Donald Trump's America First Energy Plan

In this article, the energy policy views of US presidential candidate Donald Trump are reviewed.

In a speech given in Bismarck, North Dakota, US presidential candidate Donald Trump outlined his plans for the energy policies he plans if elected. This was his first speech dedicated to his America First energy plan, which is to achieve US energy independence. His primary point was discussed in his plans to utilize domestic fossil fuels including coal and natural gas via fracking. Trump did not rule out other sources of energy including nuclear and renewables, however, his position was that the government should not favor those sectors while there are abundant, untapped fossil fuels on (beneath) American soil.

Trump’s America First plan has, as its primary goal, American energy independence. During his speech in Bismarck, he stated, “Imagine a world in which our foes, and the oil cartels, can no longer use energy as a weapon.” American energy dominance will be declared a strategic economic and foreign policy goal of the United States. The revenue from domestic energy production will be used to rebuild roads, schools, bridges and public infrastructure. In order to realize such an energy plan, a significant bureaucratic transformation is planned in the form of loosening restrictions on fossil fuel extraction. In Trump’s speech at the Republican National Convention on July 21, he declared, “We’re going to deal with the issue of regulation, one of the greatest job killers of them all...we are going to lift the restrictions on the production of American energy.”

Utilization of domestic fossil fuels is the cornerstone of Trump’s energy plan. He has stated multiple times how he wants to resurrect the coal industry. “We have to protect your coal industry which is being decimated by EPA regulations,” Trump declared at a rally in Dayton, Ohio last March. Likewise, he referenced the apparent 2 million jobs that could be generated if shale energy was opened up via deregulation of fracking during his speech in North Dakota. Trump has also declared his interest in renewing permits for the Keystone pipeline, which would see Canadian oil piped into the United States for refining.

Trump’s views on sources of energy are not all carbon based, however, he believes that government should not intervene in innovation. Trump explained, “We will get the bureaucracy out of the way of innovation, so we can pursue all forms of energy. This includes renewable energies and the technologies of the future. It includes nuclear wind and solar energy—but not to the exclusion of other energy. The government should not pick winners and losers.” He cited a long return on investment as his primary reason for not promoting solar power. While in an interview last December with Bill O’Reilly, when asked about his opinion on wind energy Trump stated, “Wind is destroying a lot of problems [sic] and number one, it is killing the birds and the eagles by the hundreds.” As with solar, however, his primary argument against wind is that it requires subsidies from the government and is not economically competitive in its current state.

Following his remarks about solar and wind energy, Trump took a moment to expound his position on what he called ‘real environmental challenges, not phony ones.’ Trump plans to cancel the Paris Climate Agreement, which would keep present American tax dollars from funding global warming projects. He also plans to enable broad energy exploration, which will take place in regions that are currently restricted for such activities, like Alaska and the outer continental shelf. At this point Trump has not made any statement about who would be the head of the Department of Energy if he is elected.

—Cyrus Daugherty
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.
WHEC 2016 was held June 13-16, 2016, in Zaragoza, Spain, with over 900 people from 60 countries in attendance. The Spanish Hydrogen Association, led by its President and Conference Chair Javier Brey Sanchez, hosted the conference.

IAHE President T. Nejat Veziroğlu gave an inspiring and optimistic opening address, telling the audience, “When I see the enthusiasm among the young and old, among the pioneers and disciples, I am heartened. I believe that the day of clean and abundant energy is close, maybe sooner than we think.”

The WHEC 2016 Awards were presented to:

Professor Deborah J. Jones, France—William Grove Award
Professor Adam Z. Weber, USA—Sir William Grove Award
Professor Armen Trchounian, Armenia—Akira Mitsui Award
Hydrogen Energy Systems Society (HESS), Japan—Jules Verne Award
International Scientific Journal for Alternative Energy and Ecology (ISJAEE), Russia—Jules Verne Award
Professor Debabrata Das, India—IAHE Fellow

The European Hydrogen and Fuel Cell Association gave briefings online each day of the conference. To access the daily briefings visit http://www.h2euro.org/2016/whec-2016-links-spain-to-europes-h2-corridors/.
The U.S. Department of Energy (DOE) has announced up to $14 million in funding for the advancement of hydrogen fuel technologies, including advanced high-temperature water splitting, advanced compression and thermal insulation technologies.

According to the DOE, these projects will accelerate American innovation in hydrogen and fuel cell technologies by supporting research and development and domestic manufacturing.

The DOE’s current goal is to reduce the cost of producing and delivering hydrogen to less than $4 per gallon of gas equivalent (gge) by 2020 and $7/gge for early markets.

To combat a limited supplier base, the DOE is also announcing the launch of HFCNexus, an online tool for hydrogen and fuel cell technologies, developed through a current DOE-funded project by Virginia Clean Cities at James Madison University. A business-to-business website that connects fuel cell and hydrogen technology developers with potential suppliers, HFCNexus will be a resource when it comes to necessary equipment, such as hoses, nozzles and meters, according to the department.

The projects selected under this funding opportunity are as follows:

**High-Temperature Water Splitting**

Salt Lake City-based Ceramatec Inc.—Improve the performance of durable materials for high-temperature water splitting stack technology through the development of a novel cell architecture that introduces macro-features to provide mechanical support of a thin electrolyte and micro-features of the electrodes to lower polarization losses.

Danbury, Conn.-based Fuel Cell Energy Inc.—Demonstrate the potential of solid oxide electrolysis cell systems to produce hydrogen at a cost of $2 per kilogram.

Newton, Mass.-based Giner Inc.—Develop high-temperature alkaline water electrolyzers with improved electrical efficiency at a reduced cost.

**Advanced Compression**

Giner Inc.—Demonstrate a cost-effective method for compressing hydrogen while eliminating the need for mechanical compressors, which can have significant reliability issues.

Aiken, S.C.-based Greenway Energy LLC—Combines two novel technologies, Electrochemical Hydrogen Compression and Metal Hydride Compression, into a new hybrid solid state hydrogen compressor in order to overcome the reliability issues of mechanical compression and the efficiency challenges of solid state compression technologies.

Livermore, Calif.-based Sandia National Laboratories—Investigate and demonstrate a laboratory-scale, two-stage metal hydride-based hydrogen gas compressor.

**Thermal Insulation**

Reston, Va.-based Vencore Services and Solutions—Apply integrated cryogenic tank approaches and novel technologies developed by NASA’s Cryogenics Test Laboratory to build an integrated subscale insulation system prototype demonstrating the heat leak targets applicable to cryogenic hydrogen storage tanks for commercially produced fuel cell-powered automobiles.


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The UK Government has made US$39 million (£30 million) of funding available to bus operators and local authorities in England, enabling them to buy low emission buses and install charge points and other infrastructure. In total, the 13 successful bidders will be able to add 326 buses, including electric, hybrid, hydrogen and biomethane buses, to their fleets, and install more than US$9 million (£7 million) worth of infrastructure.

Among the winners is Sheffield City Region, which has been awarded US$1.7 million (£1.3 million for) 44 buses fitted with hybrid technology.

Other successful bidders include West Midlands Travel,
which has been awarded more than US$4 million (£3 million) to fund 10 hybrid and 19 fully electric buses, and install electric charging facilities. Birmingham City Council and Transport for London have jointly won US$3.6 million (£2.8 million) for 42 state-of-the-art hydrogen fuel cell buses, while Merseytravel has received US$6.4 million (£4.9 million) for a total of 72 biomethane, hybrid or electric buses and associated infrastructure. Nottingham City Transport has been awarded US$5.7 million (£4.4 million) for 53 biomethane buses and infrastructure.

The low emission bus scheme builds on the Green Bus Fund, which saw US$116 million (£89 million) of government funding put more than 1,200 green buses on England’s roads—representing four percent of buses in service. The government has also invested more than US$34 million (£26 million) since 2013 to retrofit more than 2,000 buses in pollution hotspots with low emission technology.


**New initiative aims to expand solar energy throughout the United States**

Clean Energy Savings for All to increase accessibility of solar power systems

President Barack Obama has announced new plans to increase the availability of solar energy, particularly for low-income households. The initiative is called the Clean Energy Savings for All and aims to increase the use of clean power in low and moderate-income homes throughout the country by a significant margin. The solar energy market in the United States has been growing quickly in recent years, particularly among the residential sector. The demand for solar power systems has grown significantly, but such energy systems had been too expensive for many people to afford.

**Cost of solar power continues to fall throughout the US**

The cost of solar power has dropped significantly since 2009. According to President Obama, the Clean Energy Savings for All will give more communities and families the chance to embrace clean energy. Since Obama took office, the use of solar power has increased 30 fold. Notably, the solar industry in the United States has grown 12 times faster than any other economic in the country. This has created many opportunities for many of those interested in renewable energy. Despite the quick growth of the solar energy market, solar power remains a largely underutilized resource for the United States.

**Solar power remains underutilized in the United States**

According to the Solar Energy Industries Association, approximately 1 million homes in the United States make use of solar power. This only represents only one-quarter of the new goal established by the Clean Energy Savings for All initiative. The endeavor aims to vastly increase solar usage by 2020. The goal is more ambitious than President Obama’s previous endeavor to increase the use of renewable energy by 100 megawatts by 2020.

**Federal agencies will aid in the adoption of solar energy**

Housing authorities in 36 states have all agreed to invest some $287 million in order to help finance some 280 megawatts worth of solar projects in low and moderate-income communities. Six federal agencies will also participate in the Clean Energy Savings for All initiative. These agencies will provide additional financing for rooftop solar energy system, further increasing the availability of solar energy systems for many communities.

University of Waterloo receives award and presents winning design at the AMR in Washington, DC

On June 6, 2016, the grand prize winner of the Hydrogen Education Foundation's 2016 Hydrogen Student Design Contest was announced at a session of the U.S. Department of Energy (DOE)'s Annual Merit Review and Peer Evaluation Meeting (AMR) in Washington, DC. This year's contest required student teams to design a hydrogen powered micro-grid with the capability of solely supporting a community, facility, or military base for two days, with the ability to handle at least 10% of peak demand while the macro-grid is active, as well as provide grid support during peak times.

DOE, National Renewable Energy Laboratory (NREL) and Air Liquide sponsored the contest and announced University of Waterloo, in Ontario, Canada, as the Grand Prize Winner, their third Grand Prize and fifth award in the history of the contest. The team's design used Cornwall, ON, Canada, as the basis for the location of their renewable hydrogen-powered micro-grid design. Hydrogen is used as an energy storage medium to be converted back into electricity by PEM (Polymer Electrolyte Membrane) fuel cells. The system is designed to supply hydrogen to 100 forklifts used at a food distribution center and more than 30 FCEVs used in the residential community. Wind, solar and hydrogen power continuously supply 10% of the energy demand of the community as well as the full demand for two days in the event of a blackout. Key to meeting this criteria is the vehicle-to-grid concept used in the design, where FCEVs can be connected to charging stations to supply power back to the grid during peak demand or emergency scenarios.

Jeff Serfass, president of the Hydrogen Education Foundation, remarked: "I continue to be impressed by the ingenuity of these student teams, especially as hydrogen technologies continue to evolve. Waterloo’s design was detailed and thorough, taking into account the constraints of today’s technology with their vision for the future."

Sixteen teams from the United States, Canada, Great Britain, Japan, India, Indonesia, Peru, and South Africa participated in the contest.

- Arizona State University, USA
- Bogor Agricultural University, Indonesia
- California State University, Los Angeles, USA
- Farmingdale State College, USA
- Kyushu University, Japan
- North-West University, South Africa
- Stanford University, USA
- Universidad de Ingeniería y Tecnología—UTEC Team A, Peru
- Universidad de Ingeniería y Tecnología—UTEC Team B, Peru
- Universidad de Ingeniería y Tecnología—UTEC Team C, Peru
- University of British Columbia
- University of California, San Diego, USA
- University of Manchester, UK
- University of South Florida, USA
- University of Waterloo, Canada
- West Texas A&M University, USA

As part of their award, the team from the University of Waterloo received a travel stipend to DOE's AMR in Washington, DC to present their design in front of industry representatives. The winning team will also have their design submitted for publication in an issue of the International Journal for Hydrogen Energy.

Since 2004, the annual contest has demonstrated the talents of the student teams in numerous fields, including engineering, environmental science, architecture, marketing, and entrepreneurship. Previous contest winners attracted the funding necessary for project implementation; a hydrogen fueling station at Humboldt State University was opened on September 9, 2008, based on their winning design in the 2005 contest.

Source: http://energy.gov/eere/fuelcells/articles/university-waterloo-wins-2016-hydrogen-student-design-contest
Detroit automaker General Motors and the US Navy announced a partnership in which the Navy would be able to take advantage of hydrogen fuel cell research from GM to develop a long-endurance unmanned undersea vehicle (UUV).

According to Karen Swider-Lyons, the head of the Naval Research Laboratory’s (NRL) Chemistry Division of its Alternative Energy Section, the Navy is looking for “weeks if not months of endurance” from a UUV. She stressed that research and testing is still in early stages and that the Navy had not yet pinpointed a single application it wanted to apply fuel-cell powered underwater drones to. “As the technology becomes available, we'll see,” Swider-Lyons said on a conference call this morning. “You can look at the history of unmanned air vehicles and guess.”

Fuel cell technology has been lauded as a potentially revolutionary energy source for zero-emissions vehicles, using hydrogen to create electricity and emitting H₂O as waste. While fuel-cells are more energy dense than batteries, batteries have generally won out when it comes to building zero-emissions cars because hydrogen refueling centers are scarce, and storing hydrogen itself can require a high-pressure container or very cold temperatures.

That hasn’t stopped automakers from developing concept cars to take advantage of fuel cell ideas. GM, Toyota, Nissan, Audi, Hyundai, and Volkswagen have all experimented with building fuel-cell cars. USA Today also notes that “Last November, GM and the US Army signed a contract to build and demonstrate a fuel-cell reconnaissance vehicle for the US Army Tank Automotive Research, Development and Engineering Center (TARDEC) in Warren, Mich.”

The US Navy has turned to fuel cells in lieu of batteries as UUVs have grown larger and larger. Fuel cells also have the advantage of being reliable and are quickly refilled, unlike batteries that can take hours to charge up again. A press release from GM claims its fuel cells "are compact and lightweight, and have high reliability and performance."

"Lower cost is achievable through volume production," the company claimed.

GM and Navy representatives praised their continued partnership on today’s conference call, highlighting how many parallels exist between engineering a car and engineering a UUV. Still, Swider-Lyons said that "information comes one way from General Motors to NRL, it does not go back," suggesting that more confidential aspects of NRL’s research would not be shared with General Motors.

NRL has already run prototype tests of UUVs at the Naval Surface Warfare Center in Carderock, Maryland, using General Motor’s fuel cells. Now, the Navy wants to improve upon its prototypes. “We’re trying to develop a powertrain that’s very, very efficient,” Swider-Lyons said today. “We try to carry hydrogen efficiently too... it’s a little tricky underwater because it’s not just weight or volume, but buoyancy as well” that the Navy has to account for.

“Part of the research program is determining how much power we need,” Swider-Lyons added.

The Detroit News notes that the Department of Defense budgeted $600 million for UUV development over five years starting in 2017.


**Toyota Mirai hydrogen cars land in Australia for landmark three-year trial**

It’s a car, but not as we know it.

A trio of Toyota hydrogen vehicles—which emit only water vapor from their tailpipes —has landed in Australia ahead of a three-year trial of the future technology.

There is just one catch: for now there is only one hydrogen refueling point in Australia—at the headquarters of rival car company, Hyundai.
But Toyota is importing a special mobile hydrogen refueler which will enable the hi-tech cars to be driven across the country.

The Toyota Mirai—dubbed the “puffer fish” because of its bulbous face and large “gills” in the front bumper—is already on sale in Europe, the US and Japan priced about $70,000, roughly twice the cost of a Toyota Prius hybrid.

However, in a classic chicken versus egg dilemma, there are currently no plans to introduce hydrogen cars in Australia because, for now, there is nowhere for customers to refuel them.

Hydrogen cars are seen as the solution to future mobility—beyond electric cars—because they can be refueled in the same time as petrol-powered cars and can travel the same distance between refills, more than 500km. “We are extremely interested in fuel cell technology, but we need the relevant infrastructure in place before we can sell these vehicles in Australia,” said Dave Buttner, Toyota Australia president.

“Fuel cell technology is expected to play a key role in the future and we do not want Australians to miss out.”

What it’s like to drive a hydrogen car?

Inside it sounds as eerily quiet as an electric vehicle. Outside the vehicle there is a hi-tech hum and the occasional subtle whistle sound from the compressors. Acceleration is about the same as a small hatchback, like a Toyota Corolla.

The long road for hydrogen powered cars

Mercedes-Benz imported an experimental hydrogen car as long ago as September 2004, but it was here only briefly for a demonstration to highlight a three-year hydrogen bus trial in Perth. When the program ended in 2007 it was not renewed and the hydrogen refueler was decommissioned.

In March 2015, Hyundai imported the world’s first mass produced hydrogen car (built on the same production line as petrol and diesel versions of the same vehicle) and unveiled the only hydrogen refueling point in Australia. It has since travelled 4500km.

In October 2015, after more than a decade of experimental vehicles, Toyota imported its first mass produced hydrogen car, the Mirai, for a month of local demonstrations. However, it could not be driven far because Toyota only had the hydrogen that came in the car’s tank. There was no way to refuel it at the time.

In July 2016, Toyota imported three of its Mirai hydrogen sedans for a three-year trial; the mobile refueler is due in October 2016.

This will give the cars an unlimited driving range, from Sydney to Perth, Darwin to Adelaide, and from Cairns to Melbourne along the east coast.


**Hyundai and U.S. Department Of Energy extend fuel cell vehicle loan partnership in concert with new D.C. based hydrogen fueling station**

Hyundai and the U.S. Department of Energy (DOE) are extending their fuel cell vehicle confirmation program, originally from 2013 through 2015, to its second phase, from 2016 through 2017. The program involves Hyundai providing a number of Tucson Fuel Cell CUVs for daily use and confirmation by the DOE using existing hydrogen infrastructure. This phase of the program will make significant use of a newly-opened hydrogen refueling station in the Washington, D.C. region.

Phase one of the Hyundai/DOE program focused exclusively in the Southern California region, where the earliest hydrogen infrastructure existed. Phase two further expands the program’s reach to Northern California, Washington, D.C., Michigan, and Denver. Phase two starts in July 2016 in conjunction with the opening of the newest D.C. based hydrogen station. Tucson fuel cell
vehicles will use this newest DOE-developed hydrogen station extensively.

The Hyundai/DOE partnership effectively continues preparation for the rollout of fuel cell vehicles nationwide in the near future. Some key advantages of hydrogen fuel cells over battery-powered electrified vehicles is their quick refueling capability, longer range, more flexible vehicle size scalability and maintenance of range performance in colder climates.


**Hyundai to unveil new fuel cell system at 2018 Winter Olympics**

Automaker has developed a new fuel cell system that will be used in an innovative vehicle

South Korean automaker Hyundai has revealed that it will be launching its next generation fuel cell system in 2018. This new fuel cell system will be used to power a new vehicle, which will be ready to showcase in time for the Winter Olympic, which is being held in South Korea. According to Hyundai, the system will be used in an entirely new vehicle, which will appear to be a hybrid sports utility vehicle and crossover utility vehicle.

**Hyundai has been working to improve fuel cell technology for years**

Hyundai first entered into the realm of fuel cell transportation in 2013, when it introduced the ix35. Since then, the automaker has produced less than 1,000 units of this model, but has been aggressively promoting the capabilities of hydrogen fuel cells and how they can be used in transportation. Hyundai has been slow to develop vehicles equipped with a fuel cell system, but has been working to improve the technology behind such systems, making them more efficient and less expensive.

**New system will be lighter and less expensive than its predecessor**

The new fuel cell system developed by Hyundai will be smaller than its predecessor. The system will also require less platinum, which will make it considerably more affordable than its earlier counterpart. The system will be accompanied by a battery, which will be larger and capable of storing more electrical power. The vehicle itself will have a smaller and lighter electric motor, though this motor will also have higher performance.

**Winter Olympics to be a major event for clean transportation**

The fuel cell system is set to be on display during the 2018 Winter Olympics, which will be held in Pyeongchang, South Korea. Hyundai plans to make this a big event for clean transportation and fuel cell technology. The automaker has already generated a great deal of buzz around its fuel cell vehicle and technology over the past three years and has even invested in helping establish a hydrogen infrastructure in South Korea and other markets.


**Audi Plans 3 Electric Cars by 2020**

Audi is gearing up to take on Tesla by launching three electric car models by 2020.

As Reuters reports, Audi chief Rupert Stadler reportedly told German paper *Heilbronner Stimme* that he expects EVs to account for 25 to 30 percent of the company’s sales by 2025.

This focus on electric car development is part of a “strategic overhaul,” prompted by parent-company Volkswagen’s ongoing emissions scandal, Reuters says. Audi also intends to funnel more resources into the development of digital services and autonomous driving technologies.

So what, exactly, is Audi working on? Mini-style electric vehicles, for starters, along with something Stadler called a “robot car.”

The robot vehicle “may not even need a steering wheel or pedals, so it’s ideal for urban traffic,” Stadler said, according to Reuters. The company intends to establish a new subsidiary, dubbed SDS Company, to
Hydrogen Vehicle News

develop the autonomous car.

Audi has also considered dropping the two-door version of the A3 to free up some money for new models. And while Sadler called fuel cell cars a "must," the company's technical development head, Stefan Knirsch, said production of one would not start before 2020 due to the current shortage of charging stations.

Meanwhile on the Audi EV front, one model said to be in the works is an SUV. Audi last year teamed up with Samsung and LG to produce electric car batteries, which the company plans to use in a new SUV with a potential 300-mile range.


Hydrogen fuel-cell vehicle landscape truly changed, says longtime expert

Hydrogen fuel-cell cars are currently available to consumers, but only in small numbers.

The Hyundai Tucson and Toyota Mirai are on sale in certain regions of California, and will soon be joined by the 2017 Honda Clarity Fuel Cell.

The three manufacturers only plan to sell very small volumes of fuel-cell cars over the next few years, and lack of fueling infrastructure restricts sales to the Golden State for now.

But the current fuel-cell landscape represents an important change from past efforts to promote hydrogen cars, according to one expert.

There has been significant positive change in the hydrogen sector compared to even a decade ago, Dr. Joan Ogden—a UC Davis professor who studies energy policy—said in an interview with Autoblog Green during the recent launch of the 2017 Honda Accord Hybrid.

Interest in hydrogen fuel-cell vehicles has waxed and waned over the years, but Ogden believes "there is something different this time."

That something is the framework for a long-term commitment to developing fuel-cell cars, and the fueling infrastructure needed to support them, she said.

Part of that is due to the technology becoming more "real" through the development of more prototype cars, and the low-volume production Tucson Fuel Cell, Mirai, and Clarity Fuel Cell.

At the same time, development of policies for fuel-cell adoption is becoming more focused, she said.

Regions such as Southern California, and parts of Germany and Japan now serve as "lighthouse cities" where efforts to deploy fuel-cell cars in large numbers can be concentrated.

Helping to accomplish that is greater coordination among stakeholders in those regions, including carmakers, fueling-network operators, and governments, Ogden said.

As more hydrogen fuel-cell cars hit the road, advocates are gaining more knowledge about how they work and what can be expected of them, inspiring greater confidence in potential investors, she noted.

The growing fuel-cell fleet is also exposing technical issues, including problems with fueling-station reliability, and the need for accurate metering of hydrogen dispensed into vehicle fuel tanks.

It also remains to be seen whether fuel-cell cars can compete with battery-electric cars, and whether a suitability low-emission process for large-scale hydrogen production can be found.

Given time, Ogden is confident these issues can be addressed. The biggest change in the state of fuel-cell cars may be that Ogden also feels confident that advocates will actually get time to do that.

How solar energy can be transformed into fuel

The sun is a clean and inexhaustible source of energy, with the potential to provide a sustainable answer to all future energy supply demands. There’s just one outstanding problem: the sun doesn’t always shine and its energy is hard to store. For the first time, researchers at the Paul Scherrer Institute PSI and the ETH Zurich have unveiled a chemical process that uses the sun’s thermal energy to convert carbon dioxide and water directly into high-energy fuels: a procedure developed on the basis of a new material combination of cerium oxide and rhodium. This discovery marks a significant step towards the chemical storage of solar energy. The researchers published their findings in the research journal Energy and Environmental Science.

The sun’s energy is already being harnessed in various ways: whilst photovoltaic cells convert sunlight into electricity, solar thermal installations use the vast thermal energy of the sun for purposes such as heating fluids to a high temperature. Solar thermal power plants involve the large-scale implementation of this second method: using thousands of mirrors, the sun light is focused on a boiler in which steam is produced either directly or via a heat exchanger at temperatures exceeding 500 °C. Turbines then convert thermal energy into electricity.

Researchers at the Paul Scherrer Institute PSI and the ETH Zurich have collaborated to develop a ground-breaking alternative to this approach. The new procedure uses the sun’s thermal energy to convert carbon dioxide and water directly into synthetic fuel.

"This allows solar energy to be stored in the form of chemical bonds," explains Ivo Alxneit, chemist at the PSI’s Solar Technology Laboratory. "It’s easier than storing electricity." The new approach is based on a similar principle to that used by solar power plants.” Alxneit and his colleagues use heat in order to trigger certain chemical processes that only take place at very high temperatures above 1000 °C. Advances in solar technology will soon enable such temperatures to be achieved using sun light.

Producing fuel with solar heat

Alxneit’s research is based on the principle of the thermo-chemical cycle, a term comprising both the cyclical process of chemical conversion and the heat energy required for it—referred to by experts as thermal energy. Ten years ago, researchers had already demonstrated the possibility of converting low-energy substances such as water and the waste product carbon dioxide into energy-rich materials such as hydrogen and carbon monoxide.

This works in the presence of certain materials such as cerium oxide, a combination of the metal cerium with oxygen. When subjected to very high temperatures above 1500 °C, cerium oxide loses some oxygen atoms. At lower temperatures, this reduced material is keen to re-acquire oxygen atoms. If water and carbon dioxide molecules are directed over such an activated surface, they release oxygen atoms (chemical symbol: O). Water (H2O) is converted into hydrogen (H2), and carbon dioxide (CO2) turns into carbon monoxide (CO), whilst the cerium re-oxidizes itself in the process, establishing the preconditions for the cerium oxide cycle to begin all over again.

The hydrogen and carbon monoxide created in this process can be used to produce fuel: specifically, gaseous or fluid hydrocarbons such as methane, petrol and diesel. Such fuels may be used directly but can also be stored in tanks or fed into the natural gas grid.

One process instead of two

Up to now, this type of fuel production required a second, separate process: the so-called Fischer-Tropsch Synthesis, developed in 1925. The European research consortium SOLAR-JET recently proposed a combination of a thermo-chemical cycle and the Fischer-Tropsch procedure.

However, as Alxneit explains: "although this basically solves the storage problem, considerable technical effort is necessary to carry out a Fischer-Tropsch Synthesis." In addition to a solar installation, a second industrial-scale technical plant is required.

Direct production of solar fuel now possible

By developing a material that allows the direct production of fuel within one process, the new approach developed by Ivo Alxneit and his colleagues dispenses with the Fischer-Tropsch procedure and hence also with the second step. This was accomplished by adding small amounts of rhodium to the cerium oxide. Rhodium is a catalyst that
Hydrogen News of Interest

enables certain chemical reactions. It has been known for some time that rhodium permits reactions with hydrogen, carbon monoxide and carbon dioxide.

"The catalyst is a pivotal research topic for the production of these solar fuels," says Alxneit. His PhD candidate at the PSI Fangjian Lin emphasizes: "It was a huge challenge to control the extreme conditions necessary for these chemical reactions and develop a catalyst material capable of withstanding an activation process at 1500 °C." During the cooling process, for example, the extremely small rhodium islands on the material surface must not be allowed to disappear or increase in size since they are essential to the anticipated catalytic process. The resulting fuels are either used or stored and the cyclical process begins again once the cerium oxide is re-activated.

Using various standard methods of structure and gas analysis, researchers working in laboratories at the PSI and the ETH in Zurich examined the cerium-rhodium compound, explored how well the reduction of the cerium oxide works and how successful methane production was. "So far, our combined process only delivers small amounts of directly usable fuel," concludes Alxneit. "But we have shown that our idea works and it's taken us from the realms of science fiction to reality."

Successful tests in high performance oven

During their experiments, researchers kept things simple by using a high performance oven at the ETH in place of solar energy. "In the test phase, the actual source of thermal energy is immaterial," explains Matthäus Rothensteiner, PhD-candidate at the PSI and the ETH Zurich whose area of responsibility included these tests.

Jeroen van Bokhoven, head of the PSI’s Laboratory for Catalysis and Sustainable Chemistry and Professor for Homogeneous Catalysis at the ETH Zurich adds: "These tests enabled us to gain valuable insights into the catalyst’s long-term stability. Our high performance oven allowed us to carry out 59 cycles in quick succession. Our material has comfortably survived its first endurance test." Having shown that their procedure is feasible in principle, researchers can now devote themselves to its optimization.

Air Products open $300 million hydrogen plant in western Canada

Air Products said it has opened a $300 million hydrogen production plant in western Canada. The company’s Air Products Canada Ltd. subsidiary dedicated the facility Thursday with a ribbon-cutting ceremony.

The plant, less than 20 miles northeast of Edmonton, Alberta, is tied into about 30 miles of existing pipelines linking it to production customers and two other Air Products’ plants, according to the company.

"This plant and its connection to our pipeline network are key to meeting the growing hydrogen demands of our customers located in Alberta’s Industrial Heartland," Marie Ffolkes, president of Air Products’ Industrial Gases-Americas, said in a news release. She said Air Products is the top provider of the gas in western Canada.

Hydrogen is widely used in oil refining to remove such impurities as sulfur that are found in crude oil. Hydrogen has been found to be a key component in producing cleaner fuels. In addition to hydrogen, the plant, which employs about 20 people, creates carbon dioxide that is vented into the atmosphere.

Air Products also has a hydrogen pipeline in Ontario, and operates the world’s largest hydrogen pipeline network in the U.S. Gulf Coast. It also has pipeline systems in California and Rotterdam, Netherlands.

Trexlerstown’s Air Products, which will release its quarterly earnings July 28, is the world’s leading global hydrogen seller and supplier of liquefied natural gas process technology and equipment.

Hydrogen News of Interest

Key improvement for fuel cells: Work improves understanding of process that stops reactions

Washington State University researchers have determined a key step in improving solid oxide fuel cells (SOFCs), a promising clean energy technology that has struggled to gain wide acceptance in the marketplace.

The researchers determined a way to improve one of the primary failure points for the fuel cell, overcoming key issues that have hindered its acceptance. Their work is featured on the cover of the latest issue of *Journal of Physical Chemistry C*.

Fuel cells offer a clean and highly efficient way to convert the chemical energy in fuels directly into electrical energy. They are similar to batteries in that they have an anode, cathode and electrolyte and create electricity, but they use fuel to create a continuous flow of electricity.

Fuel cells can be about four times more efficient than a combustion engine because they are based on electrochemical reactions, but researchers continue to struggle with making them cheaply and efficiently enough to compete with traditional power generation sources.

An SOFC is made of solid materials, and the electricity is created by oxygen ions traveling through the fuel cell. Unlike other types of fuel cells, SOFCs don’t require the use of expensive metals, like platinum, and can work with a large variety of fuels, such as gasoline or diesel fuel.

When gasoline is used for fuel, however, a carbon-based material tends to build up in the fuel cell and stop the conversion reaction. Other chemicals, in particular sulfur, can also poison and stop the reactions.

In their study, the WSU researchers improved understanding of the process that stops the reactions. Problems most often occur at a place on the anode’s surface, called the triple-phase boundary, where the anode connects with the electrolyte and fuel.

The researchers determined that the presence of an electric field at this boundary can prevent failures and improve the system’s performance. To properly capture the complexity of this interface, they used the Center for Nanoscale Materials supercomputer at the Argonne National Laboratory to perform computations.

The researchers studied similar issues in solid oxide electrolysis cells (SOECs), which are like fuel cells that run in reverse to convert carbon dioxide and water to transportation fuel precursors.

The work provides guidance that industry can eventually use to reduce material buildup and poisoning and improve performance of SOFCs and SOECs, said Jean-Sabin McEwen, assistant professor in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering, who led the project.

The research is in keeping with WSU’s Grand Challenges, a suite of research initiatives aimed at large societal issues. It is particularly relevant to the challenge of sustainable resources and its theme of energy.

Source: [https://www.sciencedaily.com/releases/2016/07/160718142218.htm](https://www.sciencedaily.com/releases/2016/07/160718142218.htm)

Ballard Power Systems signs fuel cell factory deal with China

Burnaby-based Ballard Power Systems Inc. has signed an agreement to manufacture its hydrogen fuel cells under license in China, a deal worth $168 million over five years, the company said Monday.

News of the deal sparked a 40 percent increase in Ballard’s share price, though the transaction isn’t expected to close until late in 2016 and revenue won’t start flowing back to Ballard until late 2017.

In the meantime, Ballard continues to rack up losses—$10 million in the first quarter of 2016, compared with $7 million in the same quarter a year ago—despite rising revenue. The company reported its second-quarter results July 27.

The manufacturing agreement will see Ballard and Chinese firm Guangdong Nation Synergy Hydrogen Power Technology Co. Ltd. form a joint venture to produce fuel-cell stacks at a facility in Yunfu, a city north west of Hong Kong. The stacks will be installed in hydrogen-powered buses and trucks in what is becoming one of the
world’s largest markets for zero-emission heavy-duty vehicles powered buses and trucks in what is becoming one of the world’s largest markets for zero-emission heavy-duty vehicles.

Guangdong Nation Synergy will pay Ballard $18.4 million for the transfer of technology, purchase of equipment, procurement services and training, then at least $150 million over five years—starting in 2017—to buy key components from Ballard on a “take-or-pay” basis as the plant’s exclusive supplier.

Under the terms, Ballard will contribute $3 million to development of the joint venture and will own a 10-per-cent stake in the operation.

“We would describe it as a landmark, not just for (Ballard) but for development of the Chinese market,” Ballard CFO Tony Guglielmin said in an interview.

The arrangement will involve the production of a “significant volume” of fuel cells, Guglielmin said, though his company declined to state a number citing confidentiality.

And while the assembly of fuel cells is to take place in Yunfu, Ballard will manufacture their core components—called membrane electrode assemblies—at its plant in Burnaby.

Final assembly in China allows the joint venture to avoid some import duties in China as well as allowing it to take advantage of local subsidies for zero-emission vehicles, Guglielmin said.

“This deal is transformational in terms of positioning fuel cells as a compelling solution for clean energy buses and commercial vehicles in China’s high-population cities where air quality is a top priority,” Guangdong Nation Synergy Chairman Frank Ma said in a news release.

For Ballard, the manufacturing agreement is the latest in a string of deals it has made in China, where the government has put a priority on curbing emissions in its transportation sector.

On the business side, however, the prospect of Ballard breaking even after a long string of losses is still a bit further into the distance.

Guglielmin said that with the 20 to 30 per cent annual growth rate the company is experiencing, combined with its cost-control efforts, that could be in 2017 or 2018.

“I don’t want to get too specific, but certainly over the next couple of years we’re going to get extremely close, if not profitable, based on this transaction and other things we’re working on,” Guglielmin said.


Reports show smart cities, energy storage, and fuel cell vehicles are on the rise globally

Reports from Navigant Research highlight the expansion of the low-carbon economy

Within the next decade, the adoption of a low-carbon economy throughout the world will have made major strides. This is according to new reports from Navigant Research. The reports highlights the significant growth that has been seen in four sectors within the emerging low-carbon economy. These sectors are smart city development, energy storage deployment, the adoption of fuel cell vehicles, and the sale of clean powertrains for heavy-duty vehicles.

Smart cities are becoming more prominent, thanks especially to energy storage systems

A smart city is an urban development that incorporates many new technologies in order to make the city itself more efficient and capable of meeting the needs of residents. According to Navigant Research, smart cities have the potential to generate $36.8 billion in revenue this year. This will leap to $88.7 billion in revenue by 2025. These smart cities will be made more efficient through the adoption of efficient energy storage solutions. Navigant Research predicts that energy storage deployment in major markets will reach 62 gigawatts within the next 10 years.

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Fuel cell vehicles are becoming more popular

One of the reports from Navigant Research highlights the continued rise of fuel cell vehicles. These vehicles are
becoming more popular by the day, with many major automakers planning to launch new fuel cell vehicles within the next year or two. The report from Navigant Research predicts that the number of fuel cell vehicles, including buses, that will be available throughout the world will reach 580,000 by 2024, and 800,000 by 2026. These vehicles may soon become the crux of clean transportation throughout the world.

**Fuel cell vehicles may take over every sector of transportation**

As transportation continues to evolve, fuel cells are moving beyond industrial uses and consumer transit. Hydrogen fuel cells are beginning to see significant use in heavy-duty transportation. These energy systems are expected to play a much larger role in heavy-duty transportation in the coming years. As such, fuel cell vehicles are set to expand into every sector of transportation within the next decade.


**UK ban on wind energy subsidies could hurt the Scottish wind sector**

Scottish officials seek to remove ban on wind subsidies

The United Kingdom is being urged to reconsider its ban on wind energy subsidies. This ban concerns onshore projects and severely limits the financial aid that energy developers can tap into when building new projects in the country. The ban on wind subsidies may be having a very detrimental impact on Scotland, in particular. The Scottish government suggests that the ban on wind energy subsidies will cost Scotland some $3.9 billion and make some environmental goals impossible to attain.

The wind industry has been growing in Scotland for many years

Wind energy has long received support from the UK government. Onshore projects, in particular, had been receiving strong financial support for years. According to Bloomberg New Energy Finance, wind power represents the least expensive form of energy production in the UK. In Scotland, wind is particularly attractive, as the breadth of Scottish coastlines are ideal locations for wind farm due to strong wind currents. In Scotland, the wind industry supports approximately 21,000 jobs and brings in more than $1.3 billion in annual investments.

Scotland hopes to see more clarity in plans to support wind energy in the future

Scottish officials are now urging the overall government to reconsider the ban on wind energy subsidies. At the very least, Scottish officials hope that the government will clarify what steps will be taken to support the wind sector in the future. Without a clear plan, the ban on wind subsidies could have a very prominent and harmful impact on the wind sector in Scotland. This impact could stagnate growth for some time and decrease investments as investors lose confidence in the financial stability of the wind sector.

Offshore wind projects will continue to receive financial aid

While the ban on wind subsidies has caused concern in Scotland, the ban only affects onshore projects. Offshore wind energy projects will retain a degree of financial aid. These projects have also established a strong foothold in Scotland, which has quickly become an attractive home for offshore wind farms. These energy systems have the potential to generate large quantities of energy, surpassing their onshore counterparts. This is because of their ability to take advantage of the strong wind currents that can be found at sea.

Grass grows as a surprise source of hydrogen fuel

The grass is always greener on the other side, as the saying goes, and this may prove especially true if a team of scientists can build on a promising early breakthrough. Researchers from Cardiff University have come up with a way to unlock hydrogen from fescue grass, raising the possibility of using turf to power life on Earth.

Hydrogen has long been recognized as a hugely promising alternative to fossil fuels because of its high energy content and the fact that it doesn’t to spew greenhouse gases into the atmosphere when it’s burnt. But sourcing the fuel isn’t so environmentally-friendly, involving processes that are themselves expensive and carbon intensive, such as natural gas or coal reforming.

This has led scientists to hunt for hydrogen that can be extracted more cheaply and cleanly, such as that lying beneath the ocean floor, within wastewater, and now possibly fescue grass, a plant that can be found on every continent other than Antarctica.

One potential way scientists are looking to open up the hydrogen floodgates is by focusing on cellulose, an important organic compound key to the cell wall structures of green plants. The Cardiff team partnered with researchers from Queen’s University Belfast to explore how cellulose could be converted into hydrogen with a little help from sunlight and a catalyst, through a process known as photocatalysis.

In its experiments, the team used three metal-based catalysts—palladium, gold and nickel, with the latter of particular interest to the researchers due to its relative abundance and affordability. The team mixed the three catalysts with cellulose in a flask and placed it under a desk lamp, taking gas samples from the mix every 30 minutes to check how much hydrogen it was generating. The experiment was then recreated using the fescue grass taken from a domestic garden.

“Our results show that significant amounts of hydrogen can be produced using this method with the help of a bit of sunlight and a cheap catalyst,” explains Cardiff’s Professor Michael Bowker, co-author of the study. “Furthermore, we’ve demonstrated the effectiveness of the process using real grass taken from a garden. To the best of our knowledge, this is the first time that this kind of raw biomass has been used to produce hydrogen in this way. This is significant as it avoids the need to separate and purify cellulose from a sample, which can be both arduous and costly.”

Source: http://www.gizmag.com/grass-hydrogen-fuel/44497/

Hydrogenics to bolster hydrogen fuel production in Thailand

Hydrogenics, a leading developer of hybrid hydrogen fuel production technology, has been awarded a role in helping develop Southeast Asia’s first renewable hydrogen fuel storage system and power plant. The project is being headed by Pharam 2 Civil Engineering and is backed by the Electricity Generation Authority of Thailand. This project will seek to generate hydrogen through the use of renewable energy. This hydrogen will then be used to generate electrical power through fuel cells.

Hydrogenics to deliver innovative hybrid technology to Thailand

Hydrogenics has extensive experience in the field of renewable hydrogen fuel production. The company is a pioneering in using solar energy to produce hydrogen, developing a hybrid system that is cost efficient and cost effective. The company will be delivering its 1 megawatt electrolyser to the project, which is based in Thailand. The technology provided by Hydrogenics will be incorporated into the fuel cell power plant and storage system that is being built. The project will use Hydrogenics’ technology to facilitate hydrogen fuel production through the use of wind energy. This energy will be provided to the project during off-peak hours, when demand for electricity is lowest.

Renewable hydrogen fuel production is becoming more important

Fuel cells are quickly gaining popularity as primary energy systems. For years, these energy systems have been used for industrial purposes, but have seen little application in other sectors. Now, however, fuel cells have established a foothold in the residential space as well as in transportation. The growing popularity of fuel cells is attracting
more attention to hydrogen fuel production. Current production methods rely heavily on fossil-fuels and are considered somewhat expensive and inefficient. This is why renewable energy is becoming a greater priority when it comes to hydrogen production.

Company has made significant progress with its hybrid technology

Hydrogenics has extensive history in using clean energy to produce hydrogen. The company has made major strides in making renewable hydrogen production more efficient and attractive in recent years. Hydrogenics is currently participating in several projects focused on the expansion of hydrogen production and has reached many new milestones with its innovative production technologies.


Nissan and Ceres Power team to promote solid oxide fuel cells

New agreement to benefit clean transportation in the United Kingdom

Japanese automaker Nissan has announced that it has finalized an agreement with Ceres Power, a developer of fuel cell technology. Per the agreement, both organizations are to work together to improve clean vehicles, increasing their performance and efficiency. The deal is taking advantage of funding being offered by Innovate UK and the Office of Low Emission Vehicles. The funding is part of a larger initiative to improve clean vehicles and promote clean transportation throughout the United Kingdom.

Solid oxide fuel cells will be based on technology developed by Ceres Power

Ceres Power is a leader of a consortium, along with Nissan. Through this consortium, the two companies are working to develop compact, on-board solid oxide fuel cells. These energy systems will initially serve as range extenders for electric vehicles, allowing them to travel long-er before needing to be charged. Eventually, these fuel cells could be used to power a vehicle by themselves. The solid oxide fuel cells will be based on technology already developed by Ceres Power. The technology is “fuel agnostic,” meaning that diesel, natural gas, hydrogen, and other fuels can be used by the system to generate electrical power.

Fuel agnostic fuel cells could be a boon for the auto industry

Ceres Power believes that its fuel cell system will be much easier to deploy than conventional hydrogen fuel cells. Fuel cells that consume hydrogen have become popular in the auto industry, but interest in these energy systems is relatively low among consumers. This is partly due to the high cost of fuel cells and the low availability of hydrogen fuel. The lack of a hydrogen infrastructure has slowed plans to deploy fuel cell vehicles. A fuel agnostic fuel cell system can help relieve some of the deployment pressure that automakers are experiencing.

Nissan is growing more involved in clean transportation

Nissan has long held an interest in clean technology. The company has primarily been focused on using batteries to power its zero emission vehicles, however. Fuel cells are becoming more attractive, especially those that can use a variety of fuels to generate electricity. Solid oxide fuel cells, in particular, could become a strong focus for the automaker in the future.


Oceans may be large, overlooked source of hydrogen gas

Rocks formed beneath the ocean floor by fast-spreading tectonic plates may be a large and previously overlooked source of free hydrogen gas (H₂), a new Duke University study suggests.

The finding could have far-ranging implications since scientists believe H₂ might be the fuel source responsible for triggering life on Earth. And, if it were found in large
enough quantities, some experts speculate that it could be used as a clean-burning substitute for fossil fuels today because it gives off high amounts of energy when burned but emits only water, not carbon.

Recent discoveries of free hydrogen gas, which was once thought to be very rare, have been made near slow-spreading tectonic plates deep beneath Earth’s continents and under the sea.

“Our model, however, predicts that large quantities of H\textsubscript{2} may also be forming within faster-spreading tectonic plates—regions that collectively underlie roughly half of the Mid-Ocean Ridge,” said Stacey L. Worman, a postdoctoral fellow at the University of Texas at Austin, who led the study while she was a doctoral student at Duke’s Nicholas School of the Environment.

Total H\textsubscript{2} production occurring beneath the oceans is at least an order of magnitude larger than production occurring under continents, the model suggests.

“A major benefit of this work is that it provides a testable, tectonic-based model for not only identifying where free hydrogen gas may be forming beneath the seafloor, but also at what rate, and what the total scale of this formation may be, which on a global basis is massive,” said Lincoln F. Pratson, professor of earth and ocean sciences at Duke, who co-authored the study.

The scientists published their peer-reviewed study in the July 14 online edition of the journal *Geophysical Research Letters*.

The new model calculates the amount of free hydrogen gas produced and stored beneath the seafloor based on a range of parameters—including the ratio of a site’s tectonic spreading rate to the thickness of serpentinized rocks that might be found there.

Serpentinized rocks—so called because they often have a scaly, greenish-brown-patterned surface that resembles snakeskin—are rocks that have been chemically altered by water as they are lifted up by the spreading tectonic plates in Earth’s crust.

Molecules of free hydrogen gas are produced as a byproduct of the serpentinization process.

"Most scientists previously thought all hydrogen production occurs only at slow-spreading lithosphere, because this is where most serpentinized rocks are found. Although faster-spreading lithosphere contains smaller quantities of this rock, our analysis suggests the amount of H\textsubscript{2} produced there might still be large," Worman said.

"Right now, the only way to get H\textsubscript{2}—to use in fuel cells, for example—is through secondary processes," Worman explained. "You start with water, add energy to split the oxygen and hydrogen molecules apart, and get H\textsubscript{2}. You can then burn the H\textsubscript{2}, but you had to use energy to get energy, so it’s not very efficient."

Mining free hydrogen gas as a primary fuel source could change that, but first scientists need to understand where the gas goes after it’s produced. "Maybe microbes are eating it, or maybe it’s accumulating in reservoirs under the seafloor. We still don’t know," Worman said. "Of course, such accumulations would have to be quite significant to make hydrogen gas produced by serpentinization a viable fuel source."

If further research confirms the model’s accuracy, it could also open new avenues for exploring the origin of life on Earth, and for understanding the role hydrogen gas might play in supporting life in a wide range of extreme environments, from the sunless deep-sea floor to distant planets.

Worman and Pratson conducted the study with Jeffrey Karson, professor of earth sciences at Syracuse University, and Emily Klein, professor of earth sciences at Duke.

Worman received her Ph.D. in earth and ocean sciences from Duke in 2015.

Source: [https://www.sciencedaily.com/releases/2016/07/160720122844.htm](https://www.sciencedaily.com/releases/2016/07/160720122844.htm)
**History and past activities of The Young Scientist Division**

The Young Scientist Division (YSD) was born in 2009 in the framework of HY-SYDAYS (World Congress of Young Scientists on Hydrogen Energy Systems). The YSD shares the same mission of the IAHE in striving to advance the hydrogen energy as the principal mean to achieve the goal of an abundant and clean energy for mankind. To stimulate the exchange of information in hydrogen energy field, the Young Scientists Division organizes international conferences, workshops, short courses and researcher exchange programs, and promotes activities that inform the general public of the important role of hydrogen energy in the planning of an inexhaustible and clean energy system.

The YSD has organized:

- 2010-1st Meeting of the Founding Committee-Rome, Italy-H2Roma Congress
- 2012-Mini-Symposium for Young Scientists-Toronto, Canada-19th WHEC
- 2014-2nd Young Scientists Symposium (YSS)-Gwangju, Korea-20th WHEC
- 2014-Special Issue of International Journal on Hydrogen Energy (IJHE)

**Presence of the YSD at the WHEC 2016 in Zaragoza (Spain)**

With the aim of promoting the activities of this division and recruiting new members we held three important presentations at the WHEC 2016 in Zaragoza (Spain). We had the chance to participate at the following panels:

- IAHE Board Meeting
- IAHE Advisory Board Meeting
- Plenary Session 4: Cross-cutting Initiatives and Upcoming Events

By participating in these panels we were able to make contact with the scientific organizers of WHEC 2018 in Rio de Janeiro, Brazil. We received confirmation of the support of IAHE members in the organization of a Young Scientist Symposium in Rio within the next WHEC. We also informed scientists from all over the world about how to become a member of the YSD.

**Future events**

We encourage you to participate in the following two future events we are organizing:

- Meeting: “Young Scientists—a key for the future of hydrogen system” inside H2R at Ecomondo that is held every year in Rimini, Italy (November 2017).
- The 3rd Young Scientists Symposium—22nd WHEC 2018—Rio de Janeiro, Brazil.

For any additional information contact us at: iahe.young.division@gmail.com
The *International Journal of Hydrogen Energy* provides scientists and engineers throughout the world with a central vehicle for the exchange and dissemination of basic ideas in the field of hydrogen energy. The emphasis is placed on original research, both analytical and experimental, which is of permanent interest to engineers and scientists, covering all aspects of hydrogen energy, including production, storage, transmission, utilization, as well as the economical, environmental and international aspects. When outstanding new advances are made, or when new areas have been developed to a definitive stage, special review articles will be considered. As a service to readers, an international bibliography of recent publications in hydrogen energy is published quarterly.

**Most Cited IJHE Articles (past 5 years)**

1. **A comprehensive review on PEM water electrolysis**

2. **Nanoscale and nano-structured electrodes of solid oxide fuel cells by infiltration: Advances and challenges**

3. **Non precious metal catalysts for the PEM fuel cell cathode**

4. **Hydrogen from renewable electricity: An international review of power-to-gas pilot plants for stationary applications**

5. **An overview of hydrogen safety sensors and requirements**

6. **Pd-Ni electrocatalysts for efficient ethanol oxidation reaction in alkaline electrolyte**

7. **Progress in sodium borohydride as a hydrogen storage material: Development of hydrolysis catalysts and reaction systems**

**Top IJHE Downloads (May–July 2016)**

1. **Hydrogen and fuel cell technologies for heating: A review**

2. **A comprehensive review on PEM water electrolysis**

3. **Metal hydride materials for solid hydrogen storage: A review**

4. **Review of the proton exchange membranes for fuel cell applications**

5. **Changing the fate of Fuel Cell Vehicles: Can lessons be learnt from Tesla Motors?**

6. **Hydrogen from renewable electricity: An international review of power-to-gas pilot plants for stationary applications**

7. **Progress of electrochemical capacitor electrode materials: A review**
A stable and efficient photocatalytic hydrogen evolution system based on covalently linked silicon-phthalocyanine-graphene with surfactant

Production of hydrogen via light-driven water splitting has been a topic of research since the 1970s when it was first demonstrated with a Titanium dioxide electrode. This article demonstrates the effectiveness of novel graphene-organic hybrid electrodes that use covalently bonded organic moieties to increase catalytic activity in water splitting. Phthalocyanine (Pc) and silicon phthalocyanine (SiPc) were used on account of their excellent electronic and optical properties. Covalently functionalized graphene has been shown to be more stable, efficient and more catalytic than non-covalently bonded graphene. The paper outlines the process of material preparation, which included graphene, graphene/Pt, SiPc(phenyl)-NFG (non-covalently functionalized graphene), SiPc(phenyl)$_2$G$_2$, and SiPc(phenyl)$_2$G$_2$/Pt. Characterization was done on the morphology of the different samples via SEM, TEM, and AFM, while composition was analyzed with Raman, EDX, and FTIR. Photoelectrochemical performance was analyzed in a three-electrode system with the catalysts coated on an indium tin oxide (ITO) electrode. Catalysts were tested with both UV-vis and visible light irradiation. The SiPc(phenyl)$_2$G$_2$/Pt catalyst proved to be the top performer in terms of charge transfer resistance (determined via impedance spectroscopy) and photocurrent response (i.e. hydrogen production; measured with potentiostat). The catalysts were compared on the metric of molar hydrogen production over time with the platinum doped catalyst having the highest performance. The SiPc(phenyl)$_2$G$_2$/Pt catalyst, being the best performer, was also given the treatment of a Pt weight percentage loading optimization experiment. This catalyst also showed relatively strong durability over multiple cycles.


A comparison of evaporative and liquid cooling methods for fuel cell vehicles

Polymer electrolyte membrane fuel cells (PEMFC) have emerged as a promising technology for transportation and vehicle applications. However, before the widespread uptake of hydrogen fuel cell vehicles, several issues needs to be addressed. One such issue is designing an effective waste heat removal system.

The low exhaust heat flow of PEMFCs compared to the internal combustion engine (IC) means that, despite higher efficiencies, the heat rejected to the cooling system is higher in fuel cell vehicles. This combined with lower operating temperatures, limited by the boiling point of water, creates a significant demand on the vehicle thermal management system. Fuel cell cooling can generally be split into three categories, air cooling, liquid cooling and cooling through phase change.

In this paper, a full system simulation has been provided and a conventional liquid cooled fuel cell system has been compared to two types of evaporatively cooled fuel cell systems. Both steady state and transient operation are considered. Results show the radiator frontal area required to achieve thermal and water balance for an evaporatively cooled system with an aluminum condensing radiator is 27% less than a conventional liquid cooled system at 1.25 A/cm$^2$ steady state operation. The primary reason for the reduction is higher heat transfer coefficients in the condensing radiator due to phase change. It is also shown that the liquid water separation efficiency has a significant influence on the required radiator frontal area of the evaporatively cooled system.

Compendium of Hydrogen Energy Vol. 2: Hydrogen Storage, Distribution and Infrastructure
-Edited by: Ram Gupta, Angelo Basile, T. Nejat Veziroglu

This volume is a follow-up to the first volume (highlighted in last summer’s IAHE newsletter), which focused on hydrogen production and purification. The new volume, which is the second in a four volume set, turns its focus to different methods used in storage and distribution, which lend themselves to the implementation of a Hydrogen economy’s infrastructure. The first chapter introduces the reader to a brief background in motivation for hydrogen as an energy carrier, before a cursory introduction to the different hydrogen storage methods that exist and are proposed, i.e. compressed gas phase $\text{H}_2$, cryo-compressed $\text{H}_2$, metal hydride storage and chemical storage. The following two chapters look at hydrogen storage in pure form covering the theoretical background, proposed uses, energy requirements/pros and cons regarding production and distribution of liquefied hydrogen, slush hydrogen. These concepts lend themselves to chapter 4 where underground and pipeline hydrogen storage is outlined. Part 2 of the book gives a similar treatment to the various physical and chemical storage techniques such as adsorption on carbon nanostructure, carbohydrates, and metal-organic frameworks for hydrogen storage. Part 3 of the book is dedicated to infrastructure where transportation of hydrogen via pipelines and other means are covered. Technical difficulties in implementation are also covered, while the last few chapters are dedicated to discussing the building blocks and progression to realize a hydrogen infrastructure.

—Cyrus Daugherty

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.

- **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.
Laboratory for Electrochemical Interfaces focuses on the development of the next generation of high-efficiency devices for energy conversion and information processing, based on solid state ionic-electronic materials including:

- Efficient and durable solid oxide fuel cells
- Redox based memristive information storage and logic
- Efficient and durable thermo/electro-chemical splitting of water and CO₂
- High energy density and high power density solid state batteries
- Corrosion resistant films in a wide range of extreme environments as in nuclear energy generation, concentrated solar energy, and oil exploration

The development of in-situ scanning tunneling spectroscopy and x-ray spectroscopy methods in conjunction with first-principles calculations and novel atomistic simulations are the fundamental tools adopted in this lab for conducting cutting-edge research.

The main research areas:

**Material Aging in Nuclear Power and Oil Exploration Infrastructures**

- Hydrogen absorption, transport and trapping in surface passive films
- Degradation of nuclear fuel cladding via corrosion and radiation damage
- Deformation-enhanced corrosion reactivity on metal surfaces
- Long time-scale simulations of microstructure evolution

**Material Activation in Solid Oxide Fuel / Electrolysis Cells**

- In situ investigation of the surface activity of model electrode thin films
- Strain and hetero-interface effects on surface chemistry, electronic structure and reactivity on model electrode and electrolyte thin films
- Effect of oxygen defect concentrations on the stress state of oxide thin films

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Press Release

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No. 4 July 4, 2016

Fuel cell and battery: Tesla, CATARC and METI present differentiated international markets and market requirements for e-mobility at the WORLD OF ENERGY SOLUTIONS 2016 conference and trade fair.

With ambitious targets for electric mobility, Japan and China are currently driving the organisation of their national vehicle markets forward. In March 2016, for the first time the Japanese government published its goals for the structure of hydrogen mobility: 40,000 fuel cell vehicles will be registered by the 2020 Olympic Games in Tokyo. In addition, 160 hydrogen-fuelling stations will be in operation. From the Chinese perspective, activities are focused on increasing the current manufacturing capacities: In the first four months of the year, China manufactured 78,000 “New Energy Vehicles” – battery- and fuel cell-powered electric vehicles and plug-in hybrids. In April 2016 alone, 10,400 buses and 21,000 cars with alternative drives were manufactured. The manufacturing ramp-up will be complemented in China by the expansion of the infrastructure of recharging stations; incentive programs for municipal fleet providers and consumers as well as an innovation platform for the development of high-performance drive batteries. According to the federal China Automotive Technology & Research Centers (CATARC), in future the average fleet consumption for the automobile manufacturers will be limited in such a manner that it will be mandatory to include New Energy Vehicles into the product portfolio.

“China is now taking its urban environmental problems very seriously and is redefining its industry and research landscape. Both in the hydrogen and fuel cell technologies as well as in the further development of battery-driven systems, the emission-free drives for cars and busses are being advanced. The combination of rigid pollutant regulations and attractive incentive systems is – in China and in leading European markets as well as the USA – the unavoidable way that needs to be taken in order to meet the requirements of the Paris World Climate Accord,” says Dr Klaus Bonhoff, National Organisation for Hydrogen and Fuel Cell Technology.

Which requirements and opportunities the increasing differentiation of the international market will have on both the aspiring new vehicle manufacturers such as Tesla as well as the European automobile manufacturers and machine engineering companies, will be the topic of discussions at the WORLD OF ENERGY SOLUTIONS 2016 with the prominently staffed conference plenum “International Markets”. Yuki Maehiro, METI, Ministry of Economy, Trade and Industry, presents the Japanese plans for hydrogen mobility turnaround. Cheng Wang, Vice Director of Beijing Operation, China Automotive Technology &
Research Center (CATARC) introduces the current development in the Chinese e-mobility market. Sunita Satyapal, Director of Fuel Cell Technologies of the Office of Energy Efficiency and Renewable Energy (EERE) in the Department of Energy, USA, explains the role of the fuel cell technology as a building block of the US energy and environmental policy. Diarmuid O’Connell, Vice President of Business Development at Tesla Motors, provides an outlook on the effects of the Tesla mega factory on the US and European car battery markets. Dr Jürgen Garche from FCBAT Consulting in Ulm (Germany) provides an outlook on the effects of the European markets for stationary battery storage and drive batteries for electric vehicles.

WORLD OF ENERGY SOLUTIONS 2016 builds the crucial bridge between mobility and energy transition. The conference and trade fair welcomes exhibitors from all relevant branches of industry and offers 21 topic-related conference sessions as well as 113 speeches made by international specialists on topics such as storage technologies, e-mobility, alternative drive systems, smart cities and manufacturing processes of batteries and fuel cells.

The current program can be viewed at: www.world-of-energy-solutions.com

WORLD OF ENERGY SOLUTIONS 2016

The 2016 WORLD OF ENERGY SOLUTIONS will be held in Stuttgart from October 10 – 12, 2016.

WORLD OF ENERGY SOLUTIONS combines the potentials and networks of the leading international companies and brings them to Stuttgart. The convergence of power generation, storage systems and mobility solutions along with the technologies and services related to the segments battery, hydrogen and f-cell applications are the main focus.

If you have any questions regarding the trade fair, booth space and side program, please contact Ms. Julia Krügeloh of Peter Sauber Agentur Messen und Kongresse GmbH, Tel. +49 711 656960-56, julia.kruegeloh@messe-sauber.de

If you have any questions regarding the conference and the sponsors, please contact Ms. Silke Frank of Peter Sauber Agentur Messen und Kongresse GmbH, Tel. +49 711 656960-55, silke.frank@messe-sauber.de

Press Contact:
Sybille Riepe, motum GmbH, Tel: +49 40 8079046-12, riepe@motum.net, www.world-of-energy-solutions.de;

Host: Peter Sauber Agentur Messen und Kongresse GmbH, Wankelstraße 1, 70563 Stuttgart
# Upcoming Meetings & Activities

## September 2016

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## April 2017

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## May 2017

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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.
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, manufacturers 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**

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.

**Fuel Cell Nation**
Fact-Based Analysis and Discussion of Clean Energy
http://blog.fuelcellnation.com/

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

**International Association for Hydrogen Energy (IAHE)**
- [http://www.iahe.org](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](http://www.elsevier.com/locate/he)