international association for hydrogen energy
Clean and Abundant Energy for Sustainability

Summer 2013 • Volume 5 • Issue 2 Electronic Newsletter

Commentary from the U.S. DOE Director of Fuel Cell Technologies

Intro

The need for clean, sustainable energy, combined with the need to reduce emissions, has come together to form a powerful global imperative—one that demands new technologies and new approaches for the way we produce and use energy.

Widespread use of hydrogen and fuel cells play a substantial role in a portfolio of clean energy technologies that will overcome key energy challenges. A study by the National Academies has shown that by 2050, fuel cell electric vehicles could provide the largest reduction in emissions and oil consumption of any advanced vehicles.[1] In addition, growing interest and investment among leading world economies, such as Germany, Japan, and South Korea, underscores the global market potential for these technologies.

The U.S. Department of Energy's Fuel Cell Technologies Office works to overcome the technological, economic, and institutional barriers to the widespread commercialization of hydrogen and fuel cells. The office addresses technical barriers through activities that span the full spectrum of basic research, pre-competitive applied R&D, and technology validation and demonstration.

Key R&D Accomplishments and Cost Reduction

Energy Department R&D investments have enabled significant advancement in the last few years—reducing the cost of automotive fuel cells by more than 35% since 2008 and more than 80% since 2002. Research activities have enabled a doubling of fuel cell durability— increasing from 950 hours in 2006 to 2,500 hours on the road in 2011—and a reduction in the amount of platinum needed by more than a factor of five since 2005. The current projected high-volume cost of automotive fuel cell systems is now down to $47/kW, well on the way to achieving the target of $30/kW, which will enable cost-parity with internal combustion engines. In addition, the Department's activities have resulted in more than 400 patents, nearly 40 commercial technologies now in the market, and more than 65 emerging technologies anticipated to be commercialized in the next 3 to 5 years.

Continued on page 2

[1] *Transitions to Alternative Transportation Technologies – A Focus on Hydrogen,* National Research Council of the National Academies, 2008, http://www.nap.edu/catalog.php?record_id=12222

IN THIS ISSUE

Contact Us:
IAHE, 5794 SW 40 St. #303, Miami, FL 33155, USA
Any questions on the E-Newsletter or IAHE? Email Matthew Mench at mmench@utk.edu

Early Market Success

The Department's investments have also acted as a catalyst for market success. With the support of the American Reinvestment and Recovery Act, over 1,300 fuel cells have been deployed with over 1.4 million hours of operation in emergency backup power and material handling equipment applications. These successful deployments led to more than 11,000 additional fuel cells on order or purchased with no additional government investment. By accelerating early adoption, the Energy Department is enabling the growth of a domestic manufacturing base, prompting additional private-sector investment, and helping drive down costs through economies of scale. That's true market transformation.

Challenges

While there has been significant progress in the hydrogen and fuel cell industry, there are specific challenges that still need to be overcome.

- More work is needed to reduce the cost of renewable hydrogen and technologies for hydrogen delivery and storage. Depending on the production technology, the cost of hydrogen from renewables can be more than $10/gallon gasoline equivalent (gge). We need to achieve a cost of $2 to $4/gge to be competitive with gasoline.
- Advancements need to be made in compression, storage, and dispensing technologies.
- Advanced low-pressure hydrogen storage is needed for the widespread commercialization of FCEVs across all vehicle platforms.

Fuel Cell Electric Vehicles

Fuel cell electric vehicles, or FCEVs, are a technology and fuel combination that can play a key role in our portfolio approach to reducing greenhouse gas emissions.

The Energy Department's National Fuel Cell Electric Vehicle Hydrogen Learning Demonstration deployed 183 FCEV vehicles and 254 hydrogen fueling stations across the country. Through this demonstration project, participating vehicles traveled 3.6 million miles in more than 500,000 trips. Additionally, the projected completed more than 33,000 refuelings and produced or dispensed more than 152,000 kg of hydrogen. These demonstrations have validated the status of several key technologies in integrated systems operating under real world conditions. Key results include demonstrating fuel cell system efficiency of up to 59% (double the efficiency of gasoline internal combustion engines), fuel cell system durability of 2,500 hours (about 75,000 miles), and a driving range of more than 250 miles between refueling. The program also validated one vehicle capable of achieving up to 430 miles on a single fill. Projects like these that bring real world data back to the lab enhance technology development and improve crucial elements that are important for commercialization.

Automakers have also reiterated support for FCEVs. A number of automakers like Hyundai, Daimler, Ford, Nissan, and Toyota have made announcements for commercial rollouts of FCEVs in the 2015–2017 timeframe.

Infrastructure

Over 9 million metric tons of hydrogen are produced annually in the U.S. and used primarily for the petroleum refining and fertilizer industries. About 95% of the hydrogen is produced from natural gas via the steam-methane reforming process. Over 1,200 miles of hydrogen pipelines exist and there are 60 hydrogen fueling stations in the United States, though most are not available to the public.

But infrastructure remains a key challenge to the widespread adoption of FCEVs. While there has been significant progress by fuel cell and vehicle developers, more work is needed to produce and deliver clean hydrogen at low cost.

H_2USA

Together with other Federal agencies, automakers, state government, academic institutions, and

Continued on page 3

additional stakeholders, the Energy Department has recently formed a public-private partnership called H_2USA to promote the widespread adoption of FCEVs by overcoming the hurdle of hydrogen infrastructure. The partnership's first actions will be to form a strategy to coordinate vehicle and infrastructure rollout, conduct situational assessment and analysis, and identify synergies and opportunities to leverage other alternative fueling infrastructure—such as natural gas—to enable cost reductions and economies of scale. They will also focus on identifying actions to incentivize early adopters and evaluating the business cases required for commercialization of FCEVs and hydrogen infrastructure technologies.

Current members of the H_2USA partnership include the American Gas Association, Association of Global Automakers, the California Fuel Cell Partnership, the Electric Drive Transportation Association, the Fuel Cell and Hydrogen Energy Association, GM, Hyundai Motor America, ITM Power, Massachusetts Hydrogen Coalition, Mercedes-Benz USA, Nissan North America Research and Development, Proton OnSite, and Toyota Motor North America. Although the initial focus has been on automakers, other stakeholders are welcome to join.

Conclusion

The Program's activities are aimed at achieving critical breakthroughs and advancing pre-competitive technologies. Due to the high-risk nature of this research, these areas would not be sufficiently funded by private industry in the absence of government support. These early public R&D efforts will help establish a strong foundation for industry-led efforts to make ongoing refinements and improvements as these technologies reach maturity and full commercialization. A longer-term effort in R&D for hydrogen fuel technologies is envisioned to enable the fullest realization of the benefits of fuel cell technologies.

—Written by Sunita Satyapal, Director, Fuel Cell Technologies Office

Biography of Sunita Satyapal

Sunita Satyapal is the Director of the Fuel Cell Technologies Office in the Office of Energy Efficiency and Renewable Energy (EERE) at the Department of Energy (DOE). In this capacity, she is responsible for the Office's overall strategy and execution, including oversight and coordination of approximately $100 million in research, development, demonstration, and deployment activities related to hydrogen and fuel cells.

After joining DOE in 2003, she served primarily as the Hydrogen Storage Team Lead until 2008. She then served as the Hydrogen Office's Chief Engineer and Deputy Director. For several years she has coordinated hydrogen and fuel cell activities across DOE, with other agencies as well as with international stakeholders, including with seventeen countries and the European Commission, through the International Partnership for Hydrogen and Fuel Cells in the Economy.

In addition to her time at DOE, she has more than twenty years of experience in academia, industry, and government, including at United Technologies Research Center and at UTC Fuel Cells in Connecticut. While in industry, she was responsible for managing research groups ranging from 15 to 50 scientists, engineers, and technicians covering a broad range of chemistry and energy technologies, including hydrogen and fuel cell research and development (R&D). She also served as business development manager to develop strategic R&D collaborations, both for government programs and international markets.

She received her Ph.D. from Columbia University and completed her postdoctoral work in Applied and Engineering Physics and Physical Chemistry at Cornell University.

HYDROGEN *news of interest*

New Endurance Record for Small Electric Unmanned Aerial Vehicle

Researchers at the U.S. Naval Research Laboratory (NRL) flew their fuel cell powered Ion Tiger unmanned aerial vehicle (UAV) for 48 hours and 1 minute on April 16-18 by using liquid hydrogen fuel in a new, NRL-developed, cryogenic fuel storage tank and delivery system. This flight shatters their previous record of 26 hours and 2 minutes set in 2009 using the same vehicle, but with gaseous hydrogen stored at 5000 psi.

Liquid hydrogen is three times more dense than 5000-psi compressed hydrogen. The cryogenic liquid is stored in a lightweight tank, allowing more hydrogen to be carried onboard to increase flight endurance. Success in flight requires developing a high quality, lightweight, insulated flight dewar for the cryogenic fuel, plus matching the boil-off of the cryogenic hydrogen to the vehicle fuel consumption.

"Liquid hydrogen coupled with fuel-cell technology has the potential to expand the utility of small unmanned systems by greatly increasing endurance while still affording all the benefits of electric propulsion," said Dr. Karen Swider-Lyons, NRL principal investigator.

Although long endurance is possible with conventional, hydrocarbon-fueled systems, these are usually loud, inefficient, and unreliable in this aircraft class. Similarly, small, electric, battery-powered systems are limited to only several hours of endurance.

To address the logistics of in-theater supply of liquid or gaseous hydrogen, NRL proposes in-situ manufacture of LH_2 for use as fuel. An electrolyzer-based system would require only water for feedstock, and electricity, possibly from solar or wind, to electrolyze, compress, and refrigerate the fuel.

The NRL liquid H_2 flight capability is being developed by NRL's Tactical Electronic Warfare and Chemistry Divisions, and is sponsored by the Office of Naval Research.

Fueled by liquid hydrogen (LH_2), the Ion Tiger unmanned aerial vehicle (UAV) completes a record flight time of 48 hours and 1 minute. The electric fuel cell propulsion system onboard the Ion Tiger has the low noise and signature of a battery-powered UAV, while taking advantage of high-energy hydrogen fuel and the high electric efficiency of fuel cells. (Credit: Image courtesy of Naval Research Laboratory)

HYDROGEN *news of interest*

Battery Low? Give Your Cell Phone Some Water

A power source for your cell phone can now be as close as the nearest tap, stream, or even a puddle, with the world's first water-activated charging device. Based on micro fuel cell technology developed at KTH Royal Institute of Technology in Stockholm, the MyFC PowerTrekk uses ordinary water to extend battery life for devices of up to 3 watts. Anders Lundblad, KTH researcher and founder of MyFC, says that the device can be powered by fresh or seawater. The water need not be completely clean.

"Our invention has great potential to accelerate social development in emerging markets," Lundblad says. "There are large areas that lack electricity, while mobile phones fulfil more and more vital functions, such as access to weather information or electronic payment." A USB connector attaches the compact PowerTrekk charger to the device. When plain water is poured onto a small disposable metal disc inside the unit, hydrogen gas is released and combines with oxygen to convert chemical energy into electrical energy. The resulting charge is enough to power an iPhone to between 25 and 100 percent of its battery capacity.

Lundblad has done research on micro fuel cells and small flat Proton Exchange Membrane (PEM) fuel cells for more than 15 years at the Department of Applied Electrochemistry at KTH. He says the business vision behind MyFC is to commercialize fuel cell technology and contribute to the development of environmental technology. He says the charger is the first step toward building fuel cells in laptops.

"The launch of our charger is a strategic move to gain wide acceptance of fuel cells throughout society," he says. "Our chargers may be considered expensive now; but in the longer term, as they reach a mass market, they would go down in price."

Fuel cells can already be found in electric cars, trucks and buses, and backup electrical power supply systems for hospitals and cogeneration plants. The process by which fuel cells generate electricity is considered to be safe and environmentally-friendly, and the only by-product is water vapor. The fuel cell system is passive and has no fans or pumps.

Lundblad says that fuel cell chargers are faster and more reliable than solar chargers. The main target groups for MyFC PowerTrekk are those who travel or live in remote areas of the world, outdoor enthusiasts and aid workers, he says. The charger is both a fuel cell and a portable battery, providing a direct power source as well as a storage buffer for the fuel. MyFC plans to open an online shop for its MyFC PowerTrekk product. The company has already sold the technology to users in China, Japan, the U.S. and much of Europe.

Source: http://www.sciencedaily.com/releases/2013/04/130418094803.htm

HYDROGEN *news of interest*

Fuel Cell breakthrough in UK improved power density by 30%

A major development in fuel cell performance has been made by the Enhanced Fuel Cell Systems project, a collaborative effort in the United Kingdom. The project, headed by Intelligent Energy, resulted in a power density increase of one of their test systems from 30kW to 40kW, a 30% increase. The feat is impressive because the increase was made without increasing the system mass or size. A key partner included Dyson Technology, which developed a compact, high-efficiency compressor for air delivery to the stack. The systems were then assessed by TRW Conekt and Ricardo for integrity under adverse conditions and compliance with automotive specifications. A second key outcome of the project provided consistent cold-start performance of the stack at temperatures as low as -20°C via the development of a new coolant module. These key improvements assist in the steps towards commercialization of fuel cell systems for automotive applications.

Source: http://www.renewableenergyfocus.com/view/31864/uk-consortium-delivers-enhanced-fuel-cell-systems-in-collaborative-project/

Join IAHE—*membership Information*

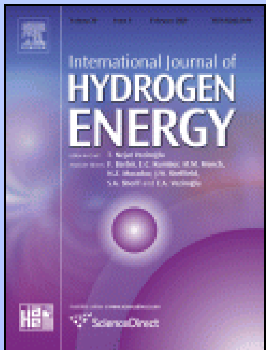
The International Association for Hydrogen Energy (IAHE) has five categories of membership:

- **Members:** Professional persons who are active in fields relating to some aspect of Hydrogen Energy
- **Associate Members:** Laypersons who may have in interest in Hydrogen Energy
- **Emeritus Members:** Persons who are in a retired status and have no income other than retirement payment.
- **Student Members:** All undergraduate, graduate, and postdoctoral students with an interest in Hydrogen Energy.
- **IAHE Fellows:** Long-time IAHE members who have significantly impacted society by promotion of Hydrogen Economy through research, education and/or service.

Membership benefits include a no-cost subscription to the International Journal of Hydrogen Energy, savings on all IAHE publications, and reduced registration fees for workshops, symposia and conferences organized by IAHE.

If you are interested in becoming a member of IAHE, please visit the membership page at http://www.iahe.org/membership.asp?membertype=1. You can sign up for membership directly on the membership page.

INTERNATIONAL JOURNAL of HYDROGEN ENERGY *highlights*



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

1. **Progress of electrochemical capacitor electrode materials: A review**
   Zhang Y, Feng H, Wu X, Wang L, Zhang A, Xia T, Dong H, Li X, Zhang L. Int J Hydrogen Energy 2009;34(11):4889–4899.
2. **Biohydrogen as a renewable energy resource—prospects and potentials**
   Meher Kotay S, Das D. Int J Hydrogen Energy 2008;33(1):258–263.
3. **Factors influencing fermentative hydrogen production: A review**
   Wang J, Wan W. Int J Hydrogen Energy 2009;34(2):799–811.
4. **Potential importance of hydrogen as a future solution to environmental and transportation problems**
   Balat M. Int J Hydrogen Energy 2008;33(15):4013–4029.
5. **Hydrogen storage in Mg: A most promising material**
   Jain IP, Lal C, Jain A. Int J Hydrogen Energy 2010;35(10):5133–5144.
6. **"Green" path from fossil-based to hydrogen economy: An overview of carbon-neutral technologies**
   Muradov N, Veziroğlu TN. Int J Hydrogen Energy 2008;33(23):6804–6839.
7. **Advances in biological hydrogen production processes**
   Das D, Veziroğlu TN. Int J Hydrogen Energy 2008;33(21):6046–6057.

Top IJHE Downloads (March 2013—May 2013)

1. **Metal hydride materials for solid hydrogen storage: A review.**
   Sakintuna B, Lamaridarkrim F, Hirscher M. Int J Hydrogen Energy 2007;32(9):1121–1140.
2. **A comprehensive review on PEM water electrolysis.**
   Carmo M, Fritz DL, Mergel J, Stolten D. Int J Hydrogen Energy 2013;38(12):4901–4934.
3. **Review of the proton exchange membranes for fuel cell applications.**
   Peighambardoust SJ, Rowshanzamir S, Amjadi M. Int J Hydrogen Energy 2010;35(17):9349–9384.
4. **Progress of electrochemical capacitor electrode materials: A review.**
   Zhang Y, Feng H, Wu X, Wang L, Zhang A, Xia T, Dong H, Li X, Zhang L. Int J Hydrogen Energy 2009;34(11):4889–4899.
5. **Production of hydrogen from renewable resources and its effectiveness.**
   Bičáková O, Straka P. Int J Hydrogen Energy 2012;37(16):11563–11578.
6. **Hydrogen production by biological processes: a survey of literature.**
   Das D, Veziroğlu TN. Int J Hydrogen Energy 2001;26(1):13–28.
7. **Photo-electrochemical hydrogen generation from water using solar energy. Materials-related aspects.**
   Bak T, Nowotny J, Rekas M, Sorrell CC. Int J Hydrogen Energy 2002;27(10):991–1022.

Phase and morphology evolution study of ball milled Mg-Co hydrogen storage alloys

-Shao H, Matsuda J, Li H-W, Akiba E, Jain A, Ichikawa T, Kojima Y. Int J Hydrogen Energy 2013;38(17):7070–7076.

In this work, the phase and morphology evolution process of $Mg_{50}Co_{50}$ alloys ball milled for 0.5 h-400 h was studied by X-ray diffraction and scanning electron microscopy. Also, the formation mechanism of the $Mg_{50}Co_{50}$ alloys has been clarified. $Mg_{50}Co_{50}$ alloys ball milled for various durations were found to present different hydrogen storage properties which could result from the phase and morphology difference in these samples.

Mg-Co-H system for hydrogen storage was first investigated by Reilly and Wiswall. Recently this system has been synthesized using ball milling method by Bobet et al. Ball milled Mg-Co alloys with body-centered cubic structure (BCC) may absorb hydrogen at 258 K with a hydrogen capacity around 3 mass%.

http://www.sciencedirect.com/science/article/pii/S0360319913008781

Hydrogen storage systems based on hydride–graphite composites: computer simulation and experimental validation

-Herbrig K, Röntzsch L, Pohlmann C, Weibgärber T, Kieback B. Int J Hydrogen Energy 2013;38(17):7026–7036.

The design of hydride-based hydrogen storage systems is nontrivial because numerous physical, chemical and engineering principles must be considered. In particular, gas and heat transport properties of the hydride bed are crucial for a high-dynamic tank operation. Since most hydrides show low intrinsic heat conductivities, auxiliary materials or structures inside the reaction zone are beneficial. For that purpose, hydride–graphite composites with strong anisotropic thermal conductivities have been developed recently.

In this paper, a comprehensive numerical model to simulate the dynamics of hydrogen storage tanks based on pelletized hydride–graphite composites is presented. Among other common characteristics, it includes anisotropic thermal conduction properties, convective heat transport as well as local shrinkage and swelling effects in the hydride bed. For experimental validation, a room temperature AB_2-type hydrogen storage alloy was used in the form of alloy-graphite pellets whose specific materials parameters were experimentally obtained and implemented into the computer simulation. In view of the thermodynamic properties of the AB_2-type alloy, a novel mathematical formalism was developed to describe realistic pressure-composition isotherms. The comparison of experimental and simulation results reveals a good agreement. Thus, the validated model allows predictive studies on tank design and operation scenarios.

http://www.sciencedirect.com/science/article/pii/S0360319913007441

INTERNATIONAL JOURNAL of HYDROGEN ENERGY *highlights of recent publications*

5 Years of hydrogen storage research in the U.S. DOE Metal Hydride Center of Excellence (MHCoE)

- Klebanoff LE, Keller JO. Int J Hydrogen Energy 2013;38(11):4533–4576.

The U.S. Department of Energy (DOE) Metal Hydride Center of Excellence (MHCoE) was established to conduct multi-disciplinary research to develop hydrogen storage materials for light-duty vehicles. The center addresses three broad areas within the field: mechanisms and modeling, materials development, and system design and materials engineering. These three areas cover every facet of hydrogen storage from theory to material synthesis and development for practical implementation. Highlights of MHCoE research is presented and details are provided from each of the "project" groups: destabilized hydrides; complex anionic materials; amide/imide materials; AlH_3 and $LiAlH_4$ regeneration; and engineering analysis and design. Developed materials are compared to the 2010 DOE hydrogen storage targets and future research recommendations are suggested based upon findings.

http://www.sciencedirect.com/science/article/pii/S0360319913001365

A comprehensive review on PEM water electolysis

- Carmo M, Fritz DL, Mergel J, Stolten D. Int J Hydrogen Energy 2013;38(12):4901–4934.

Polymer electrolyte membrane (PEM) water electrolysis provides a sustainable method for hydrogen production. This method is receiving more attention as a result of the growing interest in renewable and clean energy sources. The large power range of such sources demands comparably sized storage mechanisms, of which PEM electrolysis could fulfill. Carmo et al. introduces various water electrolysis techniques, then highlights the current state-of-the-art technology for PEM electrolysis as well as introduces meaningful research completed and future challenges. Every aspect of the cell is considered, from catalysts and membranes to current collectors and separator plates. The review provides a guideline for scientists to assist in the establishment of PEM electrolysis as a commercially viable hydrogen production source.

http://www.sciencedirect.com/science/article/pii/S0360319913002607

Call For *New Student Chapters*

The IAHE is continuing its call for the development of student chapters all over the world. To begin a chapter at your school a faculty leader and interested students are needed. In total, over 26 student chapters in 9 countries are officially recognized by the IAHE. The activities for the chapter members can include participation in the hydrogen design competition, research seminars for graduate students, job fairs, social activities, and various other related activities chosen by the students. To become a student member (registration is free), please register online at:

http://www.iahe.org/Studentmembership.asp

IAHE Affiliates:

The IAHE has organizational affiliate organizations worldwide. To see a complete listing, please go to: www.iahe.org

The IAHE also seeks to further develop and promote hydrogen-based organizations worldwide. For more information on collaboration opportunities, please contact Dr. Matthew Mench at mmench@utk.edu.

New Technology for Producing Hydrogen

Aingeru Remiro-Eguskiza
(Image courtesy of Basque Research)

The PhD thesis of Aingeru Remiro-Eguskiza, a chemical engineer of the University of the Basque Country (UPV/EHU), deals with the quest for a process to produce hydrogen from bio-oil that has a lower impact on the environment than current processes.

The gradual increase in the price of crude oil and the negative environmental consequences that its use entails are putting us on the threshold of a change in the energy model that will need to be tackled over the coming decades. Faced with the obvious necessity of finding an energy alternative that will replace fossil fuels in the near future at least partially and in a gradual way, hydrogen is emerging as one of the alternatives.

Currently, hydrogen is obtained through various methods that require separating the hydrogen from other chemical elements like carbon (in fossil fuels) and oxygen (from water). The methods used for this purpose are not viable from an environmental or economic perspective, respectively, as far as the large-scale production of hydrogen is concerned.

The aim of this thesis was to contribute towards the laboratory scale development of a process for producing hydrogen from bio-oil by means of catalytic reforming using water vapor. Bio-oil is a heterogeneous mixture of wood-based oxygenated products, the catalytic transformation of which routinely entails problems of operability and deactivation of the catalyst. This is because when it is being heated, a fraction of the compounds that make up the bio-oil form a solid residue (the so-called pyrolytic lignin) which collects on the inlet pipes of the reactor and in the reactor itself. The bio-oil used for the research in the thesis was developed at an IK4-Ikerlan plant.

An In-house Designed Reaction Unit

To solve the problems caused by the use of bio-oil, an in-house designed reaction unit was used, which comprises two stages: the thermal and the catalytic stages. In the thermal stage (in which the bio-oil is heated) the controlled deposition of the pyrolytic lignin takes place and this minimizes the operational problems and the deactivation of the catalyst. That way the compounds obtained in the thermal stage are more susceptible to being transformed.

In addition, a third stage has been incorporated into the process: the CO_2 capture intended to intensify the production of H_2 increases its purity and cuts the associated contaminating emissions. The process involves using an adsorber in the reaction bed, which is designed to capture the CO_2. "When the CO_2 is eliminated from the reaction bed, we are encouraging the displacement of the reaction equilibriums and, as a result, a greater yield and a greater output of hydrogen are obtained," explains Remiro.

In this context, he stresses that improvement in the CO_2 capture in the reaction bed was verified when extremely pure hydrogen, close to 100%, was obtained and at a lower operating temperature with respect to the process minus the CO_2 capture.

Source: http://www.sciencedaily.com/releases/2013/02/130213082336.htm

HYDROGEN *education*

GREAT LAKES FUEL CELL EDUCATION PARTNERSHIP

Stark State College in North Canton, Ohio, along with its academic and industrial partners, has created the Great Lakes Fuel Cell Education Partnership, dedicated to fuel cell technology education. The partnership is sponsored by the National Science Foundation and has a mission to provide leadership in creating innovative fuel cell-related education and training programs through curriculum development and enhancement; professional development; and partnerships with high schools, institutions of higher education, businesses and government entities. The purpose of this is to meet the future workforce needs of the fuel cell industry in the region, which includes, but not limited to, Ohio, Pennsylvania, New York, Michigan, Tennessee, and Indiana.

The goals of the Great Lakes Fuel Cell Education Partnership are to:

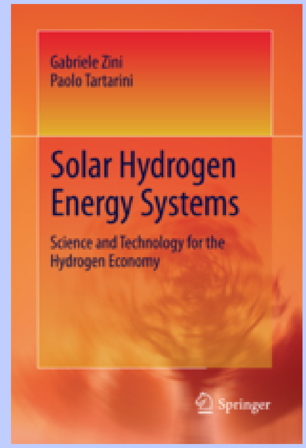
1. Aggregate and evaluate innovative solutions for advancing fuel cell education and training in collaboration with high schools and undergraduate education entities, top research universities, business and industry, government agencies and professional societies.
2. Research and define essential technical skills to advance workforce development in fuel cell-related technologies and promote the creation of additional jobs.
3. Serve as a clearinghouse to share proven curriculum materials and foster public understanding of fuel cell technologies, the hydrogen-related economy and the importance of developing alternative energy sources.

Ohio partners include the Ohio Department of Education, Hocking College and Kent State University. New York is represented by Rensselaer Polytechnic Institute and Hudson Valley; Michigan, by Kettering University; Indiana, by Oakland City University and Rose-Hulman Institute of Technology; Tennessee, by University of Tennessee, Knoxville and Pennsylvania, by Penn State University. Fuel Cell industry, business and government organizations include, but are not limited to, Plug Power Inc., General Motors and ENrG Inc. in New York; Lockhead Martin, TMI, LG Fuel Cell Systems (US) and Graftech in Ohio.

FROM *the bookshelf*

Solar Hydrogen Energy Systems

-by Gabriele Zini and Paolo Tartarini



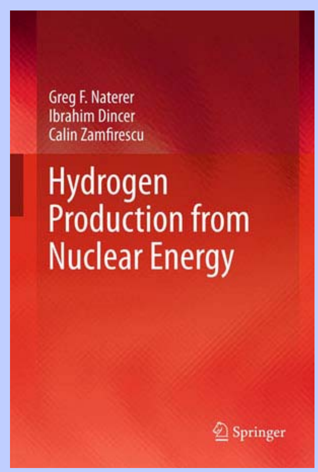
It is just a matter of time until fossil fuels will become unavailable or uneconomical to retrieve. On top of that, their environmental impact is already too severe. Renewable energy sources can be considered as the most important substitute to fossil energy, since they are inexhaustible and have a very low, if any, impact on the environment. Still, their unevenness and unpredictability are drawbacks that must be dealt with in order to guarantee a reliable and steady energy supply to the final user.

Hydrogen can be the answer to these problems. This book presents the readers with the modeling, functioning and implementation of solar hydrogen energy systems, which efficiently combine different technologies to convert, store and use renewable energy. Sources like solar photovoltaic or wind, technologies like electrolysis, fuel cells, traditional and advanced hydrogen storage are discussed and evaluated together with system management and output performance. Examples are also given to show how these systems are capable of providing energy independence from fossil fuels in real life settings.

http://www.springer.com/engineering/book/978-88-470-1997-3

Hydrogen Production from Nuclear Energy

-by Greg F. Naterer, Ibrahim Dincer, and Calin Zamfirescu



Hydrogen may be generated via several different mechanisms, the most common include chemical reformation and electrochemical electrolysis; however, an alternative is conversion using nuclear energy. The authors introduce the important role of hydrogen for clean energy and how nuclear energy may be utilized for large-scale hydrogen production. The combination of electricity and hydrogen production in a co-generation facility provides an appealing characteristic for future implementation. The latest technological developments and key features of nuclear-based production are discussed. Specific topics such as cycle and equipment design, modeling and implementation issues are addressed in detail. The book concludes with recent advancements and key aspects for this technology to integrate seamlessly with nuclear reactors to assist with clean energy generation.

http://www.springer.com/engineering/energy+technology/book/978-1-4471-4937-8

UPCOMING *meetings & activities*

July 2013

The Sixth International Exergy, Energy and Environment Symposium (IEEES-6)
July 1-4, 2013
Rize, Turkey
http://ieees6.rize.edu.tr

2013 Zing International Hydrogen & Fuel Cells Conference
July 12-15, 2013
Napa Valley, California
http://www.ZINGhydrogen.info

2013 ACEEE Summer Study on Energy Efficiency in Industry
July 22-26, 2013

August 2013

Biohydrogen Division Meeting (BioH_2 2013)
August 5-7 2013
Montreal, Canada
http://www.bioh2.org

September 2013

ICHS 2013: 5th International conference on hydrogen safety
September 9-11, 2013
Brussels, Belgium
http://www.ichs2013.com/

3rd Global Geothermal Energy Summit
September 11-12, 2013
Stuttgart, Germany
http://www.wplgroup.com/aci/conferences/eu-egt3.asp

WHTC 2013: The 5th World Hydrogen Technologies Convention
September 25-28, 2013
Shanghai, China
http://www.whtc2013.com/

October 2013

4th International Conference on Fuel Cell and Hydrogen Technology 2013
October 7-10, 2012
Yogyakarta, Indonesia
http://hpi-polimer.org/icfcht-2013

2013 Hydrogen & Fuel Cells Energy Summit
October 30-31, 2013
Berlin, Germany
http://www.wplgroup.com/aci/conferences/eu-ehfl.asp

224th Electrochemical Society (ECS) Meeting
October 27-Nov. 1, 2013
San Francisco, California
http://www.electrochem.org/meetings/biannual/224

November 2013

EVS27: The 27th World Electric Vehicle Symposium & Exhibition
November 17-20, 2013
Barcelona, Spain
http://www.evs27.org

8th International Renewable Energy Storage Conference and Exhibition (IRES 2013)
November 18-20, 2013
Berlin, Germany
http://www.energystorageconference.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 Matthew Mench at mmench@utk.edu.

Conference *spotlight*

WHTC2013: The 5th World Hydrogen Technologies Convention

Shanghai Everbright Convention & Exhibition Center
Shanghai, China
September 25-28, 2013
www.whtc2013.com

World Hydrogen Technologies Convention (WHTC) is a leading conference and exhibition in hydrogen, fuel cell and other related renewable energy technologies, under the auspices of the International Association for Hydrogen Energy (IAHE).

WHTC takes place every two years on a different Continent, which achieved success in Singapore in 2005, Italy in 2007, India in 2009 and Glasgow UK in 2011, will come to China in 2013, aiming to:

- Present high-profile presentations on up-to-date topics by selected international speakers from industry, academia and government.
- Demonstrate latest products, and services in hydrogen, fuel cell and related fields.
- Encourage networking among anticipated 1,500 global participants.

WHTC2013 was organized by China Association for Hydrogen Energy (CAHE), the only registered hydrogen energy academic committee in China with Mr. Shi, the former secretary general of Ministry of Science & Technology as the president and Prof. Mao from Tsinghua University as the chairmen. CAHE has succeeded in organizing a number of top international hydrogen related conferences such as the 13th World Hydrogen Energy Conference in 2000, International Hydrogen Energy Forum in 2004, International Hydrogen Energy Forum in 2008, and etc.

Organized by

Sponsored by

Shanghai Everbright Convention & Exhibition Center

GET CONNECTED—*internet groups of interest*

LinkedIn e-Connections

Fuel Cell & Hydrogen Network

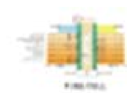
Bringing together professionals and enthusiasts alike, the Fuel Cell & Hydrogen Network serves to connect those advocating fuel cell and hydrogen technologies. The group welcomes people who are interested in all types of fuel cell technologies as well as the wide variety of hydrogen technologies, and 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 Technology

All those engaged in teaching, research, manufacturing and application of fuel cells are welcome to join the group.



Fuel Cells: Investment, Funding and Commercialization

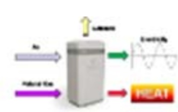
The group is to discuss the path of fuel cell technology towards commercialization. While technology will be discussed, there is a special focus on private investment, government funding and updates in international policy as relating to fuel cells.

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.

Hydrogen Fuel Cell (Micro-CHP)

This group is intended to educate and share knowledge associated with micro-CHP systems that generate distributed energy—heat and/or electricity. This group is intended to cover residential, commercial, and public applications.



GET CONNECTED—*internet groups of interest*

Facebook e-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. In 2009, the team also began Horizon Energy Systems, a separate company in Singapore which applies its ultra-light fuel cell technologies for customers in Aerospace & Defense

Fuel Cell and Hydrogen Energy Association

The trade association for the fuel cell and hydrogen energy industry. Dedicated to the commercialization of fuel cells and hydrogen energy technologies. Fuel cells and hydrogen energy technologies deliver clean, reliable power to leading-edge corporate, academic and public sector users, and FCHEA members are helping to transform our energy, economic, and environmental future.

Fuel Cell Nation

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

Get Connected with IAHE

Read any interesting articles about hydrogen you want to share? Would you like to advertise an upcoming event? Want to connect with other professionals in your field? Well, now you can! IAHE has joined Facebook and LinkedIn as a way to stay connected with its members and to provide important hydrogen-related information, news, and upcoming events. IAHE has a Facebook page and Facebook group, which are both great ways for individuals to post and share information and events. IAHE also started a group on LinkedIn as a way to connect with professionals and gain access to news, people, and jobs. If you want to get connected, we encourage you to join our groups.

Here's how to get connected:
Like IAHE on Facebook: https://www.facebook.com/#!/InternationalAssociationForHydrogenEnergy
Join the IAHE Facebook Group: https://www.facebook.com/#!/groups/453059908094778/
Join the IAHE LinkedIn Group: http://www.linkedin.com/groups?gid=4119716

Photo Gallery

Istanbul Technical University IAHE Student Chapter

Send us a photo. If you would like a photo of your student chapter or IAHE related event included in an upcoming issue of the IAHE newsletter, email the photo to Kathy Williams at williamk@utk.edu .

Newsletter Production

Published by IAHE through
The University of Tennessee
Mechanical, Aerospace, and Biomedical Engineering Department
233 Dougherty Engineering Building
Knoxville, TN 37996

Editor in Chief	Dr. Matthew M. Mench, Professor and Condra Chair of Excellence
Designer/Editor	Kathy Williams, IAHE Administrative Coordinator
Writers	Jason Clement and Yasser Ashraf Gandomi, Ph.D. Students

If you have any questions about the newsletter, email Matthew Mench at mmench@utk.edu.

"like" us on facebook

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.

Contacts and Information

Board of Directors

Officers of the IAHE

T. Nejat Veziroğlu
President, IAHE
Hussein K. Abdel-Aal
Vice President, Middle East & Africa
Juan Carlos Bolcich
Vice President, South America
Ibrahim Dincer
Vice President, Strategy
Stanislav R. Malyshenko
Vice President, Russia & CIS Countries
Zong Qiang Mao
Vice President, China & South East Asia
Matthew M. Mench
Executive Vice President
David S. Scott
Vice President, IAHE
Detlef Stolten
Vice President, Europe
Onkar N. Srivastava
Vice President, India & South Asia
Hirohisa Uchida
Vice President, Japan & Australasia
E. Caglan Kumbur
Secretary
Ayfer Veziroglu
Comptroller

IAHE Division Officers

Annalisa D'Orazio
President, Young Scientists Division
Patrick Hallenbeck
President, Biohydrogen Division
Greg Naterer
President, Nuclear Hydrogen Division

Board of Directors of the IAHE

Hussein K. Abdel-Aal
Frano Barbir
Juan Carlos Bolcich
Gibril S. Eljrushi
Inci Eroglu
Victor A. Goltsov
Lijun Jiang
Terry Kimmel
Stanislav R. Malyshenko
Zong Qiang Mao
Cesare Marchetti
Nazim Muradov
Byeong Soo Oh
Jacques Saint-Just
Yasukazu Saito
John W. Sheffield
Thornstein I. Sigfusson
Giuseppe Spazzafumo
O.N. Srivastava
Detlef Stolten
Hirohisa Uchida
William D. Van Vorst

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