirai hydrogen fuel cell vehicles (FCVs), along with a handful of its brightest engineers and one mission: build a prototype hydrogen fuel cell truck.

A short 10 months later, the team had a fully functional hydrogen FCV-powered class 8 truck that it dubbed "Alpha Truck." Nearly all of the fuel cell components from the two Mirai were rolled into Alpha Truck, with the primary exception being the electric motors. To ensure that the performance and power requirements of a heavy truck could be met, Toyota designed a new motor specifically for Alpha Truck.

The new motor coupled with the instant torque of electric motors means Alpha Truck puts diesel-powered trucks to shame "off the line" and up hills.

Alpha has capacity to store 40 kilograms of hydrogen, which is a significant boost compared to just 4.5 kilograms of capacity in the Mirai. After generation, electricity is then stored in the onboard 12 kWh Toshiba battery, which ensures a constant flow of juice into the motor.

### To Scale or Not to Scale

The Alpha Truck is being tested in the Toyota Logistics Services yard in the Port of Los Angeles today, where the team has put 8,200 miles on it, to date, vetting out the design in a real-world use case.

Heavy-duty vehicles are prime targets for electrification due to the higher torque that comes from electric motors as compared to internal combustion engine vehicles.

Heavy duty vehicles also consume much more power in a single vehicle than passenger vehicles. A typical family driving a Toyota Mirai will use 170 kilograms of hydrogen per year, whereas a single hydrogen fuel cell truck will consume a mind boggling 40 times as much at an estimated 7,500 kilograms per year.

Looking to the future, Toyota is already developing the second iteration of its hydrogen fuel cell heavy-duty truck in parallel to continued testing of the Alpha Truck. The near-term use cases of the prototype trucks are clear, as Toyota continues to push its port operations to zero emissions, but the longer tail of the possibilities depend on what Toyota learns from the proof of concept work in the Port of Los Angeles.

Hydrogen FCVs are currently less efficient, more costly, and generate more pollution than even a normal hybrid Toyota Prius. To be successful with the masses, hydrogen FCV-based transportation requires significant amounts of new infrastructure in new fueling stations, hydrogen storage, hydrogen shipping, and hydrogen production.

Companies around the world are working to clean up the hydrogen supply side of the equation, with renewable hydrogen emerging as a new buzz word. To encourage hydrogen generation from renewable sources, California has mandated that a minimum of 33% of the hydrogen being sold for use in transportation come from renewable sources.

Source: <https://cleantechnica.com/2018/04/27/toyota-explores-the-potential-of-a-hydrogen-fuel-cell-powered-class-8-truck/>

## A new clean car is being developed by Honda

Honda is working with China's CATL to develop a new clean car



**HONDA**

Japanese automaker Honda has begun working on a new global partnership that could have serious implications for the clean transportation market. The company is reportedly working with CATL, the largest battery manufacturer in China to establish a new program. This pro-

gram would involve the development of a new clean car that is based on Honda's existing Fit model. The vehicle would be equipped with a battery system with a range of approximately 186 miles.

### Automaker has a lofty production goal

Honda aims to produce 100,000 of these new vehicles each year, which is significantly more than other major automakers are currently producing. Production is expected to begin in 2020 and the new vehicle will initially be available in China and other Asian markets. Honda intends to expand the availability of its new clean car to other markets eventually, hoping to establish a strong presence in the clean transportation market.

### Honda is working to compete with other automakers in clean transportation

The automaker has shown strong interest in clean transportation for several years now, but it has begun to lag behind other companies when it comes to releasing clean vehicles. Honda has committed a significant amount of its attention to fuel cell technology, planning to launch its latest hydrogen-powered car at some point this year. The company is also working with other automakers to improve fuel cell technology in order to make hydrogen vehicles more popular among consumers in the future. Now, Honda intends to launch a battery electric vehicle in order to better compete with companies that have already established a lead in the market.

### Automakers are aiming to improve battery technology

Most of the world's leading automakers are developing new vehicles that make use of hydrogen fuel cells. They have not, however, abandoned battery technology. Honda believes that batteries could help bridge the gap between conventional vehicles and those that produce no harmful emissions. Other automakers share this belief and have begun working to improve battery technology in order to encourage more consumers to embrace clean vehicles.

Source: <http://www.hydrogenfuelnews.com/a-new-clean-car-is-being-developed-by-honda/8535046/>

## Renewable hydrogen roadmap: advancing zero-emission transportation and California's clean energy economy

Today, Energy Independence Now (EIN), in collaboration with the Leonardo DiCaprio Foundation and the California Hydrogen Business Council (CHBC), released a roadmap outlining key strategies to promote renewable hydrogen (RH<sub>2</sub>) production that will help California achieve its clean energy and clean transportation goals.

On the heels of Governor Jerry Brown's recent call for 5 million zero-emission vehicles by 2030 and 200 hydrogen stations by 2025, EIN's *Renewable Hydrogen Roadmap* provides the blueprint to achieve these ambitious efforts in the cleanest possible manner. Fuel Cell Electric Vehicles (FCEVs) and renewable fuel are vital components of California's zero-emission future. This Roadmap explores the most cost-effective and scalable production technologies and feedstocks, such as renewable electricity or biogas, to present viable pathways for industry, government and consumers.

"We are proud to support these important findings to help accelerate the development and deployment of clean, renewable transportation fuel and to ensure that hydrogen electric cars are available, affordable, and accessible for every Californian," said Leonardo DiCaprio Foundation CEO, Terry Tamminen. "This paper, at the intersection of technology and cutting-edge environmental and energy policy, presents innovative solutions that government, industry and consumers all can use, and will help make California a model for the rest of the world to follow."

"EIN's *Renewable Hydrogen Roadmap* lays out policy and action recommendations to help California achieve its ambitious energy, climate and air quality goals by dramatically reducing pollution and GHG emissions from the energy generation and transportation sectors," said EIN's Executive Director, Brian Goldstein. "California is globally renowned for its environmental leadership and innovation, embracing clean energy policies that are reducing carbon emissions and pollution while creating new jobs and economic growth opportunities that are the envy of the world. Pioneering the renewable hydrogen marketplace offers a tremendous opportunity for California to continue to lead the way."

California has committed to building 200 hydrogen fueling stations by 2025 and there are already thousands of hydrogen FCEVs on the roads of the Golden State. Zero-emission FCEVs require less than 5 minutes to refuel for driving ranges up to 360 miles.

### The Renewable Hydrogen Roadmap's key proposals include:

- Increasing financial support and market-building mechanisms to catalyze the development of RH<sub>2</sub> production at scale.
- Creating state and federal policies that support the vision of RH<sub>2</sub> and the pathways to develop and scale RH<sub>2</sub> deployment.
- Educating policymakers, stakeholders and the public about the benefits of scalable RH<sub>2</sub> production, which will accelerate the adoption and deployment of renewable electricity and clean, zero-emission transportation fuels.

"CHBC members see renewable hydrogen as the cornerstone of the zero-emission transportation future in California," said Jeff Serfass, Executive Director of the California Hydrogen Business Council. "At-scale renewable hydrogen production is critical, not only for FCEVs, but also to support fueling of medium and heavy-duty vehicles like buses and trucks. This roadmap outlines initiatives to meet the demand for those vehicles."

The transportation sector is by far the largest source of greenhouse gas (GHG) emissions in California, generating 37% of the state's GHGs or 163 million tons of carbon dioxide equivalent in 2014. California's climate and clean energy laws already require cutting petroleum use in half and cutting GHG emissions by 40% (from 1990 levels) by 2030. California also has committed to dramatically increase production of renewable electricity by generating 50% of its power from renewable sources by 2030. RH<sub>2</sub> can help California achieve both initiatives, providing zero-emission fuel and critical storage opportunities for renewable energy.

EIN continues to work with environmental, energy and transportation experts such as the CHBC and the Leonardo DiCaprio Foundation to implement the findings of the roadmap, which was made possible by their generous



support as well as by the South Coast Air Quality Management District (SCAQMD), Toyota Motor Corporation, Honda Motor Company, Southern California Gas Company, Pacific Gas & Electric Company, The Linde Group, Nel Hydrogen, Hydrogenics Corporation, ITM Power, FuelCell Energy and Proton OnSite.

The roadmap and executive summary can be accessed at <https://einow.org/rh2roadmap>.

Source: California Hydrogen Business Council

## **Emissions free energy is beating coal and natural gas in the United States**



### **Report shows that gas-fired power plants will not be able to keep up with clean energy**

The coal and oil industries may be experiencing revitalization in the United States, but this may not be enough to be emissions free energy. A new report from the Rocky Mountain Institute shows that energy generators may be committing consumers and investors to as much as \$1 trillion in future investments and fuel costs through 2030 due to a rush in building new gas-fired power facilities. Clean power, however, can provide consumers with less expensive electrical power and deliver more reliable grid services.

### **Old power plants are nearing their retirement age**

The report shows that emissions free energy beats gas-fired power plants in terms of levelized costs. Renewable energy sources are also threatening the profitability of existing coal power plants and this trend is likely to continue well into the future. Fossil-fuels are falling behind partly because of how old the sector's generation capacity is. The majority of all coal and natural gas generation ca-

capacity in the country is over 30 years old. The report predicts that this capacity will reach retirement by 2030, which is when new energy sources will have to take over.

### **Renewable energy is significantly less expensive than building new gas-fired facilities**

New technology and low natural gas prices have lead to a surge in support for fossil-fuels, with utilities and merchant generators planning to invest over \$110 billion in building new power plants between now and 2025. The report from the Rocky Mountain Institute predicts that some \$500 billion will be needed to replace all aging power plants by 2030, however. This makes clean power a much more attractive option, especially as the cost of new forms of energy continues to plummet.

### **Clean power can help offset emissions production throughout the country**

The report shows that in three out of four cases, an "optimized clean energy portfolio" would cost as much as 60% less than proposed gas-fired power plants. Not only would clean energy be a better option financially, it would also help the United States move closer to achieving its environmental goals. By replacing old coal power plants, clean energy could help remove a significant amount of harmful emissions that these power plants produce on an annual basis.

Source: <http://www.hydrogenfuelnews.com/emissions-free-energy-is-beating-coal-and-natural-gas-in-the-united-states/8535015/>

## **New hydrogen generation system being put to the test in California**

### **Companies come together to use solar power to produce hydrogen fuel**

The Southern California Gas Co. (SoCalGas), Pacific Northwest National Laboratory (PWNL), and the STARS Corporation have come together to develop a new hydrogen generation system that is powered by the sun. The system is designed to use sunlight to convert natural gas and water into hydrogen. The process will produce some carbon dioxide, but this will be captured to prevent its entry into the environment. The hydrogen would then be used for various purposes, such as powering vehicles or homes.

## More hydrogen is needed to support fuel cell vehicles

SoCalGas has been a proponent of increasing hydrogen generation for some time. The company has played a role in building California's "Hydrogen Highway," which is a strand of hydrogen fuel stations running along the state's highways. Currently, the state has 35 hydrogen stations open to the public, with another 29 at various stages of development. Supporters of clean transportation believe that increasing the state's hydrogen infrastructure could accelerate the adoption of clean vehicles.

## Thermochemical process produces chemicals capable of capturing carbon dioxide

The hydrogen generation project will make use of a solar thermochemical advanced reactor system. This will produce hydrogen through a thermochemical process. This process involves using the sun to generate thermal energy, which will then be used to break down natural gas and water into their baser components. Hydrogen will be produced as a result of the process. Other chemicals are also produced through the process, which are capable of capturing any carbon dioxide that is produced alongside the hydrogen.

## New system has proven to be extremely efficient

The new hydrogen generation technology is currently being tested at the San Diego State University. The test system uses solar energy and other renewable power in order to produce hydrogen. Thus far, demonstrations have shown that the system is incredibly efficient, capable of energy conversions above 70%. In its current state, the system produces approximately 25 kilograms of hydrogen every day on a 24-hour cycle.

Source: <http://www.hydrogenfuelnews.com/new-hydrogen-generation-system-being-put-to-the-test-in-california/8534964/>

## EU and China are looking to lead the world with green investments

### EU and China intend to establish new international order

The European Union and China will work together to use clean power and technology to create and lead a new international order. Both the EU and China have become

major proponents of the Paris Agreement, which calls upon countries to reduce their emissions by embracing clean technologies and new energy sources. The initiative has helped spark an increase in green investments throughout the world. China has been especially aggressive in this regard, with the EU following suit. Both intend to establish themselves as leaders in the fight against climate change, as well as the emerging new energy market.

### Green investments saw a major upswing in 2017

In 2017, the EU and China accounted for the largest investments made in the clean power and technology space. In the EU, some \$127 billion in investments were made, with China accounting for \$41 billion in investments. This week, EU regulators approved a new plan to boost green investments by 40% by 2030. Europe's plans may find success in France, where a new generation of entrepreneurs are devoting much of their attention to new forms of energy and clean technologies.

### China has been working with other countries to embrace renewable energy

While the EU may be spending more on renewable energy and technology, China is the world's largest clean power market. China accounts for more than half of the world's total installed solar energy capacity. The government has shown aggressive support for various forms of clean power, providing energy developers with promising new opportunities. China is also leading the way in regards to working with other countries to accomplish overarching environmental goals. This cooperation is proving to be instrumental in the fight against climate change.

### Global cooperation may be vital for environmental protection

According to economist Jeffrey Sachs, director of the Earth Institute at Columbia University, the world is currently in "the Age of Sustainable Development." Sachs suggests that all countries should have a goal of working together in order to protect the environment. Cooperation on a global scale could have profound implications for the economy, especially as green investments become stronger.

Source: <http://www.hydrogenfuelnews.com/eu-and-china-are-looking-to-lead-the-world-with-green-investments/8534946/>

## **Solar is third greatest renewable energy source-What does this mean for cities?**

Solar has surpassed biomass to become the #3 renewable electricity source in the United States, according to Clean Technica and data from the U.S. Energy Information Administration.

Solar resources, including small- and large-scale photovoltaic (PV) installations and solar thermal, created 77 million megawatt-hours of electricity in 2017, outpacing biomass resources, which generated 64 million megawatt-hours in 2017. Hydropower and wind power were the only renewable sources of energy that outperformed solar, generating 300 million MWh and 254 MWh, respectively.

Overall, about 17 percent of the electricity generated last year was from renewables, the EIA said. Solar's contribution to the total electricity generated, while growing, still is around only 1 percent.

The EIA tracks three types of solar power: solar thermal, which uses sunlight to boil water to produce steam, which in turn produces power; and two sizes of solar photovoltaic. PV installations with capacity lower than 1 megawatt are considered "small-scale." Since these are typically capable of supplying about 200 homes and take up multiple acres, "small" here is relative. Meanwhile, PV installations with capacity greater than 1 megawatt are considered utility-scale.

Solar is an attractive option for cities looking to reduce their carbon footprint. The systems can be pricey to set up—the National Renewable Energy Lab estimated a cost of around \$2.80 per watt for residential systems and around \$2 per watt for commercial systems—but the price is dropping. PV module costs have fallen 75 percent since 2009, Computer World reports.

Traditional solar—PV panels placed in a wide-open, sunny field—hasn't historically been a great fit for cities, thanks to land-use requirements and other complications. Billing rules mean that homeowners can't always get credit for the power they generate, which reduces the incentive to install solar; and renters are left with nothing.

But that is changing. Companies such as Brooklyn SolarWorks have developed solar canopies specifically designed for small, flat rooftops. Many states have adopted

net metering policies, which allow—or require—electric utilities to offer a credit to homeowners if their solar panels generate more energy than they use. (Most states have adopted requirements that only apply to certain utilities—often investor-owned.) And community solar project structures are now allowing renters to get in on the action. By "subscribing" to a solar farm that may be next door or across town, renters receive a credit on their energy bill. In a pioneering model in Washington, D.C., a law firm installed solar panels and is gifting the energy credits to low-income subscribers across town, a feat the Washington Post called "a bureaucratic Rube Goldberg machine that demands more paperwork than photosynthesis, but is workable nonetheless." Low-income residents in two housing complexes now receive lower energy bills—and sometimes no bill at all.

It's not all rosy—the 30 percent tariff on imported solar panels imposed by the Trump administration in January has halted, by some estimates, billions of dollars of solar projects. But the EIA expects another 5,000 megawatts of utility-scale PV to come online by the end of 2018, and the Solar Energy Industries Association reports that PV capacity is projected to double over the next five years.

Source: <https://nextcity.org/daily/entry/solar-is-third-greatest-renewable-energy-source-what-does-this-mean-for-citi>

## **U.S. becomes second most attractive country for renewable energy, says new study**

The United States is the second most attractive nation for renewable energy investments, according to the newest annual global ranking prepared by Ernst & Young.

The international accounting juggernaut E&Y released the 2018 Renewable Energy Country Attractiveness Index (RECAI) today, showing that the U.S. is now second only to China in terms of attractiveness to the renewable energy sector.

The report described a recent wave of investment in the renewable energy sector by many of the world's largest oil companies, highlighting industry-leading investments by Total and Shell:

- In January, Royal Dutch Shell spent \$217 million agreed to buy a huge stake in Nashville, Tenn.-based solar project developer Silicon Ranch Corporation, which itself plans to invest in multi-billion dollar pipeline of clean energy acquisitions over the next two years.
- France's Total took a minority stake in solar and hydro generator EREN Renewable Energy last year after buying Lampiris, a natural gas and green power supplier based in Belgium, and the Saft, the leading French battery manufacturer.

The RECAI methodology, which was adjusted in 2017, relies on what E&Y calls the "five pillars," or five categories of specific indicators that collectively comprise the inputs used to calculate rankings for 40 nations. The five pillars are supposed to capture long term energy supply and demand dynamics, policy trends and affordability of renewable energy compared to other energy resources and other global market trends affecting investment and deployment priorities. Each of the five pillars include multiple series of datasets that are converted into a score 1-5 and weighted to generate parameter scores. The scores are then weighted again to produce pillar scores and then an overall RECAI score and ranking.

"Notwithstanding renewables' increasing cost-competitiveness, policy enablement continues to have a significant impact on market attractiveness," says E&Y in its description of the RECAI Methodology. "This means that solar in particular is continuing to increase in importance as a proportion of the overall weighting, even taking into account the higher \$/MW value of some other technologies."

In 2017, the U.S. ranked third overall out of the 40 countries included in the RECAI ranking. India took the second top spot in 2017, preceded only by China in first place. In 2018, India has fallen to the fourth slot, replaced by the U.S. in second and Germany in the third slot. China remained in first place.

Source: <https://www.forbes.com/sites/williampentland/2018/05/01/u-s-becomes-second-most-attractive-country-for-renewable-energy-says-new-study/#9a0cc732223b>

## UK engineers call for hydrogen storage drive



One of the UK's top engineering organizations is calling for a greater use of hydrogen energy storage.

The Institution of Mechanical Engineers (IMECHE) believes the British government and industry should boost investment in the technology, which in turn would "make the UK energy system greener and more efficient".

In a new report, the IMEChE says the technology would allow the gas grid to be used to store excess electricity, in the form of hydrogen, and support an expansion of renewable power in the UK.

"Government and industry need to step up efforts to provide funding programs and demonstration sites to encourage the greater use of hydrogen as energy storage," said Dr. Jenifer Baxter, Head of Engineering at the IMEChE and lead author of the report.

"The UK has a strong track record of being at the cutting edge of new energy developments, and this could present the country with a chance to be a world leader in power-to-gas and hydrogen technology."

The report calls for more support for power to gas technology, which is when excess electricity on the National Grid, from either high levels of renewable generation or low demand, is used to create hydrogen through electrolysis. This can be used locally, or injected into the gas grid at a low hydrogen concentration. Apart from producing 'green' gas, it can also be used to balance the electricity grid.

The IMEChE says the UK gas grid has the potential to store excess electricity in the form of hydrogen for a greater amount of time than some other forms of energy

storage, such as batteries.

This hydrogen can then be used in all areas of the energy system producing low emissions fuel for transport, reducing the CO<sub>2</sub> emissions from the heating system, reused to generate electricity as well as a greener feedstock for industries such as ammonia and plastics production.

"We need to move away from our wasteful culture to a more sustainable and circular economy. Power-to-gas and hydrogen technology could and should play a major role in building this future," said Dr. Baxter.

The report makes three recommendations for how power to gas technology could be used to transform the UK energy system.

Firstly, it calls for the UK government to commit to creating an industrial forum that brings together the nuclear, renewable power and gas sectors to promote the generation and storage of hydrogen for use across the UK energy system in heat, transport, power generation and heavy industry. "Investment now in the future hydrogen economy will begin to encourage further innovation, open up markets and help clarify legislation and regulation," said Dr. Baxter.

Secondly, the report says the government must work with the gas industry to promote the use of up to 20 percent hydrogen in the gas distribution network including change in pipes and materials by 2023. Funding programs and demonstration sites are crucial to decarbonizing gas. Government has the power to finance research, development and demonstration and support deployment through programs such as Innovate UK, as well as bespoke programs designed to deliver future UK infrastructure.

And thirdly the IMECHe wants the government to commission a comprehensive comparative study of the long-term sustainability of materials used to create lithium ion EV batteries versus power-to-gas/ gas systems and fuel cells, to identify appropriate technology and life cycle approach. "By understanding this more clearly, UK government can make evidence-based investment decisions that meet the requirements of sustainable development in the transport and heat sectors," says the report.

[For more information on P2G research see IJHE highlights: *Power-to-Gas in a smart city context—Influence of network restrictions and possible solutions using on-site storage and model predictive controls* ]

Source:

<https://www.powerengineeringint.com/articles/2018/05/uk-engineers-call-for-hydrogen-storage-drive.html>

## Jobs in renewable energy hit 10.3 million last year, report finds

Over 500,000 new jobs were generated by the renewable energy industry last year, a 5.3 percent rise when compared to 2016, according to a report.

The number of people working in the renewable energy sector — including large hydropower — hit 10.3 million in 2017, the International Renewable Energy Agency (IRENA) study said.

The world's biggest renewable energy employers were China, Brazil, the U.S., India, Germany and Japan. Altogether, these countries represented over 70 percent of jobs in the industry globally.

"Renewable energy has become a pillar of low-carbon economic growth for governments all over the world, a fact reflected by the growing number of jobs created in the sector," Adnan Amin, director general of IRENA, said in a statement.

"The data also underscore an increasingly regionalized picture, highlighting that in countries where attractive policies exist, the economic, social and environmental benefits of renewable energy are most evident," Amin added.

"Fundamentally, this data supports our analysis that decarbonization of the global energy system can grow the global economy and create up to 28 million jobs in the sector by 2050."

Breaking the figures down, IRENA said that the solar photovoltaic industry employed the largest amount of people, with almost 3.4 million working in that sector. China remained a solar powerhouse, and accounted for an estimated two-thirds of solar PV jobs, or 2.2 million.

# News of Interest

In the wind energy sector, IRENA noted a slight contraction in the market last year, with 1.15 million jobs recorded. China again led the way, accounting for 44 percent of employment.

Source: <https://www.cnn.com/2018/05/09/jobs-in-renewable-energy-hit-10-point-3-million-last-year-report-finds.html>

## California becomes first state in nation to require solar panels for new homes



The California Energy Commission adopted new building standards on Wednesday, May 9, that require solar photovoltaic systems in new homes starting in 2020.

The state is hoping to cut energy use in new homes by more than 50 percent, according to a press release from the energy commission.

The building energy efficiency standards will reduce greenhouse gas emissions by 700,000 metric tons over three years. It would be equivalent to taking 115,000 fossil fuel cars off the road, according to the Energy Commission.

The initiative is the first in the nation to mandate solar panels for new homes.

California's Renewables Portfolio Standard (RPS) is one of the most ambitious renewable energy standards in the country.

The RPS program requires California's electric utilities to have 50 percent of their retail sales derived from eligible renewable energy resources by 2030, according to CA Public Utilities Commission.

As a result of RPS, electricity produced for the grid is already much cleaner than it was 10 years ago, according to the energy commission.

California leads the nation in solar energy, as 15.56 percent of the state's electricity comes from solar and nearly 5.5 million homes are powered by solar, according to the Solar Energy Industries Association.

"Under these new standards, buildings will perform better than ever, at the same time they contribute to a reliable grid," Energy Commissioner Andrew McAllister said in the press release.

The ventilation measures improve indoor air quality. They protect homeowners from air pollution originating from both outdoor and indoor sources. The standards also establish requirements for newly constructed healthcare facilities.

The standards require both solar panels and upgraded insulation, air filters and other efficiency measures.

The energy commission's new building standards are expected to raise the cost of a new home by up to \$9,500. However, it will save \$19,000 in energy and maintenance costs over 30 years, according to the report.

Based on a 30-year mortgage, the energy commission estimates that the standards will add about \$40 to an average monthly payment for the average home but will save consumers \$80 per month on heating, cooling and lighting bills.

"With this adoption, the California Energy Commission has struck a fair balance between reducing greenhouse gas emissions while simultaneously limiting increased construction costs," California Building Industry Association CEO and President Dan Dunmoyer said in the release.

However, concerns arise as California is in the midst of a housing crisis. It failed for years to build enough homes to keep up with population demand causing high housing costs.

The new solar policy will exacerbate the affordable housing issues in the state, which are seen as a drag on the economy and also contribute to rising social tensions.

"With home prices having risen as much as they have, I think home buyers would find it a little distasteful to be forced to pay more for solar systems that they may not want or feel like they can't afford," Brent Anderson, a spokesman for home-builder Meritage Homes Corp, said to Bloomberg. "Even though, in the long term, it's the right answer."

The overall impacts of the initiative are widely debated by experts. However, many experts agree this solar mandate may boost the solar industry.

Solar energy accounts for less than 2 percent of total U.S. electricity generation, according to Energy Information Administration data.

California's move may prompt Hawaii, Arizona and other western states that have high levels of solar penetration to follow this mandate, according to Sunrun.

California generates only about 1 percent of global emissions, reducing California's greenhouse gas emissions will not be enough to solve climate change, according to the Energy Commission "Tracking Progress" report.

However, California Gov. Jerry Brown called for unified action to combat climate change in Beijing in 2013.

"We're in one world. We've got one big problem and we all have to work on it. And what's beautiful and exciting about climate change is no one group can solve the problem—not the United States, not California, not Japan, not China—we all have to do it," Brown said at Tsinghua University.

The initiative comes shortly after the American Lung Association's (ALA) 2018 "State of the Air" report that found that ozone pollution worsened significantly compared to the previous annual report.

California is home to 19 of the top 25 most ozone-polluted counties in the United States.

The state suffers from poor air pollution due to a number of factors, including population size, terrain that traps pollution and a warm, sunny climate that helps form ozone and other air pollutants, according to the California Air Resources Board.

On the same day the solar mandate was released, the California Environmental Protection Agency (CalEPA) also released a report highlighting the impacts of climate change on the state.

The report shows that California is already feeling the significant and growing impacts of climate change from record temperatures to proliferating wildfires and rising seas. The report tracks 36 indicators of climate change and its impacts on the state.

"This report demonstrates the value of California's extensive research and monitoring efforts, and is a valuable resource for state and local policymakers addressing critical climate adaptation and mitigation needs," CalEPA's Office of Environmental Health Hazard Assessment (OEHHA) Director Dr. Lauren Zeise said in the press release.

The recent solar initiative will help to further reduce harmful greenhouse gas emissions in the state.

Source: <https://www.accuweather.com/en/weather-news/california-becomes-1st-state-in-nation-to-require-solar-panels-for-new-homes/70004961>

## French Minister unveils €100m hydrogen plan

French Minister Nicolas Hulot presented his €100m (\$116.8m) ambitious plan for the deployment of hydrogen (H<sub>2</sub>) on June 1st and revealed his intention "to make France a world leader in this technology".

Creating a carbon-free industrial sector, developing renewable energy storage capacities and developing zero-emission solutions for road, rail and river transport are the three main axes of the Minister for the Ecological and Inclusive Transition's H<sub>2</sub> development plan, known as "plan Hydrogène".

From 2019, €100m (\$116.8m) will be dedicated to the first deployments of H<sub>2</sub> in industry, mobility and energy. ADEME (the French Environment and Energy Management Agency) will drive the deployment of these credits and support projects and actors in the sector throughout France.

"H<sub>2</sub> can become one of the pillars of a carbon-neutral energy model," he said. "This molecule, which contains a lot

of energy, will become essential given the extent of its properties: it can store electricity, feed cars, recycle carbon dioxide (CO<sub>2</sub>) and make industrial processes cleaner.”

“France is at the forefront of this sector, and I want to give it the means to maintain its lead in the heart of an already fierce global competition because it is an asset for our energy independence but also a huge source of jobs. The H<sub>2</sub> plan must be the impetus that will set in motion this sector of excellence to democratize, in the long term, the uses of this energy in our daily lives.”

The plan aims to construct 100 H<sub>2</sub> stations (there are currently 20) and have 5,000 H<sub>2</sub>-powered light commercial vehicles and 200 H<sub>2</sub>-powered heavy vehicles (such as buses, trucks, boats) on the road by 2023. This rises to 400 to 1,000 stations, 20,000 to 50,000 light commercial vehicles and 800 to 2,000 heavy vehicles by 2028.

In a statement, the Ministry of Ecological Transition said the French sector is ahead and has many leading global manufacturers present throughout the value chain. “The H<sub>2</sub> deployment plan therefore seeks to capitalize on these strengths to develop French industrial advantages and prepare the massive deployment of this molecule essential to the energy transition.”

McPhy’s CEO Pascal Mauberger was invited to speak at the event.

Speaking to Gasworld, he said, “This was a great opportunity to share our views, outlooks, key projects, and latest technological developments. We were also there to be the voice of the 60 French technology companies (startups, SMEs and intermediate-sized companies).”

“This announcement is a powerful signal to the French H<sub>2</sub> community. Both the technologies and the industrial base are ready to make France position itself at the forefront of the H<sub>2</sub> revolution, and to fully participate in the scaling-up.”

“We are very pleased at McPhy to see that the national plan is focusing on decarbonized H<sub>2</sub>. Clean H<sub>2</sub> is critical to achieve a low-carbon society and economy. Electrolysis technology hence appears as a master piece of the clean energy revolution. This fits perfectly with our strategy and positioning, aiming at offering to our Clients the cutting-

edge H<sub>2</sub> technologies they need, increasingly attractive and profitable.”

“We welcome and support this national initiative, which enables us to take another step towards a strong and sustainable growth for the H<sub>2</sub> sector, capable of providing an efficient and competitive answer for energy, environmental and economic challenges.”

## The measurements of the H<sub>2</sub> plan

### Create a carbon-free industrial sector

No 1: Set specific objectives for H<sub>2</sub> in industrial uses:

- 10% decarbonated H<sub>2</sub> in industrial H<sub>2</sub> by 2023
- Between 20% to 40% by 2028.

No 2: Put in place by 2020 an H<sub>2</sub> traceability system, forming part of the European framework under discussion (revision of the renewable energy directive).

No 3: Ensure the highlighting of the environmental impact of H<sub>2</sub> in the regulation of greenhouse gases, which will differentiate H<sub>2</sub> according to its mode of production:

### Develop renewable energy storage capacities

No 4: Quickly launch experiments in isolated territories. Electrolyzers are able to provide immediate services to the power grids and an additional outlet for the development of renewable energies.

No 5: Identify the services rendered by H<sub>2</sub>, to give them a value. For the continental metropolis, RTE and ENEDIS will have for mission to identify the value of the services rendered to the network by the electrolyzers and the existing means or to put in place to value this type of service.

No 6: Identify the needs for H<sub>2</sub> storage for each non-interconnected zone. EDF SEI (EDF’s subsidiary in the island territories) and ADEME are responsible for characterizing the services that the electrolyzers can provide for each non-interconnected zone in order to enable the communities concerned to forecast in their multi-year energy programs and specific targets for storage and H<sub>2</sub>.

No 7: Determine the technical and economical conditions of H<sub>2</sub> injection acceptable for the networks. In order to



prepare for the arrival of the “power-to-gas” process that allows for the conversion of electricity from renewable energies, gas carriers and distributors will have to determine these technical and economic conditions. An interim report is expected by the end of 2018.

Develop zero emission solutions for road, rail and river transport, etc.

No 8: Deploy territorial ecosystems of H2 mobility on the basis of fleets of professional vehicles:

5 000 light commercial vehicles and 200 heavy vehicles (buses, trucks, TER, boats) as well as the construction of 100 stations, supplied with H2 produced locally by 2023;

20,000 to 50,000 light commercial vehicles, 800 to 2,000 heavy vehicles and 400 to 1,000 stations by 2028.

No 9: Support the development of a range of heavy road vehicles but also for other modes: boats, aeronautical trains. Calls for Expressions of Interest using existing tools to support innovation will be launched.

No 10: Support the deployment of territorial fleets, H2 vehicles (trucks, commercial vehicles, buses ...), on the basis of the H2 produced in the industrial phase of priming.

No 11: Launch a parliamentary mission by the end of the first half of 2018 in particular to estimate the place of H2 in the rail and identify the locks to lift.

No 12: In order to support the projects, the ADEME will have a mission of pilot for the State, consisting of directing the carriers of projects notably for the regulatory questions or financing, to structure and to pilot the deployments of ecosystems H2 and to ensure a role of coherence of topics related to H2.

No 13: Continue the important work already done to clarify the regulations on safety and risk prevention. By mid-2018, a specific regulatory framework for service stations distributing H2 will be put in place.

No 14: Instruct and support the creation of an international qualification center - certification of high-pressure H2 components for road mobility, aeronautics, maritime, river, railway.

Source: <https://www.gasworld.com/french-minister-unveils-100m-hydrogen-plan/2014840.article#.WxKH0QgbEh8.linkedin>

## The RED Hydrogen One is coming to AT&T and Verizon this summer



RED's Hydrogen One phone is coming to Verizon and AT&T sometime this summer, although there's no word yet as to a final release date or what it will cost to buy the upcoming phone through carriers.

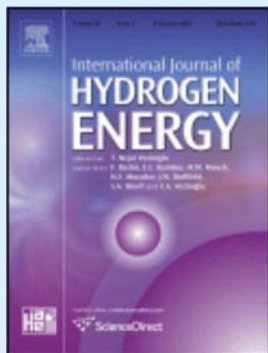
The Hydrogen One first opened preorders last July with an early \$1,200 price tag, and was recently delayed until this August. Company founder Jim Jannard explained the delay as giving RED more time to work out carrier certification. With the Hydrogen One getting support on two of the largest carriers in America, it seems that Jannard is delivering on that promise.

RED claims that the Hydrogen One will stand out from other premium smartphones with its 5.7-inch “holographic display”, which will use RED's new 4-View video format to display a 3D effect without the need for glasses. Although without seeing it in person, it's hard to gauge how groundbreaking the display really is. (It's worth pointing out that other companies have tried to create a similar-sounding 3D effect on phones, including Amazon's ill-fated Fire Phone back in 2014.)

RED is also touting an expandable pin system on the back of the Hydrogen One that will allow for customers to expand their devices with additional hardware modules — similar to the Essential Phone or the Moto Mod ecosystem.

Source: <https://www.theverge.com/circuitbreaker/2018/5/17/17362184/red-hydrogen-one-att-verizon-carrier-support-summer-release-date>

# 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  $\text{NH}_3$ ,  $\text{CH}_4$ , 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 (past 5 years)

1. **A comprehensive review on PEM water electrolysis**  
Carmo M, Fritz D, Mergel J, Stolten D. *Int J Hydrogen Energy* 2013;38(12):4901-4934
2. **Hydrogen from renewable electricity: An international review of power-to-gas pilot plants for stationary applications**  
Gahleitner G. *Int J Hydrogen Energy* 2013;38(5):2039-2061
3. **Review of hydrogen storage techniques for on board vehicle applications**  
Durbin D, Malardier-Jugroot C. *Int J Hydrogen Energy* 2013;38(34):14595-14617
4. **Review and evaluation of hydrogen production methods for better sustainability**  
Dincer I, Acar C. *Int J Hydrogen Energy* 2014;40(34):11094-11111
5. **Synthesis and characterization of composite visible light active photocatalysts  $\text{MoS}_2\text{-g-C}_3\text{N}_4$  with enhanced hydrogen evolution activity**  
Ge L, Han C, Xiao X, Guo L. *Int J Hydrogen Energy* 2013;38(17):6960-6969
6. **Review: Direct ethanol fuel cells**  
Kamarudin M, Kamarudin S, Masdar M, Daud W. *Int J Hydrogen Energy* 2013;38(22):9438-9453
7. **Layered  $\text{MoS}_2$ -graphene composites for supercapacitor applications with enhanced capacitive performance**  
Huang K, Wang L, Liu Y, Liu Y, Wang H, Gan T, Wang L. *Int J Hydrogen Energy* 2013;38(32):14027-14034

## Most Downloaded IJHE Articles (April-June 2018)

1. **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
2. **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
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. **Kinetics study and modelling of steam methane reforming process over a  $\text{NiO}/\text{Al}_2\text{O}_3$  catalyst in an adiabatic packed bed reactor**  
Abbas S, Dupont V, Mahmud T. *Int J Hydrogen Energy* 2017;42(5):2889-2903
5. **Changing the fate of Fuel Cell Vehicles: Can lessons be learnt from Tesla Motors?**  
Hardman S, Shiu E, Steinberger-Wilckens R. *Int J Hydrogen Energy* 2015;40(4):1625-1638
6. **Study on method of domestic wastewater treatment through new-type multi-layer artificial wetland**  
Lu S, Pei L, Bai X. *Int J Hydrogen Energy* 2015;40(34):11207-11214
7. **Effect of hydrogen-diesel fuel co-combustion on exhaust emissions with verification using an in-cylinder gas sampling technique**  
Talibi M, Hellier P, Balachandran R, Ladommatos N. *Int J Hydrogen Energy* 2014;39(27):15088-15102

# International Journal of Hydrogen Energy Highlights of Recent Publications

## **Power-to-Gas in a smart city context—Influence of network restrictions and possible solutions using on-site storage and model predictive controls**

D. Fischer, F. Kaufmann, O. Seliber-Lutz, C. Voglstatter. *Int J Hydrogen Energy* 2018: 43(20):9483-9494

With policies across the globe aiming to decarbonize energy systems, replacements must be capable of balancing fluctuations of renewable power output to grids (primarily wind and photovoltaic). Power-to-gas (P2G) systems, based on water electrolysis, are one such technology which can be used to level power loads by storing this energy in the form of separated hydrogen and oxygen. This work investigates a P2G unit that is part of a distributed urban energy network. The system consists of a wind array of 7.2 MW, a solar PV array of 2.5 MW, a base-load biomass plant and distributed CHP (combined heat and power) units located at industrial sites. There are, however, restrictions that exist when adding the produced hydrogen to existing natural gas networks (following a methanization step), because gas networks guarantee a stable quality of natural gas in their networks. Such restrictions are, for example, that the hydrogen in a network may not exceed 2 vol-%, which leads to limitations in the allowed feed-in and thus the economic performance of decentralized P2G stations.

This work focuses on P2G in an urban context where restrictions in the energy networks apply. On-site storage and improved controls are investigated to overcome network restrictions and a linearized model predictive control (mpc) approach is presented and shown to improve economic performance significantly. Different storage capacities are evaluated to provide knowledge on how to best size P2G units in such a setting.

Three potential use-cases were considered 1) maximization of renewable electricity use, 2) optimized operation at the electric spot market and 3) optimized operation to reduce high load in the electric grid. It was determined that imposing gas network restrictions led to a reduction of hydrogen production by more than 65%. If restrictions apply, local hydrogen storage should be added to mitigate these losses. For the investigated cases the most positive effects were yielded with a storage capacity of about 6 full load hours of the electrolysis unit. By applying the novel mpc as a control strategy, revenue could be significantly increased in all 3 cases. Results showed that depending on the use-case, up to 31% higher annual contribution margin and up to 48% less cold start cycles of the plant can be achieved over a rule-based controller. However, reduction of restrictions is still deemed the best approach even if that approach might not be feasible in many urban settings.

<https://www.sciencedirect.com/science/article/pii/S0360319918311583>

-By Cyrus Daugherty

## **Hydrogen: A brief overview on its sources, production and environmental impact**

S. Baykara. *Int J Hydrogen Energy* 2018: 43(23): 10605-10614

Today, 81% of total primary energy supply, and 66% of electricity generation are based on fossil fuels (coal, natural gas and oil), leading to almost 100% of CO<sub>2</sub> emissions in the world. At current consumption rates, world's proven coal, oil and natural gas reserves are expected to last for approximately 200, 40 and 60 years. Sustainability of conventional fuels has been a major concern because of their depletable nature. Presently, the concern is focused on the rise in global temperature mainly due to GHG (greenhouse gas) emissions resulting from their processing and combustion. A "sustainable energy source" would be one that is not substantially depleted by continued use, does not involve significant pollutant emissions or other environmental problems, health hazards or social injustices.

Renewable energy forms, especially hydrogen produced from water using solar energy comes very close to this definition. Hydrogen is not readily available on Earth in elemental form. However, it can be produced from its compounds found in natural or industrial sources. Hydrogen is the most abundant element in the universe, making up approximately 75% of all matter.

In this paper, a brief overview is presented discussing the availability of hydrogen, the properties and possible sources, and the production methods. This review also includes the impact of hydrogen consumption on the renewable energy utilization, environmental risks, and climate change. Solar hydrogen, preferably obtained from water, is considered an environment and climate compatible (causing the least damage) energy source; though not necessarily the most economic one. Production cost of hydrogen obtained from terrestrial biomass, is not the lowest either, however carbon-neutral feature of terrestrial biomass renders it highly desirable in view of steep rise in global temperature.

<https://www.sciencedirect.com/science/article/pii/S0360319918304002>

-By Yasser Ashraf Gandomi

## Fast Electrochemical Impedance Spectroscopy as a Statistical Condition Monitoring Tool

Authors: Boškosi, Pavle, Debenjak, Andrej, Mileva Boshkoska, Biljana

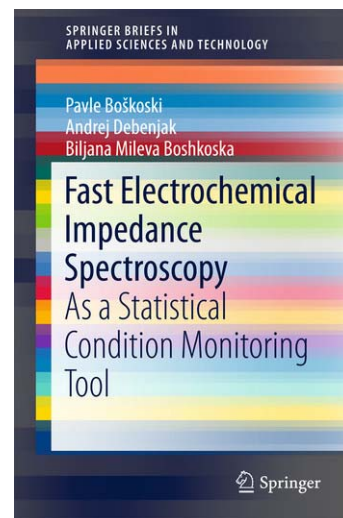
Electrochemical impedance spectroscopy (EIS) is a common technique used in a variety of settings primarily to delineate contributions from different electrochemical processes involved in a device. When EIS is performed in research settings potentiostats with frequency response analyzers (FRA) are often used, however FRA's are less practical for general commercialized products. Fast Electrochemical Impedance Spectroscopy As a Statistical Condition Monitoring Tool presents a novel method to approximate electrochemical impedance without a frequency response analyzer, which can be implemented and analyzed via a simpler control system more suited for in-line condition monitoring of commercial electrochemical systems.

Instead of concentrating all a sinusoidal wave's energy into a single frequency (which makes low frequency measurements time consuming) as is done when a frequency response analyzer is available, a discrete random binary sequence is used where the voltage is alternated discretely between two points randomly. With this method, a gaussian distribution of complex wavelet transforms coefficients are calculated and the probability distribution of the impedance at any frequency can be calculated. This does not yield the precision that is afforded to the former, but allows a simpler control scheme to be utilized.

After the background and statistical methods are introduced in chapters 2 and 3, chapter 4 goes into some test cases where simple combinations of RC circuits are simulated, and the fast EIS method is applied to generate the impedance probability distributions. Chapter 5 introduces some of the statistical foundations for determining the criteria for a condition monitoring system to raise an alarm, which is the primary benefit of having this in-line system. A full test case is demonstrated in chapter 6 where a PEM fuel cell stack is analyzed with this method, followed by an overview of hardware components that can be used and utilized for this type of system.

<https://www.springer.com/us/book/9783319533896>

*Have suggestions for a future book feature? If so, send the book title to Kathy Williams at [williamk@utk.edu](mailto:williamk@utk.edu).*



# 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](mailto: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.

If you are interested in becoming a member of IAHE, please visit the membership page at [www.iahe.org](http://www.iahe.org). You can sign up for membership directly on the membership page.

# Research Lab Highlight

## Gallant Research Group



Hydrogen South Africa (HySA)

### Overview:

Initiated by the Department of Science and Technology (DST) and approved by the Cabinet in May 2007, Hydrogen South Africa or HySA is a long-term (15-year) program within their Research, Development, and Innovation (RDI) strategy, officially launched in September 2008. This National Flagship Program is aimed at developing South African intellectual property, knowledge, human resources, products, components and processes to support the South African participation in the nascent, but rapidly developing international platforms in Hydrogen and Fuel Cell Technologies. The program strives towards a knowledge-driven economy meaning that innovation will form the basis of South Africa's economy.

HySA also focusses on (i) the "Use and Displacement of Strategic Minerals", (ii) ways of harnessing South Africa's mineral endowments to promote both the hydrogen economy and renewable energy use, and (iii) seeking the most cost-effective and sustainable ways of incorporating PGM-based components in hydrogen fuel cell and other technologies, in turns resulting in commercialization ventures and a viable industry around mineral beneficiation.

Major projects being conducted in the HySA includes:

### 1. Combined heat and power

Combined heat and power (CHP) systems based on fuel cells offer high efficiency, low emission, and decentralized power and heat supply for buildings and industries. They can operate from the existing natural gas distribution network, using a

reformer to convert methane gas to hydrogen thus minimizing infrastructure requirements.

There is considerable interest in installing CHP systems in domestic properties, called micro-CHP or dCHP (domestic CHP), and for large scale applications such as community heating or industries. Globally, pre-commercial projects have already been initiated for the implementation of dCHP systems on the larger scale.

The main purpose of the R&D program on CHP is to develop internationally competitive and marketable CHP-systems and critical CHP-system components. Membrane electrode assembly development along with PEM fuel cell stack diagnostics are some examples of such an effort.

### 2. Hydrogen fuel cell vehicles

An important part of achieving the objectives of the HySA program is to integrate the technology into end-user applications that could lead to the commercial use of the technology and the resultant socio-economic benefits of new industry development and PGM and mineral beneficiation. Transport applications are seen as a major opportunity for the use of Hydrogen Fuel Cells globally and are already being demonstrated by mainstream automotive companies and even used commercially in various niche vehicle applications.

The largest demand for FCVs is expected to be in passenger vehicles, with several models already being displayed by automakers across the world. Encouraged by the significant government investments and progressively harsher emission legislations, several major automotive companies have established R&D in this field. It seems however, that infrastructure overall cost and fuel cell durability remain significant challenges that are still holding back the mainstream market uptake of FCVs.

Rather than trying to compete directly with these large companies and national

programs, HySA's strategy is to pursue opportunities in niche vehicles with the expectation that if successful, its technologies will spill over into the mainstream automotive field. In collaboration with various vehicle partners, HySA Key Program 3, Hydrogen-Fueled Vehicles addresses mainly niche FCVs, including material handling vehicles (e.g. forklifts), light passenger vehicles (e.g. three-wheelers, golf carts and micro-cars) and special-purpose vehicles (e.g. mining locomotives).

The scope of HySA Key Program 3 is to develop and integrate systems and modules that can be used in these niche vehicles, based on HySA technologies. This includes the on-board Hydrogen storage (including Metal-Hydrides), the Fuel-Cell System (the FC-stack and its controller), power electronics and the Li-ion Battery System. A modular 'HySA Power Module' is being developed that incorporates the FC Stack, Battery System, Hydrogen Storage and controlling electronics. This can be retro-fitted into existing niche battery-powered vehicles with minimal changes to the vehicle itself. One of the primary research areas of the R&D team is to investigate solid state hydrogen as a primary fuel.

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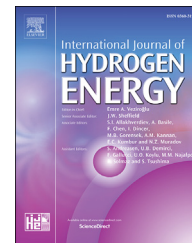
Link: <http://www.hysasystems.com/>



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## Editorial

# From the Editor



Dear IJHE Authors and Readers:

In our goal to recognize the distinguished works of our authors, I am excited to announce that the IJHE is establishing ten Awards to be given to the authors of the most cited papers in five different categories. These categories are Hydrogen Energy/Hydrogen Economy, Hydrogen Production, Hydrogen Storage & Distribution, Fuel Cells and Hydrogen Applications. As the WHEC meets every two years, two awards will be presented in each category, one for the previous even year and one for the previous odd year.

I am honored to share with you that these awards have been named after ten prominent hydrogen energy pioneers, keeping alive the legacy of hydrogen energy research & development around the world. The Award titles are:

1. **IJHE T. Nejat Veziroglu Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Hydrogen Energy/Hydrogen Economy* related paper of the previous even year.
2. **IJHE John O'M. Bockris Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Hydrogen Production* related paper during the previous even year.
3. **IJHE Juan Carlos Bolcich Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Hydrogen Storage & Distribution* related paper during the previous even year.
4. **IJHE Valery A. Legasov Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Fuel Cells* related paper during the previous even year.
5. **IJHE Zong Qiang Mao Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Hydrogen Applications* paper during the previous even year.
6. **IJHE Cesare Marchetti Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Hydrogen Energy/Hydrogen Economy* related paper during the previous odd year.
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8. **IJHE David Sanborn Scott Award** to be presented at the WHEC Conference Gala Dinner to the author or authors

of the most cited *Hydrogen Storage & Distribution* related paper during the previous odd year.

9. **IJHE Onkar N. Srivastava Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Fuel Cells* related paper during the previous odd year.
10. **IJHE Carl-Jochen Winter Award** to be presented at the WHEC Conference Gala Dinner to the author or authors of the most cited *Hydrogen Applications* related paper during the previous odd year.

The IJHE Awards Committee, who will be selecting the winning papers, consists of the following:

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The first Awardees will be selected for the most cited papers in five categories each for the years of 2016 and 2017. These awards will be presented to the authors at the Gala Dinner of the upcoming 22 World Hydrogen Energy Conference 2018 in Rio de Janeiro, Brazil, 17–22 June 2018.

Emre A. Veziroglu  
International Journal of Hydrogen Energy, USA  
E-mail address: [emrev1@cox.net](mailto:emrev1@cox.net)

<https://doi.org/10.1016/j.ijhydene.2018.04.130>  
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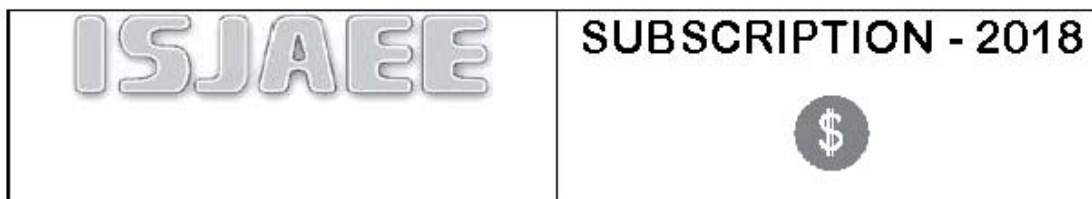
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**IEEES-10 Symposium**

The 10<sup>th</sup> International Exergy, Energy and Environment Symposium (IEEES-10) facilitates close cooperation and intellectual exchange with a large number of experts from the academia, leading R&D institutions, government agencies and the industry. It provides a platform for researchers, scientists, engineers, technologists and practitioners to discuss the current challenges, opportunities and future directions in the development of sustainable energy systems.

IEEES-10 covers a wide range of 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. A special symposium session will be devoted to hydrogen economy with a particular focus on hydrogen as a new and environmentally friendly energy carrier.

The previous successful editions of the symposium were organized in 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) and Split, Croatia (2017).

**Venue**

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- clean coal technologies
- synthetic and alternative fuels
- renewable energy systems
- hydrogen production and utilization technologies
- biowaste utilization
- fossil fuels
- nuclear energy
- exergy analysis and modeling
- energy systems and applications
- environmental impact assessment
- environmental engineering technologies
- life cycle assessment
- refrigeration and heat pump systems
- combustion, pyrolysis, and gasification technologies
- thermal systems and applications
- smart grids
- desalination technologies
- green buildings
- thermodynamic optimization
- heat and mass transfer
- sectoral energy management
- green transportation vehicles
- sustainable communities
- electrochemical devices (fuel cells, capacitors, batteries, etc.)
- new materials for energy applications

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World Society of  
Sustainable Energy Technologies



# 2018 International Symposium on Hydrogen Fire, Explosion and safety Standard (ISHFESS2018)

July 6-8, 2018- Hefei, China

## First Announcement and Call for Papers

The 2018 International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHFESS2018) will be held in Hefei, China on July 6-8, 2018 under the support of Code and Standard Division of International Association for Hydrogen Energy, National Technical Committee on Hydrogen Energy of Standardization Administration of China, Hefei University of Technology and Zhejiang University.

In view of global commercialization of hydrogen fuel cell electric vehicles and other hydrogen applications, ISHFESS hopes to provide an open platform for the presentation and discussion on hydrogen safety theory, technology and standard etc. Especially ISHFESS seeks contributions in fields such as hydrogen leakage, combustion theory, fire, explosion, material safety, risk analysis, safety management, hydrogen standard and code etc.

All contributions to ISHFESS2018 will be evaluated exclusively in the light of their scientific content and relevance to hydrogen safety and standard. High impact papers will be selected for publication in the **International Journal of Hydrogen Energy**.

### The topics include but not limited to:

1. Hydrogen combustion theory and basic physics.
2. Liquid/gas hydrogen leakage, dispersion and diffusion
3. Hydrogen fire and its protection technology
4. Hydrogen explosion and its protection technology
5. Hydrogen standards and codes
6. Hydrogen risk analysis and management
7. Hydrogen energy and Hydrogen Economy.
8. Hydrogen material.
9. Hydrogen safety in manufacture, storage and transportation etc.
10. Other hydrogen related theory, technology and applications.

### Symposium language

The ISHFESS2018 official language will be English.

### Important Dates:

Full Paper Submission (Deadline): 30 April, 2018      Notification of Paper Acceptance: 30 May, 2018  
Submission of Paper Final Versions: 15 June, 2018      ISHFESS Date: 6-8 July, 2018  
Work-In Progress Poster Submission: 30 May, 2018      Work-In Progress Poster Notification: 15 June, 2018  
Early Registration Open: 10 May, 2018

### Local Organizing Committee:

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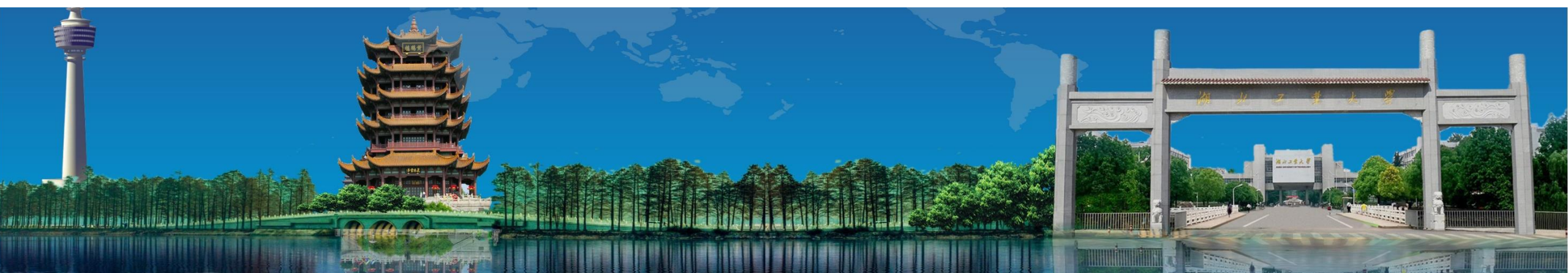
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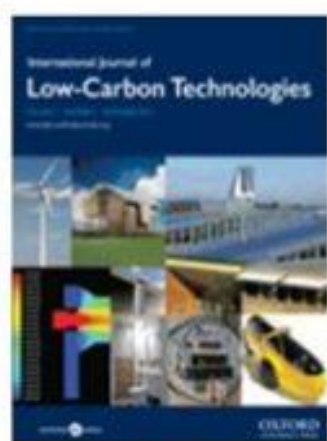
July 6-8, 2018 Hefei, China



## CALL FOR PAPERS

Contributions are invited on the topics within the conference scope of sustainable energy technologies. All contributions should be of high quality, original and not published elsewhere or submitted for publication during the review period. All accepted papers will be presented orally or by poster, and included in the conference proceedings.

Selected papers will be published in our partner journals.



Energy Technologies & Renewables | Energy Storage & Conversion | Policies & Management | Sustainable Cities & Environment

**SET 2018** is a multi-disciplinary, peer-reviewed international conference on sustainable energy sources and technologies that provides a forum for the exchange of latest technical information, the dissemination of the high-quality research results, the presentation of the new developments in the area, and the debate and shaping of future directions and priorities for sustainable development and energy security.

**SET 2018** will be hosted by the Hubei University of Technology, a Chinese tier-one university. It primarily focuses on teaching and research in the domain of green technology as well as the greening of traditional technologies, and has always been playing an active role in international academic exchange.

**Chair: Professor Saffa Riffat**, University of Nottingham  
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**Co-Chair: Ms. Amy Long**, Hubei University of Technology

**Confirmed keynote speakers include:**

**Professor T. S. Zhao**, HKUST Energy Institute  
**Professor Ibrahim Dincer**, University of Ontario Institute of Technology  
**Professor Chris Twinn**, Twinn Sustainability Innovation  
**Professor Peter D. Lund**, Aalto University, Finland  
**Professor Shengqiang Shen**, Dalian University of Technology  
**Professor Steffen Lehmann**, University of Portsmouth

WSSET members benefit from 20% discount on conference registration fees.

### KEY DATES

Deadline Date	Action
5th March 2018	One Page Abstract Submission
4th June 2018	Full Manuscript Submission
16th June 2018	Notification of Manuscript Acceptance
9th June 2018	Submission of Final Manuscript



Supported by the International Association for Hydrogen Energy (IAHE) and the International Journal of Hydrogen Energy (IJHE)

# Renewables Confo - 2018

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23 - 24 AUGUST, 2018 PARKROYAL HOTEL, SINGAPORE

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# ENERGY



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Conference will discuss the theme "Finding ways to recover renewable resources and technology transmission towards Sustainable Development" where we bring together leaders and visionaries from industries, universities, government, the scientific community, and the private sector that are looking at energy and sustainable development to speak about and debate the developments and changes, which would redefine the future of energy worldwide.

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# 2<sup>nd</sup> International Conference on Energy Materials and Fuel Cell Research.

Conference Dates: August 27-28, 2018 **Boston, Massachusetts, USA**

## About Conference:

**The EMFC 2018:** 2<sup>nd</sup> International Conference on **Energy Materials and Fuel Cell Research** is going to be held on **August 27-28, 2018** in **Boston, Massachusetts, USA** which aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results on all aspects of Advanced Energy Materials, Hydrogen Energy and Fuel Cell Technology with the Theme: *Generation of Energy Evolution for Sustainable Future*. EMFC Conference 2018 has become a premier event to connect professionals, scientists, academics, and students in the energy industry and provides a premier interdisciplinary platform to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of Energy Materials and Fuel Cell Technology.

The 2-days conference at Boston will become a must-attend event for the Energy and Fuel Cell Industry to hear about future infrastructure projects plans, government strategies and market-leading innovation. We invite you to contribute and help to shape the Energy Materials and Fuel Cell Research Congress through submission of your research abstracts, papers and e-posters.

More changes have occurred recently in the global energy sector since 100 years prior. In its 2<sup>nd</sup> edition, the EMFC Conference 2018 will be exploring enabling technologies for the future of clean energy, energy digitization, and existing energy infrastructure.

We will bring together leaders and visionaries from industry, government, the scientific community, and the private sector that are looking at the entire value chain in a holistic way and can speak about and debate the development of these complex changes, which are redefining the future of energy worldwide.

## Why to attend?

- »» Certificate Accreditation from the International Organizing Committee (IOCM)
- »» Access to All Sessions
- »» Ask the Expert Forum (One to One Pre-Scheduled meeting on interest & availability) ·
- »» Each registrant will get 50% abatement on manuscript publication fees
- »» 10% abatement on the registration fees for the next annual conference -Abstracts will be published in the conference souvenir and respected international journals.

## Conference Highlights:

1. Advanced Materials for Energy
2. Fuel Cell Technology
3. Advanced Nanomaterials
4. Hydrogen Economy and Alternative Fuels
5. Advances in Materials Science and Engineering
6. Advanced Solar Energy Materials
7. Electric, Hybrid, and Fuel-Cell Vehicles
8. Green Energy Materials

9. Batteries and Energy Storage
10. Graphene and 2D Energy Materials
11. Biomaterials and Surface Science Engineering
12. Electrical, Optical and Magnetic Materials

**Benefits:**

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Student Poster competition is organized at Energy Materials 2017 Conference, to encourage students and recent Graduates to present their original research which will be later published in Respective International Journal with D.O.I number by Cross Ref.

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  - Hydrogen Energy
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  - 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



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# NURER 2018

## CALL FOR PAPERS

6<sup>th</sup> International Conference

Nuclear and Renewable Energy Resources

September 30~October 3, 2018

Jeju, Korea

The 6<sup>th</sup> International Conference on Nuclear and Renewable Energy Resources (NURER2018) is recognized as one of the major international conference for the exchange of information on scientific, engineering, and other technical aspects of innovative nuclear and renewable energy science and technology. The conference is intended to provide an excellent opportunity to report on recent technical progress, discuss key issues and fostering international collaboration for the promotion of innovative nuclear and renewable energy system development and their synergic collaborations. Papers related to science, engineering, facilities, experiments, modeling, analysis, design and safety are welcome.



- ❖ Fission Energy
- ❖ Fusion Energy
- ❖ Renewable Energy
- ❖ Hydrogen and Solar Energy
- ❖ Energy Management and Environmental Issues
- ❖ Renewable-Nuclear Synergy, International Cooperation and Innovation
- ❖ Other relevant topics

The working language of the conference and the proceedings is English. Technical papers will be peer reviewed and accepted papers will be published in a symposium proceedings. The authors are encouraged to send full extended papers to The International Journal of Hydrogen Energy, The International Journal of Energy Research, Fusion Science and Engineering and The International Journal of Renewable Energy after the conference.

Authors are invited to submit a one-page 400 word abstract (text only) to the NURER-2018.

Website: <http://nurer2018.org>



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|--------------------------|------|---|
| ❖ March 31               | 2018 | <b>Abstract Submission Deadline</b>     |
| ❖ May 31                 | 2018 | <b>Abstract Acceptance Notification</b> |
| ❖ July 31                | 2018 | <b>Early Registration Deadline</b>      |
| ❖ August 31              | 2018 | <b>Manuscripts Submission Deadline</b>  |
| ❖ September 30~October 3 | 2018 | <b>Conference Convened</b>              |

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# NURER 2018

September 30~October 3, 2018, Jeju, Korea

Venue

## RAMADA PLAZA JEJU HOTEL

Located only five minutes away from Jeju International Airport and Jeju Port.

Web Site : <http://www.ramadajeju.co.kr/ENG/>



The Sights

## JEJU ISLAND

**JEJU ISLAND** is located in south-west and is the biggest island of Republic of Korea. Basalt rocks cover more than 90% area of this volcanic island. The island is oval-shaped with Halla Mountain in the center stretching 73 km from east to west and 41 km from north to south. It has a mild oceanic climate, where the temperature does not reach sub-zero levels (in most cases) even in the winters. A universal recreational island with beautiful natural landscape received as a gift from nature. Relatively isolated from the rest of the world, the island's nature has been well preserved in its original state.

**WORLD NATURAL HERITAGE** refers to tangible assets with outstanding universal values, which can't be replaced by any others once destroyed and must be preserved and maintained for the whole humankind. Jeju Island was designated as World Natural Heritage in the title of 'Jeju Volcanic Island and Lava Tube' in 2007.



More Information : <http://www.ijto.or.kr/korean/>

International Conference  
Nuclear and Renewable Energy Resources  
Sep. 30 - Oct. 3, 2018, Jeju, Korea

NURER 2018

# Istanbul-Türkiye 4<sup>th</sup> International Conference on Recycling and Reuse

(R&R 2018)

24-26 October 2018

## Aim and scope



The purpose of the conference is to provide an excellent platform for researchers and practitioners, to exchange emerging ideas and investigate key issues such as; recycling and reuse concerns, advanced wastewater treatment, membrane technologies for recycling and reuse, advanced oxidation technologies, waste reduction, water and wastewater management, solid waste treatment and management, hazardous waste management, resource use, renewable energy technologies, current and future recycling markets, public health issues, laws and policies of recycling and reuse.

## Important Dates



Date	Event
15 May 2018	Abstract submission
1 June 2018	Notification of acceptance
1 July 2018	Early bird registration
24-26 October 2018	Conference dates

## Topics



- Renewable energy technologies,
- Hydrogen Recycling Systems
- Utilizing modified fuel cell technology for hydrogen recovery and recycling.
- Hydrogen production and energy technologies,
- Solid waste management for recycling, reuse and energy recovery,
- Green technologies for energy production and wastewater reuse,
- Wastewater treatment, recycling and reuse technologies,
- Membrane technologies and wastewater separation technologies,
- Hazardous waste management,
- Public health issues,
- Laws and policies of recycling and reuse

## Information



For registration and more information please visit the conference website: <http://rr.istanbul.edu.tr> or send an e-mail to [rr@istanbul.edu.tr](mailto:rr@istanbul.edu.tr)

## Keynote Speakers



Giorgio Bertanza



Ibrahim Dincer



Mustafa Ersoz



Bilsen Beler Baykal

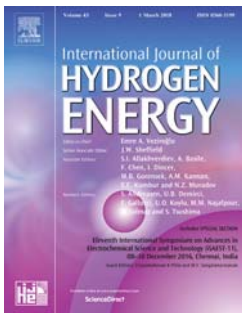


Gianluca Li Puma



Marek Bryjak

## Publications



International Journal of  
Hydrogen Energy

Hydrogen and hydrogen energy technologies related  
special issue is supported by



International  
Association for  
Hydrogen Energy  
(IAHE)

- AND -



International Journal of  
Hydrogen Energy  
(IJHE)

Other Publications:

Desalination and Water Treatment  
(Taylor & Francis)

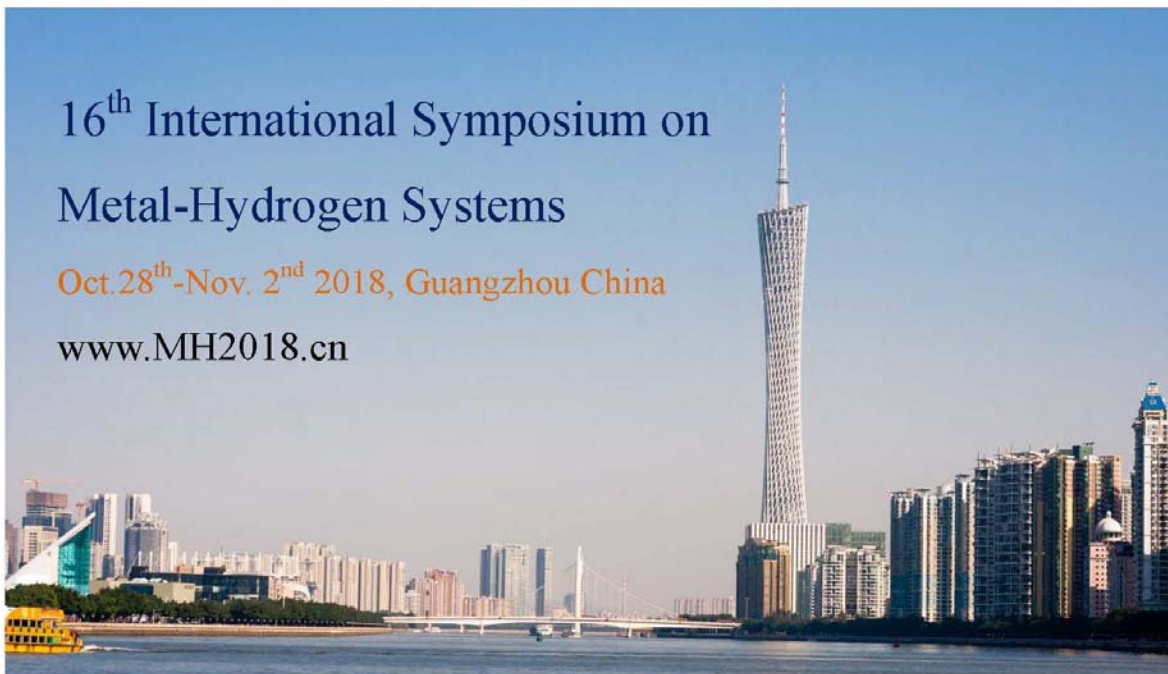
International Journal of Global Warming  
(InderScience)

International Journal of Agriculture,  
Environment and Food Sciences  
(DergiPark)

# 16<sup>th</sup> International Symposium on Metal-Hydrogen Systems

Oct. 28<sup>th</sup> - Nov. 2<sup>nd</sup> 2018, Guangzhou China

[www.MH2018.cn](http://www.MH2018.cn)



Crowne Plaza  
No. 28 Ningcai Road  
Central District, Science City,  
Guangzhou, China



## IMPORTANT DATE

Tuesday May. 1, 2018

Open for abstract submission

Saturday Jun. 30, 2018

Deadline for abstract submission

Friday Aug. 31, 2018

Deadline for early bird registration

Sunday Oct. 28, 2018

Registration and conference opening



## CONTACT

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South China University of Technology

Key Laboratory of Advanced Energy  
Storage Materials of Guangdong Province



# IC2EM'2018

## *International Conference on Electronics, Energy and Measurement*

November 27-29, 2018, Algiers, Algeria

The Laboratory of Instrumentation at USTHB organizes the *International Conference on Electronics, Energy and Measurement, IC2EM'2018* on November 27-29, 2018. The conference provides opportunity to bring scientists and engineers from academia, research institutes and industrial establishments to present and discuss the latest results in the field of electronics, instrumentation and measurement, sensors and energy. This event follows previous workshops of the Laboratory of Instrumentation series (JLINS) that held in 2007, 2010 and 2012 respectively.

### Conference themes

Papers are invited in the following themes, including, but not restricted to:

<b>Electronic systems</b> <ul style="list-style-type: none"><li>▪ Analog and digital circuits</li><li>▪ Microwaves circuits design</li><li>▪ Power Electronics</li><li>▪ Embedded systems</li></ul> <b>Energy systems</b> <ul style="list-style-type: none"><li>▪ Renewable energy</li><li>▪ Hybrid energy systems</li><li>▪ Energy storage</li><li>▪ Energy efficiency</li><li>▪ Hydrogen energy</li></ul> <b>Measurement</b> <ul style="list-style-type: none"><li>▪ Metrology and standards</li><li>▪ Laboratory accreditation</li><li>▪ Data acquisition systems</li><li>▪ Virtual measurement systems</li></ul> <b>Telecommunications</b> <ul style="list-style-type: none"><li>▪ Signal and image processing</li><li>▪ RF and wireless technology</li><li>▪ Networks and cryptography</li></ul>	<b>Instrumentation</b> <ul style="list-style-type: none"><li>▪ Sensors technology and modeling</li><li>▪ Advanced in sensing materials</li><li>▪ Smart sensors and interfaces</li><li>▪ MEMS, MOEMS and RFID technology</li><li>▪ Optical fiber instrumentation</li><li>▪ Microwaves instrumentation</li></ul> <b>Applications</b> <ul style="list-style-type: none"><li>▪ Solar and wind energy</li><li>▪ Petroleum and gas industries</li><li>▪ Health sciences</li><li>▪ Sport technology</li><li>▪ Agriculture and Environment</li><li>▪ Smart cities and IoT devices</li><li>▪ Disaster mitigation</li><li>▪ Automotive industry</li><li>▪ Avionics.</li></ul>
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### Important dates

Full paper submission **July 10, 2018**

Acceptance notification **September 15, 2018**

Final version paper **September 30, 2018**

Registration **October 15, 2018**

IC2EM-2018 Conference **November 27-29, 2018**

Conference website: <https://ic2em-2018.sciencesconf.org/>

# Upcoming Meetings & Activities

## July 2018

### 10th International Exergy, Energy and Environmental Symposium (IEEES)

July 1-4, 2018

Katowice, Poland

<http://www.ieees-10.gig.eu/>

### 2018 International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHESS2018)

July 6-8, 2018

Hefei, China

<http://ishfess.hfut.edu.cn/>

### 9th International Conference on Hydrogen Production

July 16-18, 2018

Zagreb, Croatia

<http://2018.ich2p.com/>

### HYPOTHESIS XIII

July 24-27, 2018

Singapore

<http://www.hypothesis.ws/>

## August 2018

### 17th International Conference on Sustainable Energy Technologies

August 21-23, 2018

Wuhan, China

<http://set2018.org/>

### International Conference on Renewable Recovery and Sustainable Development

August 23-24, 2018

Singapore

<https://www.renewableconference.com/index.php/home/venue>

### 2nd International Conference on Energy Materials and Fuel Cell Research

August 27-28, 2018

Boston, MA

<https://energymaterials.conferenceseries.com/>

## September 2018

### Advance Energy Materials Conference

September 10-12, 2018

Guildford, England

<http://www.advanced-energymaterials-conference.com/>

### European Summer School on Hydrogen Safety 2018

September 17-21, 2018

Athens, Greece

<http://www.jess-summerschool.eu/>

### 6th International Conference on Nuclear and Renewable Energy Resources

September 30-October 3, 2018

Ramada Plaza Jeju, Korea

<http://nurer2018.org/>

## October 2018

### 4th International Conference on Recycling and Reuse

October 24-26, 2018

Istanbul, Turkey

<http://rr.istanbul.edu.tr/>

### 16th International Symposium on Metal-Hydrogen Systems

October 28-November 2, 2018

Guangzhou, China

<http://www.mh2018.cn/dct/page/1>

## November 2018

### International Conference on Electronics, Energy and Measurement

November 27-29, 2018

Algiers, Algeria

<https://ic2em-2018.sciencesconf.org/>

Do you have a hydrogen-related meeting, workshop, or activity you would like us to include in the next issue of the IAHE Newsletter? If so, please email a description and web link to Kathy Williams at [williamk@utk.edu](mailto:williamk@utk.edu).

# 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

### [Horizon Fuel Cell Technologies](#)

Horizon Fuel Cell Technologies was founded in Singapore in 2003 and currently owns 5 international subsidiaries, including a new subsidiary in the United States. Having started commercialization with small and simple products while preparing for larger and more complex applications, Horizon already emerged as the world's largest volume producer of commercial micro-fuel cell products, serving customers in over 65 countries.

### [International Association for Hydrogen Energy](#)

Facebook community for sharing the information regarding advances in hydrogen energy.

## Blogs

### [Fuel Cell Nation](#)

Fact-Based Analysis and Discussion of Clean Energy  
<http://blog.fuelcellnation.com/>

### [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/>

# Contacts and Information

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## On the Web



International Association for Hydrogen Energy (IAHE)

<http://www.iahe.org>

5794 SW 40 St. #303

Miami, FL 33155, USA

International Journal of Hydrogen Energy (IJHE)

The Official Journal of the IAHE

<http://www.elsevier.com/locate/he>